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Analysis of healthcare professionals' acceptance of service innovations in the German telemonitoring market for diabetes

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DISCERE NE CESSA, CURA SAPIENTIA CRESCAT.
(*Disticha catonis 4,27*)

DON'T STOP LEARNING, KNOWLEDGE GROWS WITH ENGAGEMENT.

Abstract

La diabetes mellitus supone una importante carga financiera y organizativa para el sistema sanitario alemán. Una forma de *cibersalud* (o *e-health*) es la telemonitorización de los pacientes, que permite a los profesionales sanitarios controlar de forma remota las condiciones médicas y el estilo de vida que pueden respaldar un determinado diagnóstico y terapia. Para cubrir una monitorización 24/7, los centros de telemedicina pueden considerarse como proveedores de estos servicios. Así, estas infraestructuras de telemedicina interactiva pueden ser una respuesta a los desafíos que plantea tanto la hospitalización y las emergencias de estos pacientes, como la falta de especialistas y el aumento del número de diabéticos.

Pero incluso en Alemania, que es un país altamente industrializado, las estructuras digitales no están lo suficientemente avanzadas. Las implementaciones están afectadas por la tecnología en sí, por las políticas y la legislación correspondientes, por la financiación disponible, por el contexto organizacional y, no menos importante, por la aceptación de los usuarios potenciales.

La literatura científica se centra en la aceptación de la tecnología por parte del paciente, pero se ha profundizado poco en los factores de aceptación de los servicios de telemonitorización interactivos por parte de los iniciadores de la terapia: los especialistas en salud diabética, en Alemania.

Por lo tanto, esta investigación tiene como objetivo identificar, construir y evaluar los constructos de aceptación de tecnología adecuados dentro de un modelo, así como su operacionalización en un cuestionario. Este enfoque debería brindar una visión más completa de todos los posibles factores de contexto relevantes para comprender la Intención de Comportamiento (*Behavioral Intention*, BI) de los profesionales de la salud diabética en Alemania ante esas posibles soluciones. El modelo específico se ha construido sobre la base del Modelo de Aceptación de Tecnología (*TAM*) de Davis. Se ha realizado una revisión de la literatura y se han filtrado los factores ya identificados que influyen en la aceptación de un profesional de la salud para utilizar un programa de telemedicina.

Un reducido número de estudios se han centrado en el contexto alemán con participación de centros de telemedicina. Así, a los constructos de estudios previos que abarcan lo técnico, organizativo, social, jurídico e individual, se han sumado las variables "Relación con el paciente" y "Confianza en el centro de telemedicina" con el fin de incluir los aspectos de "interacción". Las variables relacionadas con el mercado se han adaptado a las características propias del sistema sanitario alemán. Con la ayuda de una encuesta online, el cuestionario se ha validado en una prueba preliminar con 40 profesionales sanitarios alemanes. Para el estudio de campo principal, se ha enviado una encuesta por correo a los diabetólogos y asesores en diabetes de todas las oficinas especializadas en diabetes de la Asociación de Seguros Médicos Obligatorios en la región Westfalia-Lippe, en Alemania, obteniéndose un total de 57 observaciones.

Con la ayuda de Smart PLS se ha aplicado el modelado de ecuaciones estructurales para comprobar la validez y las relaciones causales entre las variables. Los análisis estadísticos han confirmado que el constructo *Facilidad de Uso Percibida* influye en el constructo *Utilidad Percibida*, y han mostrado posteriormente la relación de la *Utilidad Percibida* con la *Intención de Comportamiento*.

Se ha comprobado también el efecto de la *Compatibilidad con el Estilo de Trabajo* y la *Importancia de la Seguridad de los Datos* sobre la *Intención de Comportamiento*. Los proveedores de tales servicios tecnológicos deben enfocarse, por lo tanto, en la capacitación y en una comunicación detallada de las opciones y beneficios de las implementaciones.

Se ha demostrado que el Modelo de Aceptación del Servicio de Telemonitorización Interactivo diseñado explica la Intención de Comportamiento de los futuros profesionales de la salud diabética con respecto a esta telemedicina interactiva.

Palabras clave: Aceptación de tecnología, telemedicina interactiva, diabetólogos, Alemania

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LIST OF ABBREVIATIONS

_i	Inverse
AF	Affect
AOK	Allgemeine Ortskrankenkasse (German insurance)
AP	Accessibility of patients
AR	Accessibility of medical records
ATT	Attitude
b	Bootstrapping
B2B	Business to business
BDSG	Bundesdatenschutzgesetz/ Federal Data Protection Act
BfArM	Federal Office for Drugs and Medical Devices
BI	Behavioural intention
BMWi	Bundesministerium für Wirtschaft/ federal ministry of economics
C	Clinical patient factors
Cf.	Confer (Latin), compare to
Comp	Compatibility
DAK	Deutsche Angestellten-Krankenkasse (German insurance)
DDG	Deutsche Diabetes Gesellschaft (German Diabetes Association)
DDZ	Deutsches Diabetes Zentrum (German Diabetes Centre)
DiGAV	Digitale-Gesundheitsanwendungen-Verordnung (Digital Health Applications Ordinance)
DITG	Deutsches Institut für Telemedizin und Gesundheitsförderung (German Institute for Telemedicine and Health)
DMP	Disease Management Programme
DSGVO	Europäische Union Datenschutzgrundverordnung (European Union data protection regulation)
DSP	Diabetologische Schwerpunktpraxis (diabetes medical office)
DUT	Digitalisierungs- und Technologiereport Diabetes (Digitalisation and technology report diabetes)
DVG	Digital-Versorgungs-Gesetz (Digital Supply Act)
e	Measurement error of i
e.g.	For example
EBM	Einheitlicher Bewertungsmaßstab (directory)
EE	Effort expectancy
E-health	Electronic health
EHS	Electronic health service
et al.	Et alii (Latin), and others

etc.	Et cetera (Latin) and other things
EU	European Union
ex	Excluded
f.	Following page
FAC	Facilitating conditions
ff.	Following pages
FIN	Financing, Reinforcement factor, perceived, loyalty incentives
GDPR	General Data Protection Regulation
GKV	Gesetzliche Krankenversicherung (Public Health Insurance)
GMG	Gesundheitsmodernisierungsgesetz
H	Hypothesis
HAB	Habit
HCP	Healthcare professional
HTMT	Heterotrait-monotrait ratio
i	Indicator variable/items, parameter i
I_i	Standardised loadings of i of a specific construct
ICT	Information and communication technology
IMPL	Implementation status
inav	Institut für angewandte Versorgungsforschung (Institute for Applied Health Service Research)
IOD	Importance of data security
IQ	Improved Quality
IT	Information technology
j	Parameter j
JF	Job fit
Kadis	Karlsburger Diabetes Management System
KE	Knowledge about e-Health
KV	Kassenärztliche Vereinigung (Association of Statutory Health Insurance)
KVNO	Kassenärztliche Versorgung Nordrhein (Association of Statutory Health Insurance North Rhine
KVWL	Kassenärztliche Vereinigung Westphalia-Lippe (Association of Statutory Health Insurance Westphalia-Lippe)
LICT	Level of ICT use/ICT user profile
M	Number of indicators (i = 1,…, M)
MPG	Medizinproduktegesetz (German medical device law)
n	Quantity/minimum required sample size for a finite population
N	Number of elements in the population
n. pag.	No page

NA	Not available
NC	Non-clinical patient factors
O	Original Sample
OECD	Organization for Economic Cooperation and Development
OPT	Optimism
p	Percentage share of the population
p.	Page
PC	Perceived consequences
PE	Performance expectancy/expectation confirmation
PEOU	Perceived ease of use
PEST	Private Krankenversicherung (private health insurance)
PID	Perceived importance of documentation
PII	Personal innovativeness in IT/propensity to innovate
PIU	Perceived importance of IT utilisation
PLS	Partial least squares
PKV	Political, economic, social, technological
PO	Process orientation
pp.	Pages
PSA	Perceived service availability
PU	Perceived usefulness
q	1 – p
R	Rejected
R^2	explanatory variance for the endogenous variables in the path model
RC	Reduced costs
REL	Relationship to patient
RTS	real-time telemetry system
S	Supported
s	Standard deviation of path coefficient $\bar{y}ij$
s_i^2	variance of indicator variable i
s_t^2	Total variance of all M of a construct
SE	Self-efficacy
SEI	Self-identity
SEM	Sequential equation modelling
STAN	Importance of standardisation
T2DM	Type 2 diabetes mellitus
T3DM	Type 3 diabetes mellitus
TAM	Technology acceptance model
TI	Telematics infrastructure

TK	Techniker Krankenkasse (German insurance)
TPB	Theory of planned behaviour
TRA	Theory of reasoned action
TRU	Trust in telemedicine centre
TSS	Telemonitoring service systems
TTF	Task-technology fit model
US	Usage
UTAUT	Unified Theory of acceptance and use of technology
VDBD	Verband der Diabetes-Beratungs- und Schulungsberufe in Deutschland e.V. (Association of diabetes advisory and training profession in Germany)
VAT	Value added tax
VIF	Variance inflation factor
WHO	World Health Organization
x	Indicator of a exogenous variable
y	Indicator of a endogenous variable
z	Quantile of the standard normal distribution

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LIST OF SYMBOLS

α	Creek small letter Alpha Here: Cronbach's Alpha
ε	Greek small letter Epsilon Here: targeted error
$\sum$	Sum
ў	Cyrillic capital letter u Here: average of path coefficient
ξ	Greek letter Xi Latent exogenous variable explained in the model
η	Greek letter Eta Latent endogenous variable explained in the model
γ	Greek letter Gamma Hypothesis between an exogenous and endogenous variable
β	Greek letter Beta Hypothesis between exogenous variables
ζ	Greek letter Zeta Error of variable
λ	Greek letter Lambda Connections between the latent variables and the indicators

ε	Greek letter Epsilon Indicator error for endogenous variables
δ	Greek letter Delta Indicator error for exogenous variables

1 INTRODUCTION

Healthcare systems are currently facing several challenges and are looking into the future: there is an ageing population with multimorbidities while there are shortages of healthcare professionals (HCPs). In addition, there is an increasing burden of diseases caused by unhealthy lifestyle factors such as nutrition and smoking as well as neurodegenerative diseases and illnesses due to antibiotic resistance. Thus, public healthcare spending is increasing.[1] These societal developments make telemedicine – healthcare service offered at a distance via information and communication technology (ICT)[2] – a possibly important future solution in healthcare. In particular, in 2020 due to the Covid-19 pandemic, the urgency for telemedicine has increased. This modality allows getting in contact with patients while minimizing face-to-face appointments, an effort that provides virus transfer control.[3] Implementing telemonitoring for the increasing number of chronically sick people in rural areas care can be a solution for the lack of medical specialists in pastoral areas and the ageing population. Due to increasing chronic diseases, health innovations in technology have become increasingly important.[4] Several studies have discussed the effectiveness of telemedicine, albeit controversially.[5] However, the potentials of improving the clinical outcomes and thus the quality of life of patients can be clearly seen.[6] One key solution of telemedicine is telemonitoring, defined as a patient control by a HCP (such as a treating physician) and a telemedicine centre. Parameters that are relevant for the treatment are measured

[1] Cf. European Commission (2018b), p. 1

[2] https://www.dgtelemed.de/de/telemedizin/glossar/; Kommission der europäischen Gemeinschaften (2008), n. pag., World Health Organization (2010)

[3] Cf. Boehm et al. (2020); Driggin et al. (2020); Hagge et al. (2020)

[4] Cf. Kommission der europäischen Gemeinschaften (2008), p. 4.

[5] Cf. Li et al. (2020); Zhu et al. (2020)

[6] Cf. Bundesministerium für Wirtschaft und Energie (BMWi), n. pag. https://www.charite.de/service/pressemitteilung/artikel/detail/fontane_studie_telemedizin_rettet_leben_von_herzpatienten/; Wu et al. (2018); Zhu et al. (2020)

constantly on the patient's end and transferred to a healthcare institution for documentation and analysis to diagnose, treat, alarm and prevent.[7]

Diabetes is an especially insidious chronic disease that greatly burdens healthcare systems. As of 2017, 32.7 million adults in the European Union (EU) have been diagnosed with diabetes, and there are an estimated 12.8 million additional undiagnosed patients.[8] In the EU, diabetes stands out because it is at the top of the most avoidable hospital admission reasons; hence, the costs for this condition are high.[9] Indeed, diabetes accounted for EUR 150 billion in healthcare expenditures in the EU in 2017. Diabetes is largely preventable especially by the control of nutrition and physical activity.[10] Next to cardiovascular diseases and chronic pulmonary diseases, diabetes is a potential focus of telemedicine care.[11]

Healthcare spending in terms of gross fixed capital and medications in Germany is the highest in Europe. In addition there is a high mortality due to behavioural lifestyle-influenced risks and a shortage of healthcare specialists.[12] On the one hand, the country is an industrialised and innovative nation but is still lagging behind in terms of digitalisation and thereby also e-health, with differences between East and West Germany and between pastoral and urban areas.[13] In terms of telemedicine there are a myriad of barriers that hinder full integration in the German healthcare system, not least because of the complexity of the extensive and specialised healthcare sector. There are unacknowledged issues regarding legislation[14] in terms of financing of the different services in telemedicine, information technology (IT) security as well as data and access transparency; the enhancement of medical guidelines in digital aspects; responsibilities in innovation development; and legal responsibilities of HCPs.[15] Next to the missing nationwide telemedicine infrastructure, the current implementation of telemedicine in Germany has shown

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[7] https://www.dgtelemed.de/de/telemedizin/glossar/; Kommission der europäischen Gemeinschaften (2008), p. 4 ff.; WHO (2010)

[8] Cf. OECD (2018), p. 106

[9] Cf. OECD (2018), p. 48

[10] Cf. OECD (2018), p. 106

[11] Cf. European Comission (2018a), p. 11

[12] Cf. European Commission (2018b), p. 1

[13] Cf. OECD/EU (2018), p. 132.; BMWi (2018), p. 30 ff.

[14] Cf. Bundesministerium (2020a); Bundesministerium (2020b); DVG (2019); E-Health-Gesetz (2015)

[15] Cf. Bundesärztekammer (2019), p. 2 ff.

isolated single solutions limited by region, time and financial support by insurance sources and industries.[16] Hence, telemonitoring in the German healthcare market is still in its infancy.[17] Most telemonitoring services are in a project stage and do not have a clear prospect of when they will be implemented in the healthcare system in a comprehensive way.[18]

The mentioned issues and critiques come strongly from the side of physicians and corresponding associations.[19] Thus, the acceptance of treating HCPs is a main driver for the implementation of telehealth.

1.1 PROBLEM DEFINITIONS

The implementation of technology system services is complex. In addition to the technological aspects of an implementation, there are market-related influences and sociological considerations. The determinants, which influence the integration of technology, can be classified into five major categories: (1) technology, (2) policy and legislation, (3) financing, (4) organisation and (5) acceptance.[20] All named aspects can hinder or drive the acceptance of possible users. The adoption of an **innovation** is influenced by many internal and external factors.

Slow progress has also been seen in the comprehensive expansion of telemedicine implementation in the German healthcare environment. Among systems and services maintained by medical institutions, solutions with **integration of telemedicine centres** are conceivable.[21] The interaction and service of such telemedicine structures, combined with the technology, can be seen as innovative and implies a change in the way HCPs work.

In that respect, the HCP giving treatment is the initiator of the treatment and is the person who is primarily responsible for medical care. Physicians and HCPs who actively guide the therapy are some of the principal users. Thus, it is critical

[16] Cf. Müller et al. (2013), p. 181 ff.
[17] Cf. Verfürth (2020), n. pag.
[18] Cf. Kommission der europäischen Gemeinschaften (2008), p. 4
[19] Cf. Beritbach et al. (2016), p. 14 ff.; DDG (2019), n. pag.;
[20] Cf. Broens et al. (2007), p. 303
[21] Cf. Müller et al. (2013), p. 193

to analyse the attitude of treating HCPs as a gatekeeper to the telehealth system.[22] In this working scheme, the **HCPs' acceptance** is an essential factor for a successful programme implementation.[23] Many studies have examined patient acceptance,[24] which seems insufficient on its own in this system interaction because **little is known about HCPs' acceptance.** This paucity of data is amplified in specific environments of **interactive telemedicine service**, especially in **diabetic ambulatory settings**. Due to branch specifics of healthcare in every country, the specialities of the German system need to be considered. Telemedicine programme providers must consider the needs of all users to develop a user-accepted solution and ensure successful innovation diffusion.[25]

1.2 OBJECTIVES

The structure of an interactive telemedicine centre and patient involvement are the focus of this research study, which concentrates on diabetes telemonitoring in Germany. The starting point is a potential telemonitoring service system (TSS). This system only works with remote patients relative to physicians and HCPs in telemedicine centre interactions. In this context, interactivity means communication with the system by the patient him- or herself, the physician or therapist giving treatment as well as a HCP of a telemedicine centre as the provider of the service.[26]

The aim of the current study is to analyse and understand the determinants of acceptance of treating HCPs using this interactive telemonitoring system for diabetic patients in Germany. The study should **identify main factors** that support or hinder the acceptance of diabetes telemedicine service systems by German resident physicians. The element of acceptance from the perspective of a HCP should be investigated and made measurable. A review of the German ambulatory diabetes market as well as technology acceptance research is needed to identify the relevant factors for acceptance and necessary adaptions that must be considered. Therefore, a theoretical **acceptance model** for measuring the level of influence of

[22] Cf. Brewster et al. (2013), p. 21 ff.; Verfürth (2020), n. pag.
[23] Cf. Yarbrough et al. (2007), p. 650 ff.
[24] Cf. Harst et al. (2019), ePub
[25] Cf. Arnold et al. (2016), p. 6, Verfürth (2020), n. pag.
[26] Cf. Verfürth (2020), n. pag.

several factors will be developed. Based on the findings, this thesis will recommend instruments that service system providers should use to implement a service innovation for diabetes telemonitoring service that is successfully accepted by physicians and diabetes advisors. Undesirable development and thus negative economic outcomes should be avoided. Systems should be adapted to the user's needs.[27]

The research questions are:

1. ***Which consulted determinants strongly influence the acceptance of telemonitoring systems by German resident diabetes physicians and HCPs with regular patient and therapy contact outside the telemedicine centre?***
2. ***Which instruments could a provider use to implement these systems successfully (in terms of a high usage rate)?***

1.3 STRUCTURE AND METHODOLOGY

The theoretical fundament for this thesis is examining service management, with a focus on service provision processes, technology-based services and user interactions. The theoretical basis also includes innovation research, with a concentration on the individual decision process of innovations and adoption types. This thesis also provides a comprehensive view on acceptance theory. Beginning with the placement of classification and development of individual acceptance, the chronological achievements in technology acceptance modelling are analysed. With the insights into technology acceptance modelling in healthcare, the thesis bridges into market analysis of the German ambulatory diabetes settings with a specific view on the status of telemedicine in that field. Having those contexts in mind, the model for this research is built step by step. A literature review is conducted to gather already identified factors that influence HCPs in telemedicine based on technology acceptance models (TAMs). These factors are critically reviewed and adapted to develop a structure model that also fits the environmental needs of HCPs in German diabetes care. A measurement model is built and opera-

[27] Cf. Helmreich (1980), p. 21 f.

tionalised. A pretest is subsequently carried out to test the constructs and their internal consistency. Based on the pretest conclusions, the main field survey is performed within a sample of German diabetes specialists. Using a causal analysis with the help of structural equation modelling (SEM), the datasets are analysed. Reliability and validity analysis are conducted to prove the constructs and relationships, followed by analysis to identify significant connections between factors. Hypotheses are answered. The statistical analysis concludes with an evaluation of the prognosis effect of the collected data in the proposed model. With a critical view on limitations, a conclusion is made and recommendations for TSS providers in future are given. Illustration 1 shows the content flow of this thesis.

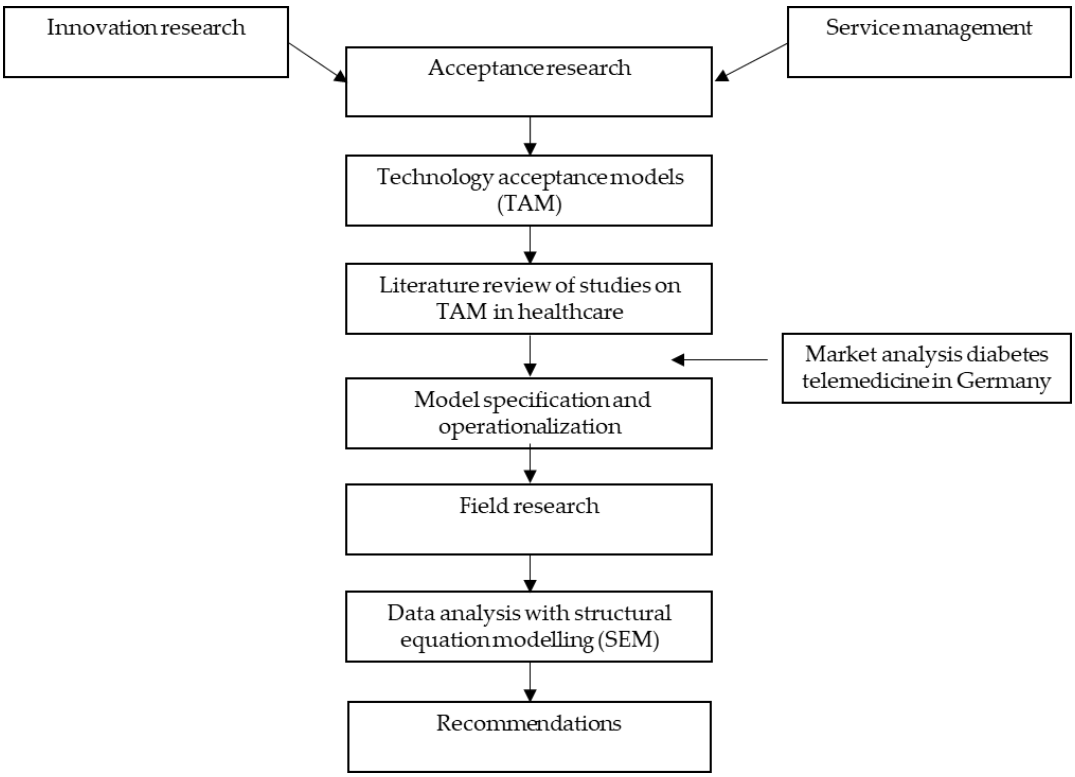

Illustration 1: Structure of the work (the author's illustration)

2 INNOVATION PROCESSES OF SERVICES

2.1 DEFINITION OF SERVICES

Since the 1980s, researches have tried to find a general definition of services, but some factors are difficult to generalise. Products and services cannot be divided clearly, because often there is a combination. To understand the term service, the identification of its characteristics may help.

All researches name **immateriality** and the **integration of an external factor** as characteristics of services.[28] Immateriality closely relates to **intangibility**: a service itself cannot be seen, heard, felt, smelt or tasted. The term (in-)visibility is most important. These services are evaluated as riskier because often the performance itself cannot be adequately evaluated. However, most services include a material component.[29] The **integration of an external factor** is also called customer integration; it describes the customer as a co-producer or prosumer (producer and consumer). This means that production or sales only can happen if the demander or a belonging object is involved in the process.[30]

The *uno actu* principle is often also mentioned as another characteristic. This principle states that the creation or production and consumption of a service happen at the same time. There have also been other opinions in the literature.[31] Some researchers have derived this aspect because of the integration of an external factor,[32] while others have concluded the principle from the immateriality.[33] Frietzsche only described a simultaneous happening at specific services and recommended discussing 'transmission', because sales and consumption of many services happen before or after the production.[34] Although a service creation is transmitted simultaneously, the benefits last longer. A medical service is an example.[35]

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[28] Cf. Haller (2015), p. 7
[29] Cf. Haller (2015), p. 8
[30] Cf. Haller (2015), p. 8 f.; Engelhardt (1990), p. 280
[31] Cf. Corsten et al. (2015), p. 45; Meyer et al. (1987), p.187 ff.; Haller (2015), p. 9 f.
[32] Cf. Corsten et al. (2015), p. 15 ff.; Frietzsche (2001), p. 3 ff.
[33] Cf. Meffert et al. (2009), p. 18
[34] Cf. Frietzsche (2013), p. 3 ff.
[35] Cf. Haller (2015), p. 10

Due to this principle, services are indivisible and immobile due to missing transportation opportunities. A further problem of a service is its **missing storage suitability**. This factor can inhibit production, and capacities must be planned. Electronic or written performances can be saved on carrier media, so they are an exception. The production is a service, but the performance at the end is a product.[36]

Another speciality of services is that at no time is a product transferred from the provider to the demander. This also means that no property is transmitted to the customer. When purchasing a service, the customer gets access to an asset for a fixed period.[37] This phenomenon puts human expertise or performance as well as technology or physical goods in concrete terms.[38]

The following characteristics of a service are also important:[39]

- The search characteristics are all attributes that can be evaluated before a service is consumed, e.g. the features or look of an end product.
- The experience characteristics are developed by the consumer while the service is happening.
- The trust characteristics cannot be evaluated before, during or after the usage of the service, e.g. consultancy services
- Due to the integration of an external factor, the service also depends on the cooperation of the user. A standardised process is difficult when considering individual preferences of the customer. This factor also leads to the process of service, which is often not predictable when customers are making mistakes or customers are not acting as expected.

These aspects highlight several challenges in service management.[40]

[36] Cf. Haller (2015), p. 10
[37] Cf. Fitzsimmons et al. (2011), p. 4
[38] Cf. Haller (2015), p. 10
[39] Cf. Haller (2015), p. 14 f.
[40] Cf. Haller (2015), p. 23 ff.; Hope et al. (1997), p. 24 ff.

2.1.1 Phases of service processes

Services can be divided into ideal-typical phases, which is presented in Illustration 2.[41]

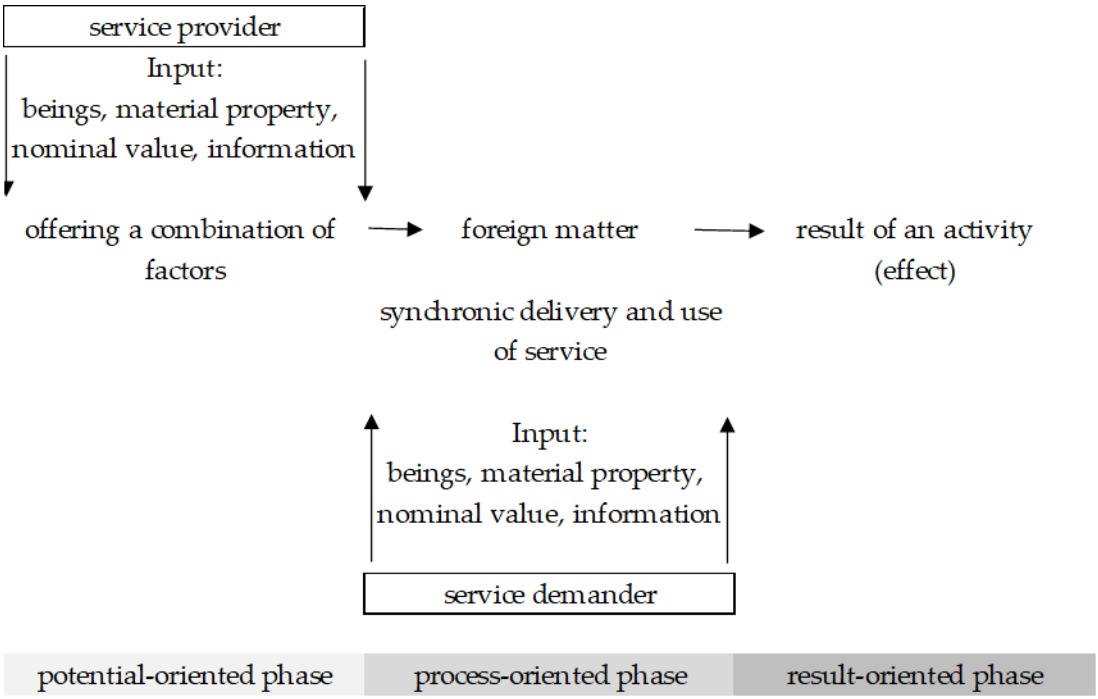

Illustration 2: Phases of service orientation[42]

In the first phase of potential orientation, the provider offers his or her ability to perform a service.[43] The supply or performance of a service depends on physical and mental abilities. That factor combined with the willingness of the provider allows the service potential to develop.[44] In the second phase, the demander appears, and he or she may bring an object. At this point the process orientation starts.[45] In this phase, the customer can influence the properties of the service. The intensity

[41] Cf. Donabedian (1980), S. 85 ff.; Haller (2015), p. 11 f.
[42] Author's illustration based on: Cf. Haller (2015), p. 11 f.; Hilke (1989), p. 15.
[43] Cf. Corsten et al. (2015), p. 17 ff.
[44] Cf. Haller (2015), p. 11 ff.
[45] Cf. Fließ (2009), p. 12

of influence depends on the degree of **individualisation** in the context of the provider's concept. If the customer only has the choice between several options, the service is standardised; otherwise, it is individualised. After the service is specified, the process of realisation starts; the degree of integration for each customer is different.[46] After this stage, the phase of result orientation starts; the customers gets an outcome and can use it.[47] The result can consist of material or immaterial components. The result is also distinguished with regard to processual and a follow-up output. The follow-up results only appear after a time period.[48]

2.1.2 Technology-based services

Nowadays many services are influenced, supplemented or based on technology. The integration of technology within a service **changes the interaction between the provider and the customer.** In general, there are five types of technology characteristics in service processes, divided into face-to-face and face-to-screen contact.[49]

Face-to-face contact:

a. Service without any technology and direct contact between provider and customer;
b. Only the provider is supported by technology to give the service; or
c. Both provider and customer have access to technology and use it.

Face-to-screen contact:

d. Provider and customers are only connected via technology; or
e. Customer is only in contact with a technology of the provider.

Electronic services describe activities that are handled immaterially or interactively via the Internet.[50] The provider is electronic in nature, and thus there is potential orientation and the integration of an external factor of electronic data transfer, which determined the process dimension and provides a valuable effect

[46] Cf. Haller (2015), p. 12 f.
[47] Cf. Fließ (2009), p. 12
[48] Cf. Haller (2015), p. 13
[49] Cf. Froehle et al. (2004), p. 2 ff.; Haller (2015), p. 20 ff.
[50] Cf. Van de Kar (2008), p. 4

to the customer (result orientation).[51] Bruhn (2002) defines e-services as independent services administered via electronic performance of a provider (the dimension of potential) and by integration of an external factor with the help of electronic data transfer (the process dimension) to an external demander who receives a beneficial outcome (the dimension of results).[52] E-services can be used everywhere and at any time.[53]

In terms of face-to-screen contact were users are connected only via a technology, there is an **interaction platform**. Ihlenburg (2012) defined an interaction platform as a restricted virtual, web-based room that offers all participants different services to exchange targeted and suitable information for location- and time-independent communication.[54]

2.2 DEFINITION AND CLASSIFICATION OF INNOVATION

There have been several definitions of innovation in the literature. It is essential to look at the various definitions to get an understanding of the term innovation.

Müller-Prothmann and Dörr (2014) described innovation with the formula: idea + invention + diffusion. Innovations result from ideas and new knowledge, which are realised (invention) and actually applied to the market.[55] Other authors have built a similar formula: invention + commercialisation. The indicated new knowledge relates to technology or to the market.[56] Rogers (2003, p. 181) defined invention as 'the process by which a new idea is discovered or created'.[57] Rogers (2003, p. 12) stated that an 'innovation is an idea, practice, or object that is perceived as new by an individual or other unit of adoption. (…) If the idea seems new to the individual, it is an innovation. (…) "Newness" of an innovation may be expressed in terms of knowledge, persuasion, or a decision to adopt'.[58] That means that an

[51] Cf. Bruhn et al. (2018), p. 13 ff.
[52] Cf. Bruhn et al. (2002), p. 6
[53] Cf. Bouwman et al. (2008), p. 9 ff.
[54] Cf. Ihlenburg (2012), p. 11, Verfürth (2020), n. pag.
[55] Cf. Müller-Prothmann et al. (2014), p. 7
[56] Cf. Afuah (2003), p. 13 f.; Roberts (1988), p. 11 ff.
[57] Rogers (2003), p. 181
[58] Rogers (2003), p. 12

idea is not defined as an innovation at the time discovery or when it enters the market; instead, it is considered an innovation due to the perception of an individual. Even if an individual knows about an innovation, the newness of an innovation also includes the evaluation of the idea.[59] In summary, an innovation is a realised idea that is accessible to market participants and perceived as new to them.

2.2.1 Characteristics of innovations

There are variables that can influence the adoption of an innovation due to the perception of an individual. Rogers (2003) named the speed of adoption of individuals in a social system the **rate of adoption**.

Characteristics called perceived attributes of innovations contain r**elative advantage, compatibility, complexity, trialability** as well as **observability**; they are product-related variables of the rate of adoption.[60] Perceived characteristics need to measured regularly, because these attributes can change when the rate of adoption develops.[61] 'Relative Advantage is the degree to which an innovation is perceived as being better that the idea it supersedes'.[62] This characteristic is described as a ratio of the benefits and costs that an individual expects when adopting the innovation. The reasons for a high relative advantage are profitability, low initial costs, social status change and reputation, saving time, ease of handling or direct incentives. An individual can also adopt an innovation because of a decrease of the probability of an unwanted future event or a consequence; this is called **preventive innovation**.[63] 'The relative advantage of an innovation perceived by members of a social system is positively related to its rate of adoption'.[64]

Compatibility can be defined as the degree to which an innovation matches with experiences and values.[65]

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[59] Cf. Rogers (2003), p. 12
[60] Cf. Rogers (2003), p. 219 ff.
[61] Cf. Rogers (2003) p. 230
[62] Rogers (2003), p. 229
[63] Cf. Rogers (2003), p. 233
[64] Rogers (2003), p. 233
[65] Cf. Rogers (2003), p. 240 f.

Complexity as a factor describes the ease of learning about and using an innovation. The easier an innovation is understood, the more it will be used and integrated in a user's habit.[66]

Trialability is another determinant that influences the adoption of an innovation: this attribute describes the possibility that potential users will test the innovation before the launch. [67]

Observability can also be an influencing factor because observable benefits can promote the understanding of an innovation and accelerate the adoption.[68]

The above-mentioned *attributes have been intensively investigated; Rogers stated that the named variables explain half of the variance of the innovation adoption rate.*[69] Rogers also added that the type of innovation decision determines the adoption rate. There are three types of innovation decisions; they differ depending on whether the decision is made voluntarily and who is making it. For optional innovation, the decision is made by an individual indepentently and different from others. Collective decisions are made with participants collectively. Authority innovation decisions happen when the decision is done for an entire social system through a power decision.[70]

Communication channels can affect the innovation's rate of adoption (Illustration 3). Furthermore, the social system with its norms and the interconnections of the networks might influence the adoption. Finally, the extent of change agents' promotion efforts also effects this factor.[71]

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[66] Cf. Rogers (2003), p. 257 f.
[67] Cf. Rogers (2003), p. 258
[68] Cf. Rogers (2003), p. 258
[69] Cf. Rogers (2003), p. 222
[70] Rogers (2003), p. 221
[71] Cf. Rogers (2003), p. 222

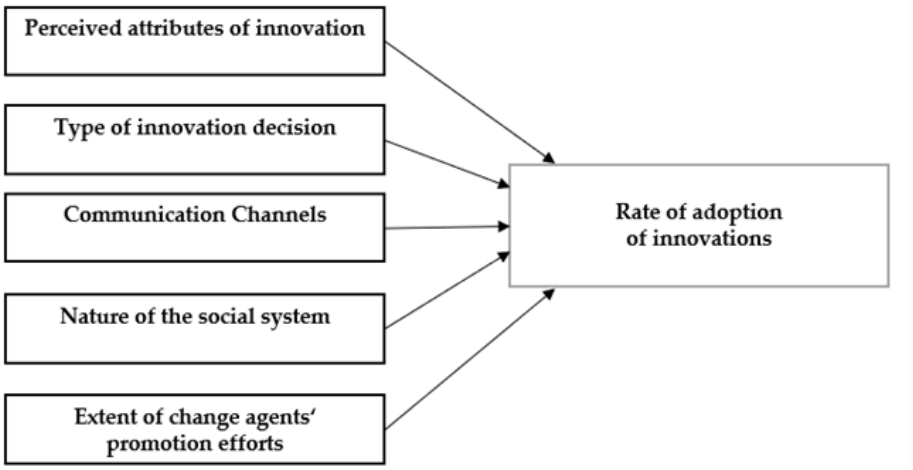

Illustration 3: Influences of rate of adoption[72]

2.2.2 Types of innovation

Innovations in relation to products, processes and organisations can be differentiated. Process and organisational innovations should improve internal processes and procedures in organisations. Innovations are often connected with technologies, which are defined as competencies, knowledge, procedures, processes, experiences, research, aids, machines and equipment that are used to design, produce or distribute products and services. Technology is rapidly developing. Thus, technology innovation can also be differentiated into radical and incremental changes, which describe the type of novelty of an innovation. A radical technological change describes the revolution of a fundamental change of the technology, which influences the output product or its production process. Incremental changes include no new findings and describe an improvement of a basic technology.[73]

[72] Cf. Rogers (2003), p. 221 ff.
[73] Cf. Jones et al. (2008), p. 793 ff.

2.3 DIFFUSION THEORY

Diffusion is the process of communication of an innovation to the members of a social system via different channels over time.[74] For this study, it is necessary to analyse the innovation diffusion on **macro and micro levels.** The thesis concentrates on the diffusion process of an individual on the micro level by the innovation decision process. The classification of adopters is considered for the macro level of diffusion.[75]

It is important is to introduce the term innovativeness, which describes 'the degree to which an individual or other unit of adoption is relatively earlier in adopting new ideas than other members of a system'. Rogers (2003) explained that innovativeness helps understand the decision process behaviour. [76]

2.3.1 Innovation decision process

Illustration 4 shows a model of the Innovation decision process (named by Rogers). This figure provides a structured overview of the relationship of the development of the individual innovation process. This service is a fundament to the following sections. The model consists of five stages. An individual or a unit with a decision responsibility seeks and processes information to reduce uncertainty about an innovation.[77]

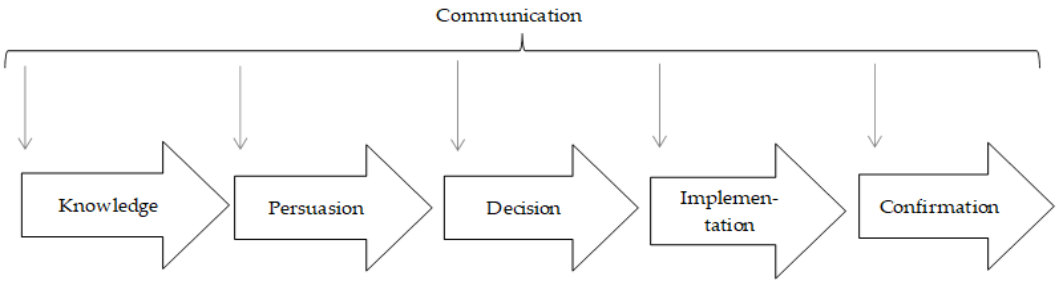

Illustration 4: An innovation decision process[78]

[74] Cf. Rogers (2003), p. 221 f.
[75] Cf. Karnowski (2011), p. 13
[76] Cf. Rogers (2003), p. 22
[77] Cf. Rogers (2003) p. 171 ff.
[78] Author's representation based on: Rogers (2003), p. 170

There is no systematic review of these different phases in literature, but several studies have supported this concept.[79] Of note, every point in this process can influence a rejection.[80]

The process starts with the knowledge stage. At this time, an individual or a unit with decision responsibility becomes aware of an existing innovation. There are different opinions in the literature as to whether an individual acts passively or actively regarding exposure to an innovation. On the one hand, it is reasoned that an individual notes an innovation by chance, because an individual can only search for an innovation when the existence is known. This is called awareness knowledge.[81] Other researchers have argued that every individual has different predispositions that affect his or her behaviour of consciously discerning messages of an innovation. These predispositions – the tendency of individuals to communicate in ways that match their interests and attitudes – are called selective exposures. **Selective perception** is when the individual judges the messages as relevant and they fit his or her beliefs.[82]

Rogers (2003) also stated that awareness knowledge follows a need for an innovation. The need can lead to an innovation and innovation can build needs. Thus, there is no clear answer if awareness knowledge creates a need or if a need comes first.[83] Awareness knowledge encourages an individual to search for further information to achieve a higher knowledge. After awareness knowledge, the individual reaches the how-to knowledge stage, when he or she has information about how to use an innovation correctly. The more complex the innovation is, the more information is needed to understand. The bigger the lack of information before testing the innovation, the higher is the risk of rejection. If an individual has information of innovation handling regarding the principle functions and knows how the innovation works, the individual has **principle knowledge**. It is crucial to build upon this level of knowledge to bring the individual to a higher knowledge stage to increase its usage and adoption.[84]

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[79] Cf. Beal et al. (1957), p. 166 ff.; Coleman et al. (1966); Karnowski (2014) p. 13

[80] Cf. Rogers (2003), p. 177

[81] Cf. Coleman et al. (1966); Rogers (2003), p. 171 f.

[82] Cf. Hassinger (1959), p. 52 f.; Rogers (2003), p. 171 f.

[83] Cf. Rogers (2003), p. 172 f.

[84] Cf. Rogers (2003), p. 173 f.

The attitude and belief about an innovation strongly influence the process of the innovation decision stages. The innovation must be realised as relevant by the individual, and the individual has to be sufficiently informed to reach the second stage: persuasion.[85] For persuasion, the individual or a unit with decision responsibility builds up an attitude towards the innovation. In this stage, the thinking changes from knowing to feeling. The individual interprets the received information about the innovation and develops a selective perception. The individual also thinks about possible usage in the future before testing. In this phase, the individual gathers subjective evaluations from others (equal partners) to get a social confirmation of his or her own thinking. The result of this phase is a positive or negative attitude about the innovation.[86] However, this attitude does not directly guide the decision about adoption or rejection. In some cases, attitude and actions are different. This divergence is called the knowledge, attitude, practice (KAP) gap.[87] Cue-to-action innovations must also be mentioned.[88] 'A preventive innovation is a new idea that an individual adopts in order to avoid the possible occurrence of some unwanted event in the future'.[89] Due to the uncertainty of the results, the probability of adoption is low. When an event causes an attitude and alters behaviour, it is called cue to action.[90]

The next phase is called decision, where the individual or a unit with decision responsibility applies actions, which guide whether an innovation is adopted or rejected. One option to reduce the uncertainty of an innovation is a trial of the new idea; the trial often happens on a small scale. Innovations that cannot be partially tested – which is relatively fast – must be tested in total. The individual decides to adopt an innovation when a relative advantage and certain usefulness are seen. Another option to reduce insecurity is to be inspired by the assessment of others.[91] Rogers (2003) described the phenomenon of overadoption. Individuals evaluate innovations by their own perceptions and assess their own actions as rational even

[85] Cf. Rogers (2003), p. 174
[86] Cf. Rogers (2003), p. 174 ff.
[87] Cf. Rogers (2003), p. 176
[88] Cf. Rogers (2003), p. 176
[89] Rogers (2003), p. 176
[90] Cf. Rogers (2003), p. 176
[91] Cf. Rogers (2003), p. 177 f.

though there is a lack of knowledge and information inaccuracy. The innovation is adopted with an individual's subjective rationality. Hence, innovations can be adopted by individuals when attributes of innovations influence individuals in a way that other attributes are overruled.[92]

The individual can reject the innovation at any stage of this process. If an individual rejects an innovation after first adopting it, the decision is called discontinuance. There are two types of rejection: active, in which the individual adopts and tries the innovation, or passive, when the individual never considers adoption.[93]

The next stage, **implementation**, arises when an individual or a unit with decision responsibility starts to use the innovation. While the previous stages mostly involved only thinking about the innovation, at this stage the innovation is used in practice. The user actively seeks information to further reduce any uncertainty about possibilities and potential usage problems.[94] The duration of this stage depends on the complexity of the innovation. The end of this phase occurs when the individual no longer sees the idea as new and has integrated it into his or her regular behaviour.[95] At this point, it is important to explain the concept of reinvention.[96] Reinvention is 'the degree to which an innovation is changed or modified by a user in the process of adoption and implementation'.[97]

The last phase describes the **confirmation of an innovation**. The individual or a unit with decision responsibility strengthens or invert the previous decision. The decider looks for messages that support his or her decision. Hence, attitude becomes a crucial part in this stage. **Discontinuance** is made either because of an better perceived replacement or the innovation is rejected because the decider is not satisfied with the innovation performance or it does not meet the decider's needs (compare: relative advantage).[98]

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[92] Cf. Rogers (2003), p. 231 f.
[93] Cf. Rogers (2003), p. 177 f.
[94] Cf. Rogers (2003), p. 179
[95] Cf. Rogers (2003), p. 180
[96] Cf. Rogers (2003), p. 180 ff.
[97] Rogers (2003), p. 180 ff.
[98] Cf. Rogers (2003), p. 189 ff.

2.3.2 Categories of adopters

Rogers (2003) defined the categories of adopters as 'the classification of members of a social system on the basis of innovativeness',[99] including innovators, early adopters, early majority, late majority and laggards. The innovativeness of the individuals within each category is similar.[100]

Innovators are open to test new ideas; hence, they have a certain level of uncertainty about the innovation. Innovators can be gatekeepers who bring new ideas to the market. They stand outside the social system because of their risk appetite. Their behaviour requires high technical knowledge.[101]

Early adopters are more restrictive within a social system. It is assumed that early adopters are more likely to be in leadership positions in the social system. Rogers (2003, p. 283) claimed that 'early adopters put their stamp of approval on a new idea by adopting it'.[102] As other individuals asks early adopters in their roles for advice about the innovation, they are important in spreading their evaluations to other members of a social system through interpersonal networks.[103]

The attributes of early majority are similar to the characteristics of early adopters.[104] However, the individuals of the early majority are not in leadership roles. Nevertheless, due to their interpersonal networks, these individuals are important in the innovation-diffusion process. Looking at Illustration 5, the early majority are the middle category within the diffusion process: Rogers (2003) described that they are **deliberate** in adopting an innovation, so their decision usually takes longer.[105] Roger (2003) listed some characteristics of early versus late knowers. Early knowers are more educated, belong to a higher social standing and participate in social life more strongly than late knowers. Thus, early knowers have more contact with interpersonal relationships, mass media channels and innovators.[106]

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[99] Rogers (2003), p. 22
[100] Rogers (2003), p. 279
[101] Cf. Rogers (2003), p. 282
[102] Rogers (2003), p. 283
[103] Cf. Rogers (2003), p. 283
[104] Cf. Roger (2003), p.174
[105] Cf. Rogers (2003), p. 283
[106] Cf. Rogers (2003), p. 174

Some adopter categories – innovators, early adopters and early majority – gain social status more strongly.[107] The late majority represent one third of all individuals who adopt an innovation. These members of the social system wait to see the outcomes of the other members using the innovation due to their scepticism. Close peers motivate them to try the innovation.[108] Eventually, the 'the late majority feel that it is safe to adopt'.[109]

Due to missing resources and awareness to build knowledge about innovation, laggards want to be sure that an innovation works before they adopt it. Thus, the decision process of laggards is relatively long.[110]

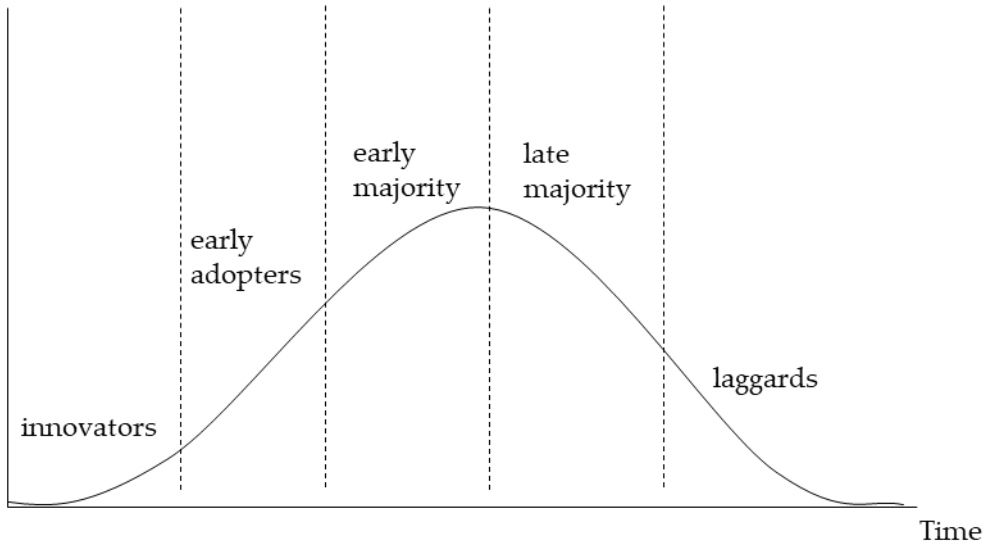

Illustration 5: The innovation curve[111]

[107] Cf. Rogers (2003), p. 230 f.
[108] Cf. Rogers (2003), p. 284
[109] Rogers (2003), p. 284
[110] Rogers (2003), p. 284
[111] Author's illustration base on: Rogers (2003), p. 282 ff.

3 ACCEPTANCE RESEARCH

Rogers (2003, p. 177) stated that 'adoption is a decision to make full use of an innovation as the best course of action available. Rejection is a decision not to adopt an innovation'.[112] **Adoption theory ends with the purchase of an innovation, while acceptance theory focuses on the actual usage of the innovation.**[113] Until now, this study has only mentioned the adoption of an innovation. Before analysing TAMs, acceptance has to be defined and classified. Acceptance describes that someone (subject of acceptance – here: technology user) accepts something (the object of acceptance – here: technology [service]) within a defined framework (acceptance context).[114]

3.1 DEFINITION AND TYPES OF ACCEPTANCE

The term acceptance has not been clearly defined in the literature; its understanding depends on the research discipline and research direction.[115] Weiber et al. (2016) defined acceptance as a positive intention to actually use a product when a concrete usage situation occurs,[116] while Simon defined acceptance as the positive decision of adoption of a innovation by the user.[117] Müller-Böling and Müller (1986) listed 20 different definitions in total and concluded that acceptance is seen as a **specific attitude or behaviour**. Acceptance should be understood as a two-dimensional construct with a component of attitude and behaviour. The additional acceptance consists of an affective characteristic that describes the motivational and

[112] Rogers (2003), p. 177
[113] Cf. Kollmann (1998), p. 146 f.
[114] Cf. Schäfer et al. (2013), p. 16
[115] Cf. Weiber et al. (2016), p. 209 f.
[116] Cf. Weiber et al. (2016), p. 210
[117] Cf. Simon (2011), p. 87

emotional aspects and a cognitive dimension that describes the personal evaluation of cost and usefulness.[118]

3.1.1 Levels of acceptance

There are several levels and types of acceptance. Acceptance can be differentiated by the number of individuals and the relationship towards the technology: [119]

- Societal acceptance;
- Operational or organisational acceptance; and
- Individual acceptance

Kollmann (1998) distinguished three levels of acceptance within the economic definition of the distribution of technological innovations on the individual level.[120]

- **Level of attitude**: The result of this level is a rational willingness and motivation to decide about the purchase and usage of the innovation. Based on the moral concepts and objectives of an individual, which are influenced by general needs and sociocultural factors, the individual builds a conative behavioural intention (BI). Advantages and disadvantages are evaluated based on cognitive knowledge. The willingness depends on rational expectations, a consistent objective system and an emotional component.
- **Level of action**: The individual reaches this level when willingness turns into active implementation. The innovation is bought and the individual prepares it for usage.
- **Level of usage**: In this phase, the action adoption or purchase transforms into the voluntary and tasked based usage of the innovation.

[118] Cf. Müller-Böling et al. (1986), p. 25 ff.
[119] Cf. Picot et al. (1987), p. 160 ff.
[120] Cf. Kollmann (1998), p. 66 ff.

The levels of acceptance have a processual character,[121] which can be added to the innovation decision process from Rogers (2003) (2.3.1). Such a process is presented in Illustration 6:[122]

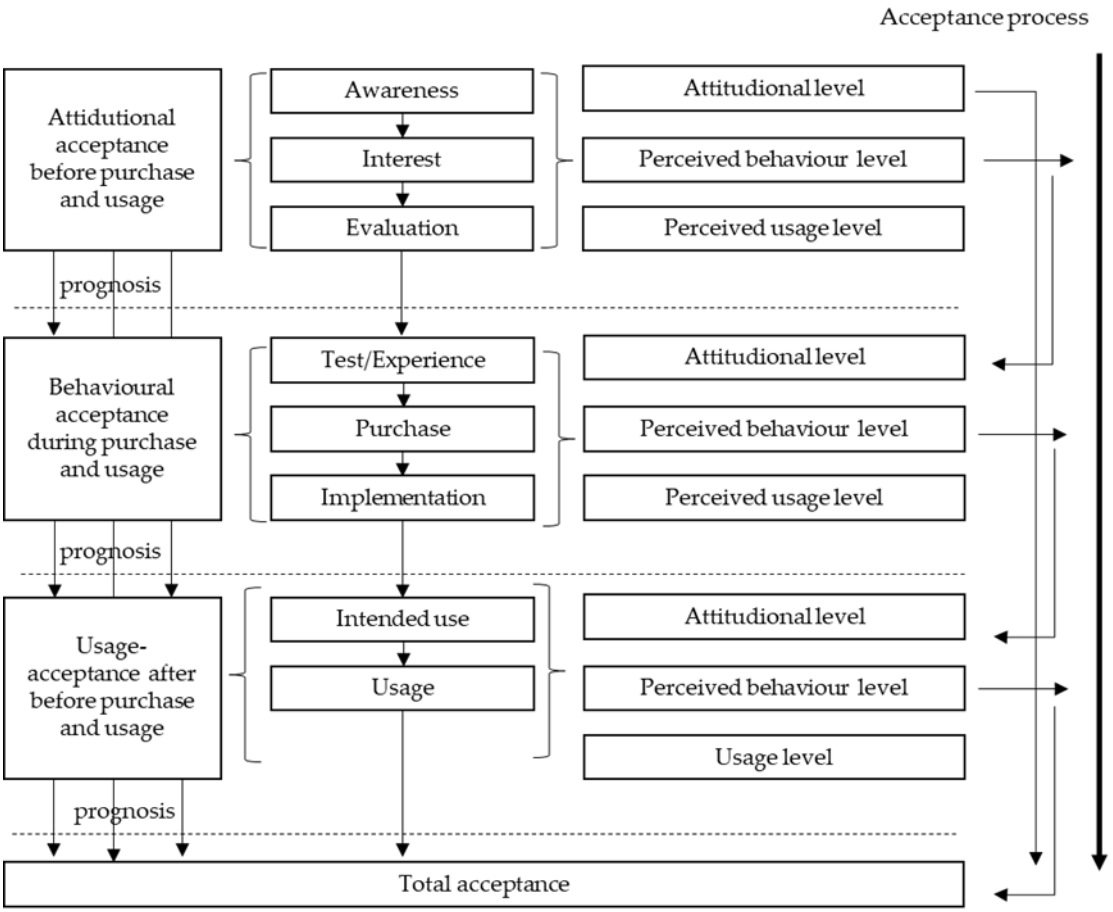

Illustration 6: Acceptance phases[123]

Kollmann (1998) also described interim acceptance among those levels. Parts of the acceptance can be evaluated differently. Hence, there are three types of acceptance categories. [124]

[121] Cf. Kollmann (1998), p. 68 f.
[122] Cf. Kollmann (1998), p. 113 ff.; Schnell (2009), p. 8
[123] Author's illustration based on: Kollmann (1998), p. 113; Schnell (2009), p. 8
[124] Cf. Kollmann (1998), p. 114 f.

- Acceptors evaluate all parts of acceptance as positive. Interim acceptance in attitude and behaviour lead to a high potential of usage.
- Undecideds only evaluate parts of acceptance positively. There is uncertainty about the usage, so the probability of usage is low to moderate.
- Non-acceptors evaluate all parts of acceptance as negative. Thus, the innovation will not be used.

This thesis will focus on different aspects of these processes. Therefore, several models[125] are consulted to analyse the terms of motivation, attitude and behaviour. Actual usage after a sale cannot not often be monitored. Thus, acceptance is often linked to BI, which is an attitudinal construct. In this sense, acceptance research is also attitude research.[126]

3.1.2 Attitude and motivation

Attitude is a psychological tendency that expresses the evaluation of a certain object with a certain degree of affection or dislike.[127] It is therefore the evaluation of a stimulus object; it can be positive or negative. The stimulus object can be a material thing or an abstract idea. Any stimulus that is evaluated as positive or negative can also be the subject of attitude. Attitudes can differ in their intensity.[128] It has an affective (emotional), a cognitive (specific imaginations) and a conative (behavioural tendence) component.[129]

It is also necessary to look at the development of adoption research motivational theory.[130] Core constructs of the motivation model are the extrinsic and intrinsic model. Extrinsic motivation means 'the perception that users want to per-

[125] Cf. Ajzen (1985), p. 11 ff.; Fishbein et al. (1975), p. 216.; Venkatesh et al. (1999), p. 1 ff.
[126] Cf. Kollmann (1998), p. 50 ff.; Müller-Böing et al. (1986), p. 25 ff
[127] Cf. Eagly et al. (1993), p. 1
[128] Cf. Wagner (2016), p. 22 f.
[129] Cf. Arnold et al. (2016), p. 9 f.
[130] Cf. Venkatesh et al. (1999), p. 1 ff.

form an activity because it is perceived to be instrumental in achieving valued outcomes that are distinct from the activity itself'. Intrinsic motivation means 'the perception that users want to perform an activity for no apparent reinforcement other than the process of performing the activity per se'.[131]

3.1.3 The Theory of Reasoned Action

Coming from social psychology, **the theory of reasoned action (TRA)**, which was developed in 1975, is an important fundament for theories in human behaviour and has influenced many models.[132] There are two preconditions of the model (Illustration 7). First, it is based on humans, a species that thinks and behaves rationally: humans make conscious decisions considering all available information. Second, humans need to perform a behaviour on purpose.[133] If these conditions are guaranteed, the BI leads to the actual behaviour.[134] However, there have been three restrictive framework conditions identified that show the strongest link of BI to behaviour. A moderator between the BI and the behaviour is the degree to which intention and the behavioural criteria match specifically as well as the stability of intention between the time of measurement and the performance of the action and the degree to which the performance of the action is of deliberate control of the individual.[135]

The intention depends on the attitude towards the potential behaviour and the subjective norm. Subjective norm is defined as 'the person's perception that most people who are important to him think he should or should not perform the behaviour in question,'[136] meaning a social pressure.[137] The factor of attitude to-

[131] Cf. Davis et al. (1992), p. 1112; Venkatesh et al. (2003), p. 428
[132] Cf. Venkatesh et al. (2003), p. 428 f.
[133] Cf. Fishbein et al. (1975), p. 216
[134] Cf. Ajzen et al. (1980); Rossmann (2011), p. 12 ff.
[135] Cf. Fishbein et al. (1975); Madden et al. (1992), p. 3 ff.
[136] Cf. Fishbein et al. (1975), p. 302
[137] Fishbein et al. (1975), p. 302; Rossmann (2011), p. 12 ff.

wards behaviour is described as an 'individual's positive or negative feelings (evaluative affect) about performing the target behaviour'.[138] Subjective norms are influenced by different beliefs, which are not specified further.[139]

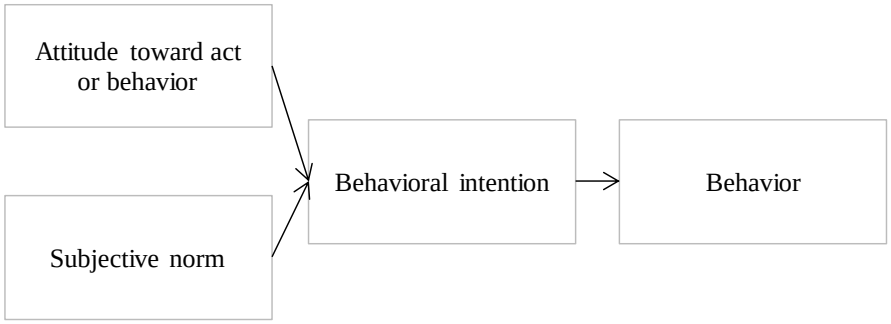

Illustration 7: The Theory of Reasoned Action[140]

To understand BI and its operationalisation to behaviour, it is useful to explain different dimensions of behaviour.[141]

- **Action element**: In this context, individual actions and behavioural patterns have to be differentiated.
- **Target element**: A behaviour refers to a specific target or object.
- **Context element**: This element describes the different possibilities of environment and conditions: different places, private or professional usage or technical equipment.
- **Time element**: Actions can be performed at different times.

Fishbein and Ajzen (1975) discussed these elements and developed the principle of compatibility. The strength of a correlation of the elements depends on the compatibility of action, target, context and time.[142]

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[138] Cf. Fishbein et al. (1975), p. 216
[139] Cf. Davis et al. (1989), p. 319 ff.
[140] Author's illustration based on: Fishbein et al. (1975), p. 216 f.
[141] Cf. Rossmann (2011), p. 14 f.
[142] Cf. Rossmann (2011), p. 14 f.

3.1.4 Theory of Planned Behaviour

The **theory of planned behaviour (TPB)**[143] (Illustration 8) is the successor to the TRA.[144] The TPB, as an early fundamental social and psychological approach, started to explain the individual's behaviour by *attitude* and *subjective norm* without focussing on technology.[145] The TPB added *perceived behavioural control* as the third influence factor on the BI. Perceived behavioural control is the degree to which a person assesses that he or she can carry out the planned behaviour on the basis of the available resources and possibilities. The more resources and possibilities a person perceives to have, the greater is the perceived behavioural control for the usage. The direct connection to behaviour depends on whether the behaviour can actually be performed.[146] The terms of BI lead to the actual use. The behavioural intention can be seen and understood as an indication for acceptance.[147]

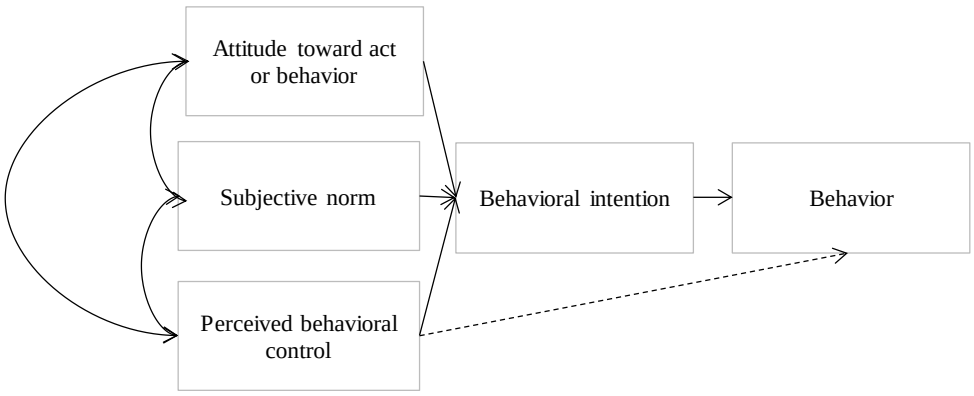

Illustration 8: The theory of planned behaviour[148]

[143] Cf. Ajzen (1985), p. 11 ff.
[144] Cf. Holden (2010), p. 159 ff.; Ajzen (1991), p. 179 ff.
[145] Cf. Fishbein et al. (1975); Momani et al. (2017), p. 51 ff.
[146] Cf. Ajzen (1985), p. 11 ff., Madden et al. (1992), p. 3 ff.
[147] Cf. Davis (1989), p. 319 ff.
[148] Author's illustration based on: Ajzen et al. (1980)

3.2 TECHNOLOGY ACCEPTANCE MODELS

Technology acceptance is defined as 'an individual's psychological state with regard to his or her voluntary or intended use of a particular technology'.[149] Acceptance is a latent (not directly observable) construct. Acceptance models are concepts that try to explain what determinants influence acceptance and what elements acceptance consists of to observe acceptance.[150] The literature includes a variety of models that have attempted to explain how acceptance of technology is composed and developed. To have a structured view on these models, a **classification of models** is needed.

A possible classification is:[151]

- **Input models**: These models only show what kind of factors that influence acceptance. Input models are most considered in literature for technology acceptance business to business (B2B).[152]
- **Input-output models**: In addition to the input factors, which influence the acceptance, these models include output factors, which are result quantities.
- **Feedback models**: These models also include feedback effects, which show that the result quantities subsequently become input factors.
- **Dynamic models**: These models consider the procedural idea. Models differ due to the number of phases, in which the acceptance process is divided.

Second, this division is needed to get a step-by-step overview of all factors and their relationships. To get an overall picture, representative models with non-reproduced, novel aspects are considered within the timeline and examined more closely.

In terms of the historical development, Lee et al. proposed a timeline to sort the models. Illustration 9 presents the four phases of TAMs. Around the 1980s, there was an introduction phase, followed by a validation phase, an expansion and finally an extension phase.[153] Most international studies during the introduction

[149] Cf. Gattiker et al. (1984), p. 327 f.
[150] Cf. Jockisch (2009), p. 237
[151] Cf. Filipp (1996), p. 26; Schnell (2009), p. 5 ff.
[152] Cf. Kollmann (1998), p. 78 ff.
[153] Cf. Lee et al. (2003), p. 752 ff.

phase were replication studies or comparisons of the studies of Adams (1992), Davis et al. (1989), Ajzen et al. (1980) and the TRA model (see 3.2.1).[154] The second phase concentrated on the assurance of validity of the models. These studies mostly evaluated the consistency and validity of TAMs (see 3.2.2).[155] The goal of most of the studies in the expansion phase was to test the applicability of TAM and identify limits.[156] There were additional variables introduced in international known models to explain differences in acceptance and usage .[157] The research in the elaboration phase synthesised knowledge and attempted to address critical points (see 3.2.3).[158]

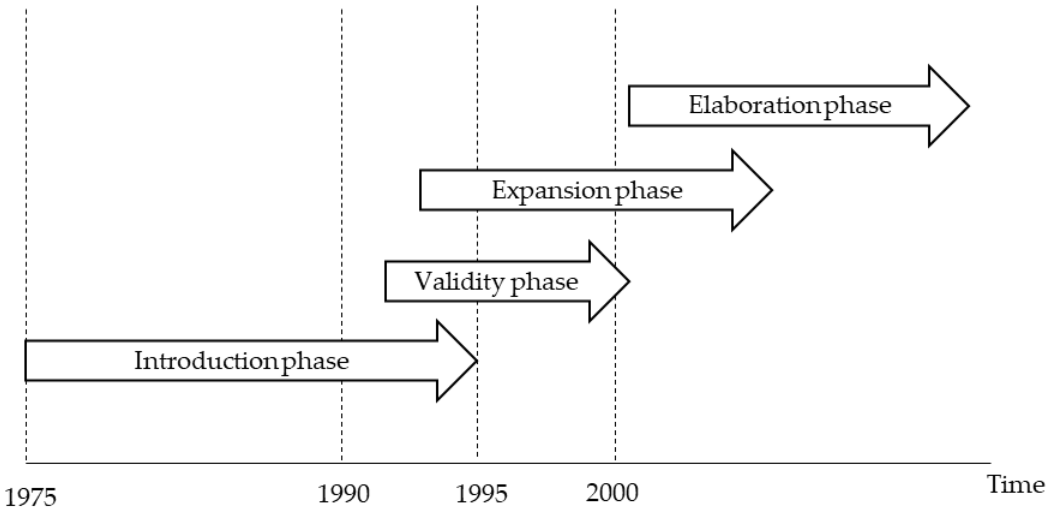

Illustration 9: Temporal development of technology acceptance models[159]

[154] Cf. Taylor et al. (1995), p. 144 ff.

[155] Cf. Jockisch (2011), p. 240 f.

[156] Cf. Jockisch (2011), p. 240 f.

[157] Cf. Taylor et al. (1995), p. 144 ff.

[158] Cf. Chin et. al. (2008); Kulviwat et al. (2007); Szajna (1996), p. 85ff.; Thompson et al. (2006); Venkatesh et al. (2003), p. 425 ff.

[159] Cf. Jockisch (2011), p. 240 f.; Lee et al. (2003), p. 725

Each of the following three chapters 3.2.1 until 3.2.3 starts with a table showing studies in this corresponding time phase. The table overviews concentrate on the German academic literature[160] (given that this thesis is focusing on Germany) as well as the international gold standard models.[161] These structured overviews summarise the main aspects of the most cited models and provides further explanations on subsequent guiding models in the sub-chapters. The tables are historically sorted.

[160] Cf. Kollmann (1998), p. 73 ff.; Schnell (2009), p. 4 ff.

[161] Cf. Holden et al. (2010), p. 159 ff.; Jockisch (2009), p. 235 ff.; Lee et al. (2003), p. 752 ff.; Momani et al. (2017), p. 51 ff.

3.2.1 Introduction phase of technology acceptance models

Year	Model	Language	Type of model	Core aspects
1975	Schultz et al.	English	Input-output	**Perceived usefulness**/job performance predicts self-predicted usage in a decision model.
1978	Reichwald	German	Feedback	Addresses the **feedback effect** as the organisational and personal consequence of acceptance influenced by technique, user and organisation (See 3.2.1.1)
1980	Schönecker	German	Feedback	Complex feedback construct: the centre of this model is the **perceived usage situation** (task, social context and **user friendliness**). Changing attitudes influences the technology-related behaviour. The behavioural intention is controlled by several factors like technique, organisational context and user capability as well as influenceability.
	Helmreich	German	Input-output	Input factors are, e.g. ergonomics, working structure and practice, which lead to the output of **performance, satisfaction and economy**.
1982	Tornatzky et al.	English	Input-output	**Complexity** (See 2.2.1) has an important influence on the usage.
	Bandura	English	Input-output	**Self-efficacy** (perceived ease of use) and **outcome judgement** (usefulness) predict the behaviour.

1984	**Hilbig**	**German**	**Input-output**	**Input factors are conditions of the implementation process, technical as well as personal factors and organisational factors. Output, defined as consequences of acceptance, are levels of usage and satisfaction.**
	Allerbeck et al.	German	Input	The attitude is influenced by the organisational environment, meaning the **interactions of the individual, technique and task.**
1985	Schönecker	German	Input	Attitude is influenced by the implementation of the system, the technique design, t**raining and support**, the social environment and organisational conditions.
1986	Müller-Böing et al.	German	Input-output	Five classes of factors are named; they influence the attitude: information-technological factors, organisational factors, personal factors, factors of **system design**, and factors of user context.
	Eidenmüller	German	Input	The acceptance is influenced by three factors: user, technique and the organisation of work.
	Degenhardt	German	Input-output	The main influence is the **perceived usefulness of a system.** This factor needs to be seen in a socio-technical context. **The process is open ended.** (See 3.2.1.3)
1988	Kredel	German	Feedback	Individual evaluation and attitude as well as the social environment are as the most important determinants that influence acceptance. The organisational-technical aspect includes availability, flexibility,

				system surface and integration. **The model highlights that the identified benefits of a system can support and drive the targets and organisation of the technique use.**
1989	Klee	German	Feedback	The individual reaction on usage is influenced by the organisational and social environment in the **acceptance context**. These influences are interpreted by the user and transferred to acceptance, which includes the **behavioural intention and the actual use.**
	Davis et al.	English	Input-output	The gold standard model, known as technology acceptance model 1 (TAM 1): perceived usefulness and ease of use influences the attitude and lead to the behavioural intention. (See 3.2.1.3)
	Wallau	German	Input-output	User, technique and organisation are input variables, which influence user adequacy and restrictions, which again influence behavioural and attitudinal acceptance. Output is described as work satisfaction and an increase in performance.

Table 1: Introduction phase of technology acceptance models

In the 1970s, technology growth and adoption of systems became more and more difficult. Hence, many researches started to investigate how to predict and measure acceptance.[162]

3.2.1.1 The acceptance model from Reichwald

By 1978, Reichwald had created a feedback model to explain the complex area of influencing factors on acceptance. Reichwald (1978) named three areas of influence on acceptance: **user-specific characteristics**, the **organisational environment** and the **features of the technical system**.[163] The empirical study showed that next to the personality-specific characteristics **situational influencing factors** are also relevant.[164] Illustration 10 shows the relationship of all variables and their description.

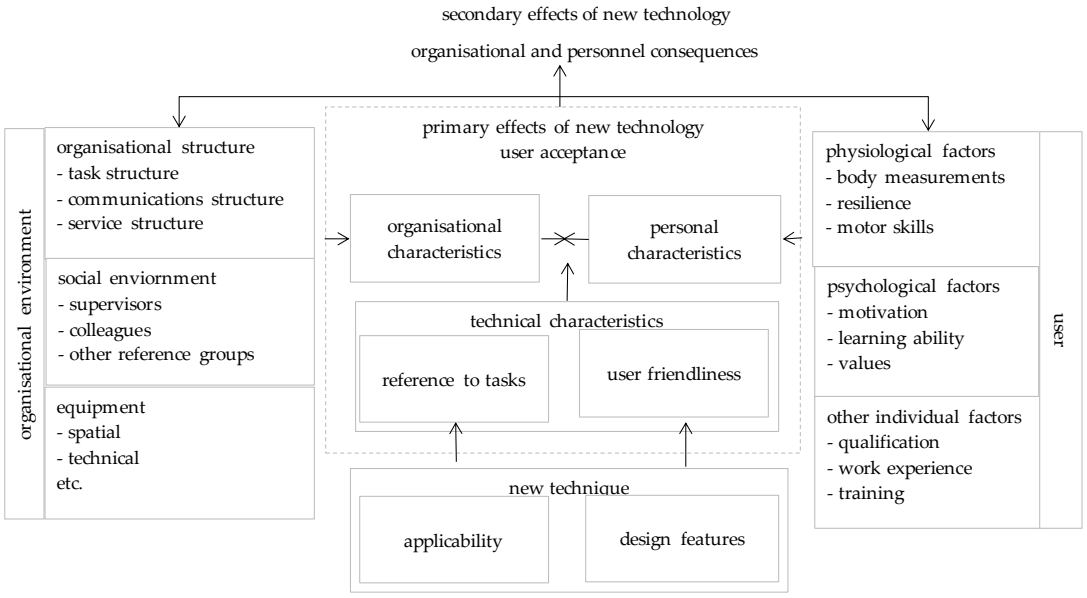

Illustration 10: Acceptance model from Reichwald[165]

[162] Cf. Chuttur (2009), n. pag.
[163] Cf. Reichwald (1978), p. 163 f.
[164] Cf. Anstadt (1994), p. 80
[165] Author's illustration base on: Cf. Reichwald (1978), p. 115

3.2.1.2 The acceptance model from Degenhardt

Degenhardt (1986) stated that the acceptance of a system depends on the **perceived usefulness (PU) – the ability of a user to use the system**. A user assesses that a system is useful if the functions are suitable for his or her tasks. The model shows three analytical dimensions. The first dimension explains **task-related factors**: the tasks of a user have different priorities and must be done in various frequencies. Furthermore, there are several ways to deal with these tasks. The second dimension describes the **features of the system**: task match means that the task should be managed and solved until the target is achieved. The usability has to be adapted to the needs of the user. The system has to be designed in a way that all functions and the handling are easily learnable. A training on the system is necessary. The third dimension shows the **user characteristics**. Users have to have skills to use the system. These skills are described with the keyword computer literacy. The user also needs **motivation** (See 3.1.2) to overcome disappointments. Usage also depends on the **social environment**, which can support, force or reject the system. Considering all these aspects, a user evaluates the usefulness of the system. Of note, the user will accept a system only after positive assessment of cost and use plus the perceived ability.[166] Degenhardt (1986) noted that the implementation of a system needs to be analysed in a **socio-technical context**. In addition, Degenhardt **emphasised that acceptance of a system is always an open-ended process, which has to be reflected continually** (Illustration 11).[167]

[166] Cf. Degenhardt (1986), p. 246 ff.

[167] Cf. Degenhardt (1986), p. 247

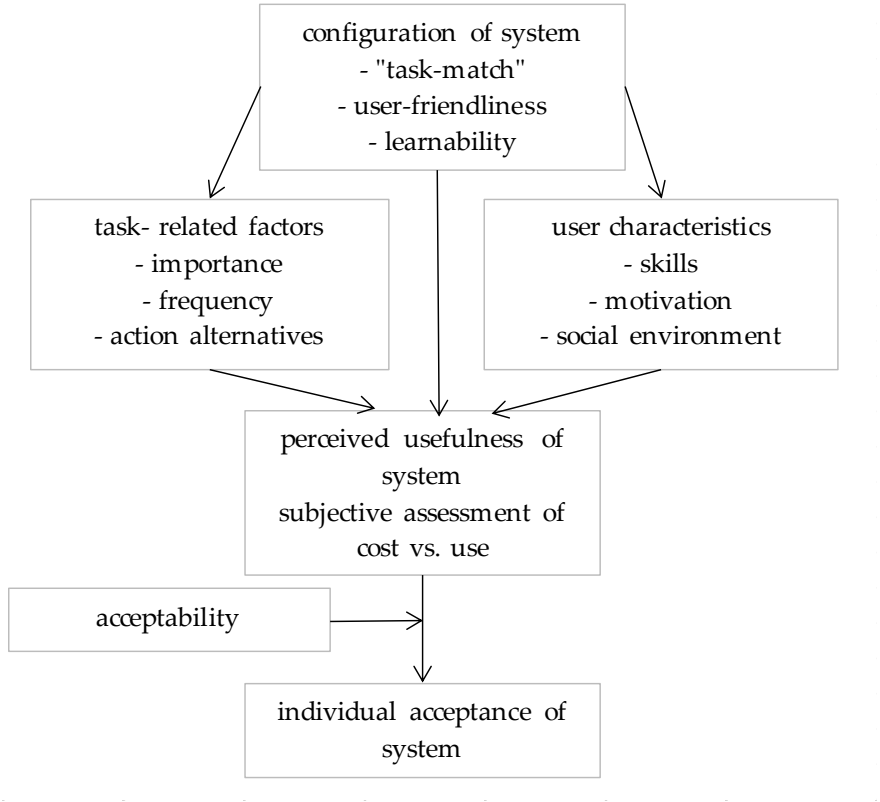

Illustration 11: Acceptance model from Degenhardt[168]

[168] Cf. Degenhardt (1986), p. 248 f.

3.2.1.3 The original technology acceptance model (TAM 1) by Davis

The gold standard in evaluating technology acceptance became the TAM 1 from Davis (1989).[169] Davis (1989) originally developed this model in the 1980s to explore why workers did not use the available IT.[170] The idea behind the model was to increase the use of IT due to an increase of acceptance. To assess this issue individuals had to be asked about their intent of usage. Illustration 12 presents Davis' core concept. The features and capabilities of a system, which serve as a stimulus, influence the organism in terms of motivation and leads to the response, which is described as the actual use of a system.[171]

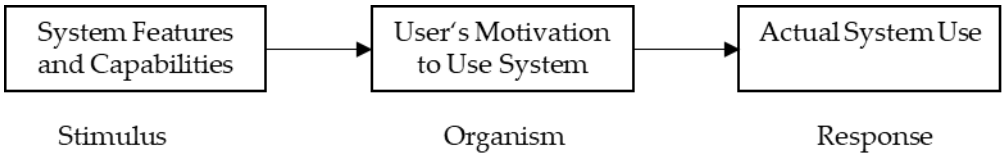

Illustration 12: Conceptual model for Davis' technology acceptance model[172]

It had been assumed that further influential determinants would lead to increased acceptance.[173] With TAM 1, Davis (1989) attempted to test what variables would influence IT use. When building this model, the TRA (See 3.1.3)[174] and several other theories from the past were considered.[175] Davis' model claimed that *PU* and *perceived ease of use (PEOU)* are the fundamental constructs to determine the attitude, which then influences the *attitude*. PEOU then further affects PU and PU independently affects attitude.[176] PU is defined as the 'prospective user's subjective probability that using a specific application system will increase his or her job performance within an organizational context'. PEOU is defined as the 'degree to which the prospective user expects the target system to be free of effort'.[177]

[169] Cf. Davis (1989), p. 319 ff.
[170] Cf. Davis (1989), p. 319 ff.
[171] Cf. Davis (1985), p. 10
[172] Cf. Davis (1985), p. 10
[173] Cf. Holden et al. (2010), p. 159 ff.
[174] Cf. Ajzen (1985), p. 11 f.; Fishbein et al. (1975)
[175] Cf. Momani (2017), p. 51 ff.
[176] Cf. Davis (1989), p. 331 ff.
[177] Cf. Davis et al. (1986), p. 985

Davis (1989) (TAM 1) assumed that behavioural acceptance (BI) depends on attitudinal acceptance.[178] Davis described that an individual with a positive attitude towards the usefulness will actually use the technology: the greater the benefit of the technology and the easier the handling, the higher the willingness to use the system. Both determinants are affected by external factors, but they were not named at that stage (Illustration 12).[179]

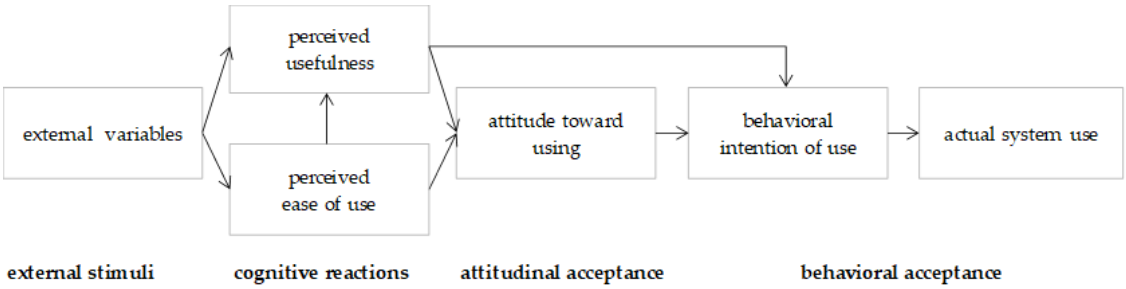

Illustration 13: The technology acceptance model from Davis[180]

Davis (1989) conducted several tests and analyses for the development of items and their scales; he determined six items each for PU and PEOU.[181] These items are still a fundament for item development in technology acceptance research.

[178] Cf. Bürg et al. (2004), p. 77 f.
[179] Cf. Davis et al. (1989), p. 985 f.; Jockisch (2010), p. 241 f.
[180] Author's illustration based on: Davis et al. (1989), p. 985; Simon (2001), p. 95
[181] Cf. Davis (1989), p. 323 ff.

3.2.2 Validation phase of TAMs

Time	Model	Type	Core aspects
1990	Joseph	Input	Individual acceptance is influenced by four factors: support of users, technique, work organisation and individual determinants.
1990	Anstötz	Input	Acceptance increases with a user's involvement in development and test phases.
1991	Moore et al.	Input-output	Adoption model operationalisation of Rogers' five innovation characteristics
	Mathieson	Input-output	Comparison of TAM and TPB
	Allerbeck et al.	Input	The organisational environment, including the individual, the technique and the task, strongly defines acceptance.
1993	Segars et al.	Input-output	TAM extension with the factor effectiveness
1995	Taylor et al.	Input-output	Comparison of TAM, TPB as well as the influence factor experience
	Goodhue	Input-output	Task-technology-fit model: this model highlights the interaction of several factors – user, technique and tasks – that together influence the performance evaluation. (See 3.2.2.1)
	Filipp	Feedback	Known influence factors – organisation, technique and user – influence the attitude. Attitude provides feedback to those factors and also to the developer of the system for changes. (See 3.2.2.2)

Table 2: Studies of the validation phase of TAMs

3.2.2.1 Task-technology-fit model

In 1995, Goodhue (1995) modelled an alternative approach to the user acceptance of technology.[182] This well-known input-output model is called the task-technology-fit model (TTFM) (Illustration 14).[183]

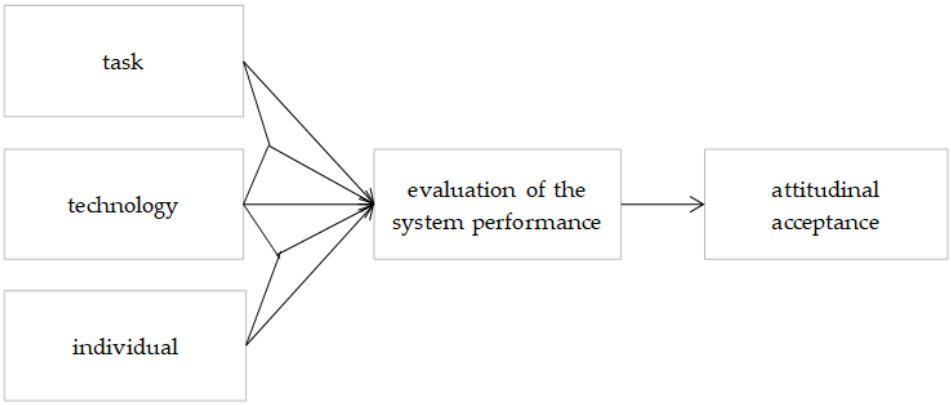

Illustration 14: The task-technology-fit model[184]

Strictly speaking, the TTFM is not a pure acceptance model, but the assumption of influence of the system performance on the attitudinal acceptance can lead to acceptance research.[185] The evaluation of system performance is in turn influenced by the task itself, the technology and the individual. The factor task includes the difficulty level as well as the variety of tasks. The offered service describes the characteristics of the factor technology. Finally, the individual context describes the ability and skills of the user.[186] The main idea of the TTFM is the cooperation of all factors – user, technique and tasks – which collectively influence the performance evaluation. No isolated factor influences the evaluation.[187] The TAM 1 and the TTFM are the most utilised TAMs in the literature.[188]

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[182] Cf. Jockisch (2009), p. 248 f.
[183] Cf. Goodhue (1995), p. 1827 ff.
[184] Own illustration base on: Goodhue (1995), p. 1827 ff.
[185] Cf. Simon (2001), p. 95
[186] Cf. Goodhue (1995), p. 1827 ff.
[187] Cf. Goodhue (1995), p. 1827 ff.; Joackisch (2009), p. 248 f.
[188] Cf. Dishaw et al. (1999), p. 9 f.

3.2.2.2 *The acceptance model from Filipp*

The concepts of Reichwald (1978) and Möller-Böling (1986) influenced Filipp's acceptance model (Illustration 15). Filipp (1996) attached importance to the dynamic character of the model. The target of the model is the constant measurement of acceptance and a feedback mechanism for the developer to adapt the system to the current needs of users. Inner acceptance is described by attitude and user-specific behavioural intention. Both determinants influence one another and affect the actual verifiable behavior. This observable behavior and the inner acceptance build the outer acceptance. The factors that influence outer acceptance are chiefly organisational effects (configuration of system and access rights), as well as technical effects (configuration of system and access rights), technical effects (innovation) and personal effects like motivation and qualification. The technique related determinants underlie constant new features.[189]

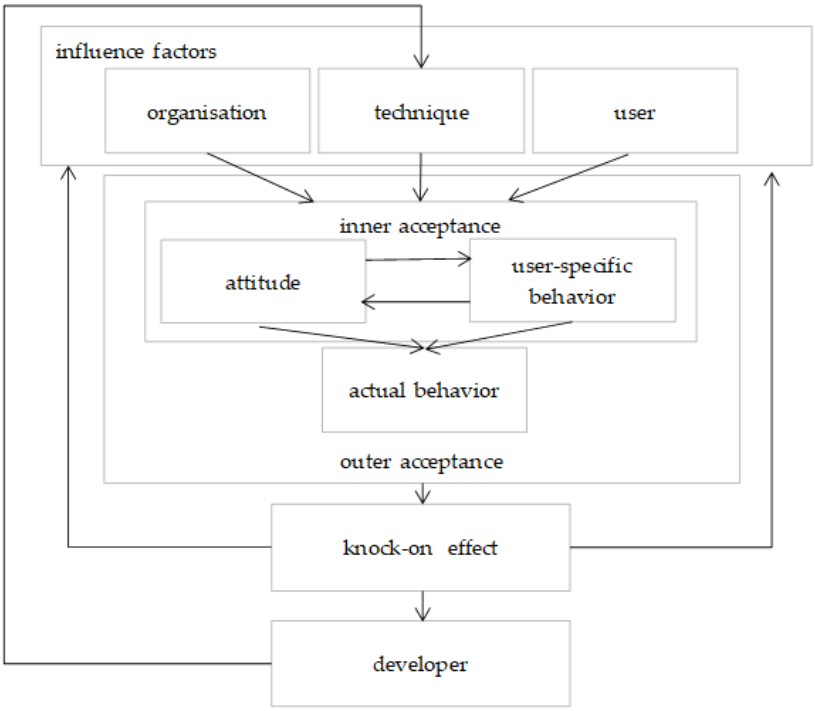

Illustration 15: The acceptance model from Filipp

[189] Cf. Filipp (1996), p. 37 ff.

3.2.3 Extension and elaboration phase of TAMs

Time	Model	Type	Core aspects
1997–2003	Gefen et al.	Input-output	Extension of TAM 1, with a moderating effect of gender and adding constructs of social presence and trust
1995–1997	Igbaria et al.	Input-output	Extension of TAM 1, adding constructs of training and management support
1998	Kollmann	Dynamic	Building a dynamic model that explains the different acceptance phases of a user on acceptance, construct and process levels until the prognosis level of actual usage influencing by product-, user- and company-specific factors as well as the macro economic environment including political-legal, technological and socio-cultural aspects.
1999–2006	Karahanna et al.	Input-output	Extension of TRA and TAM 1 by compatibility and trialability
1999	Dishaw et al.	Input-output	Combination of TAM 1 and TTFM
2000	Venkatesh et al.	Input-output	TAM 2: extension of TAM 1 with influence factors on usefulness, including subjective norm, image, job relevance, output quality and result demonstrability (See 3.2.3.2)
2001	Simon et al.	Feedback	Acceptance is measured by the system and user design.
2002	Silberer et al.	Input-output	Customer satisfaction model: satisfaction is influenced by the hardware, transmission costs and system applications.
2003	Lin	Feedback	Most popular acceptance model for interactive system: addition of audience factors to influence the acceptance process (See 3.2.3.1)

	Venkatesh	Input-output	Unified theory of acceptance and use of technology 1 (UTAUT 1): (See 3.2.3.3) combination of technology acceptance models
Time	**Model**	**Type**	**Core aspects**
2004	Wehrmann	Input-output	DART model: acceptance is influenced by perceived benefits, usability, costs and amplified benefits.
2005	Morris et al.	Input-output	Extension of TAM, with the moderating effect of age
2005	Wixom et al.	Input-output	Extension of TAM, with constructs to measure the user satisfaction
2008	Venkatesh et al.	Input-output	TAM 3: extension of TAM 2 with influence factors on perceived ease of use, including computer-self efficacy, perception of external control, computer anxiety, computer playfulness, perceived enjoyment and objective usability (See 3.2.3.5)
2012	Venkatesh et al.	Input-output	UTAUT2: extension of UTAUT by adding constructs, including hedonic motivation, habit and price value (See 3.2.3.4)

Table 3: Studies of the extension and elaboration phase of TAMs

With regard to the extension and subsequent elaborating phases, there have been hundreds of citations of the core TAM model and a great variety of proposed extensions. This breadth of information can only be covered with some representative models that are often named and cited in the literature.

3.2.3.1 The interactive communication technology adoption model from Lin

Lin (2003) proposed an acceptance model with an interactive communication context (Illustration 16). The author named several factors that affect the acceptance of those interactive technologies:[190]

- **System factors** are factors on a social-technological level, meaning the status of technology and the regulation of media as well as technology in a market influenced by industry and country specifics.
- **Technology factors** describe the characteristics of innovations (relative advantage, compatibility, complexity, evaluation and observability (See 2.2.1) as well as the ability of interactive innovations to copy face-to-face communication.
- **Audience factors** include a variety of users' personality factors that describe risk appetite, creativity and innovativeness.
- **Social factors** focus on the social environment, namely the involvement and influence of users to create an interactive communication.
- **Usage factors** concentrate on motives and needs for the use of the system and the perceived control of driving communication.
- **Adoption factors** describe future decision on adoption: adopting or not adopting the technology, discontinue the usage or reinvent the handling.

[190] Cf. Lin (2003), p. 345 ff.; Quiring (2006), p. 7 f.

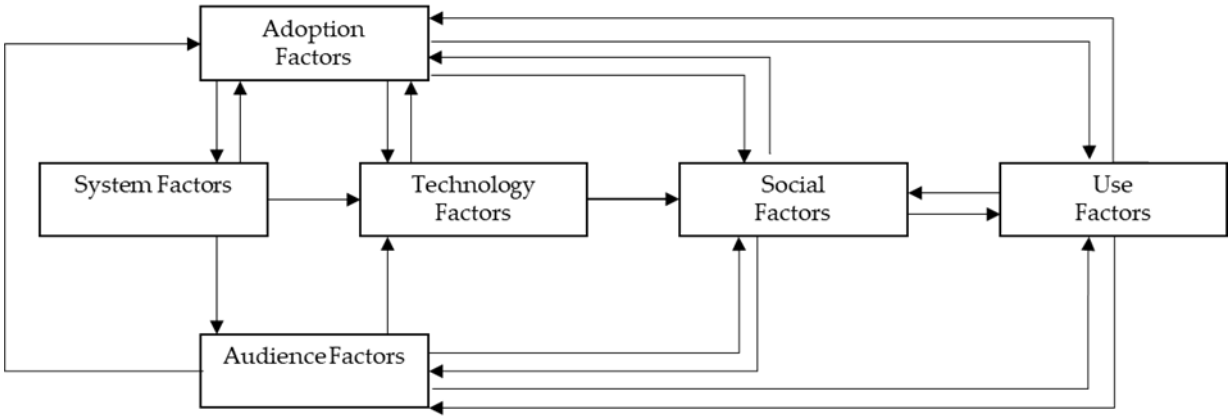

Illustration 16: The interactive communication technology model of Lin[191]

These comprehensive factors, however, are complex to measure; indeed, some cannot be measured directly. Nevertheless, they can help shape the background and facilitate interpretation of the results in surveys. [192]

3.2.3.2 Technology acceptance model 2

TAM 1 was later extended to the technology acceptance model 2 (**TAM 2**) (Illustration 17).[193] This extension adds variables covering the social influence with the factor of *subjective norm* directly influencing PU and BI. It also includes *image, job relevance, output quality* and *results demonstrability* as determinants of PU.[194] The variable subjective norm is taken from the TRA model.[195] From Moore and Benbasat (1991), the variable of image is defined as 'the degree to which use of an innovation is perceived to enhance one's ... status in one's social system'. Thus, image

[191] Cf. Lin (2003), p. 346

[192] Cf. Quiring (2006), p. 7 f.

[193] Cf. Venkatesh et al. (2000), p. 186 ff.

[194] Cf. Holden et al. (2010), p. 159 ff.; Momani et al. (2017), p. 51 ff.; Venkatesh et al. (2000), p. 186 ff.

[195] Cf. Venkatesh et al. (2000), p. 187

is influenced by the subjective norm.[196] Job relevance is described as 'an individual's perception regarding the degree to which the target system is applicable to his or her job'. The perception of the performance of the task by the system is mentioned by the variable of output quality.[197] Results demonstrability again relates to the findings of Moore and Benbasat (1991), who defined it as 'tangibility of the results of using the innovation'. [198]

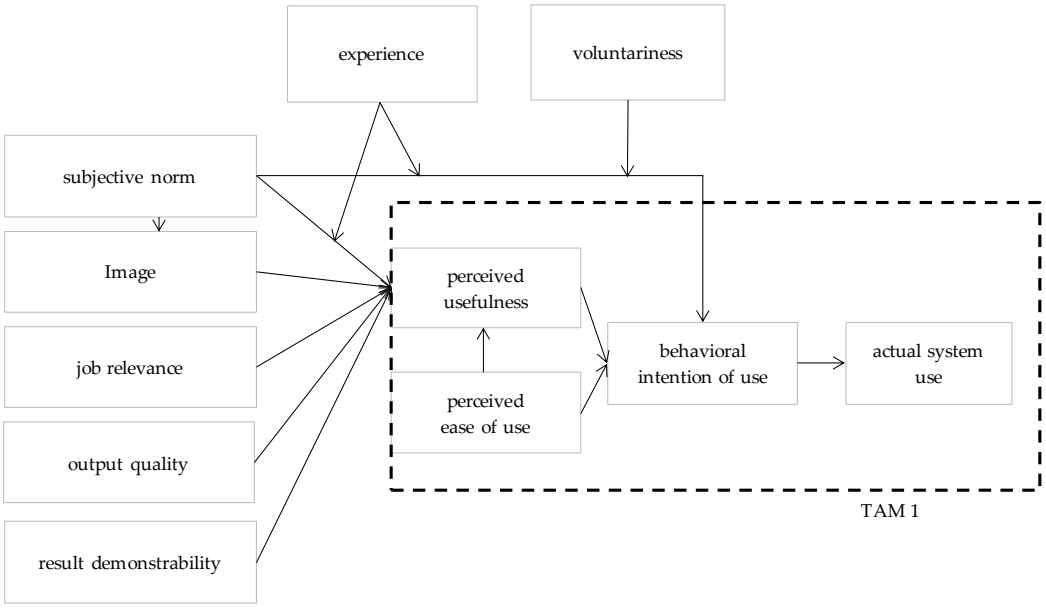

Illustration 17: The technology acceptance model 2 (TAM 2)[199]

[196] Moore et al. (1991), p. 195; Venkatesh et al. (2000), p. 187

[197] Venkatesh et al. (2000), p. 191

[198] Moore et al. (1991), p. 203; Venkatesh et al. (2000), p. 192

[199] Author's illustration based on: Cf. Boughzala (2014), p. 169; Venkatesh et al. (2000), p. 186 ff.

3.2.3.3 The unified theory of acceptance and use of technology

Venkatesh (2003) later unified acceptance studies and developed the first **unified theory of acceptance and use of technology (UTAUT 1)** (Illustration 18).[200] This change aimed to extend and adapt the model for innovation acceptance on the consumer side. The UTAUT 1 looks differently at the consumer compared with the previously mentioned models – which investigated the acceptance of employees in companies and thus non-voluntarily usage.[201]

The model has the common approach of BI as dependent factors, but also integrates PU into a *performance expectancy construct*, PEOU into *effort expectancy* and subjective norm into *social influence*. In addition, *facilitating conditions* from general IT acceptance research[202] are incorporated as one determinant of BI. Facilitating conditions describe factors in the working environment that make the technology use easy to fulfil. These external variables are moderated by gender, age, experiences and the voluntariness of use.[203] The UTAUT developed a promising model, because the first tests showed high variances in BI. [204]

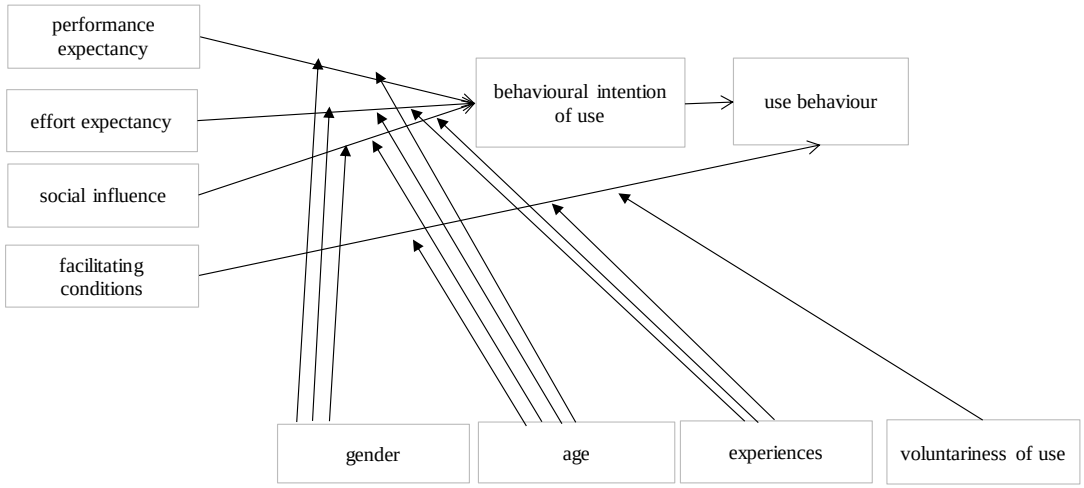

Illustration 18: The first unified theory of acceptance and use of technology (UTAUT 1) model[205]

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[200] Cf. Venkatesh et al. (2003), p. 425 ff.
[201] Cf. Venkatesh et al. (2012), p. 160 ff.; Weiber et al. (2016), p. 235 f.
[202] Cf. Taylor et al. (1995), p. 144 ff.
[203] Cf. Venkatesh et al. (2003), p. 430 ff.
[204] Cf. Holden et al. (2010), p. 159 ff.
[205] Author's illustration based on: Cf. Venkatesh et al. (2003), p. 425 ff.

3.2.3.4 The second unified theory of acceptance and use of technology

The second unified theory of acceptance and use of technology (UTAUT 2) expanded the first model by adding additional variables and assuming a relationship between facilitating conditions and BI (Illustration 19). Hedonic motivation describes the fun of using the innovation. With a focus on the consumer perspective, the voluntariness factor is eliminated. The new variable price value shows the perceived price performance ratio. Finally, UTAUT 2 includes the variable habit, which influences BI as well as the use behaviour. Habit means the custom of using current solutions and learnt behaviour patterns, which can lead to an automatic form of use.[206]

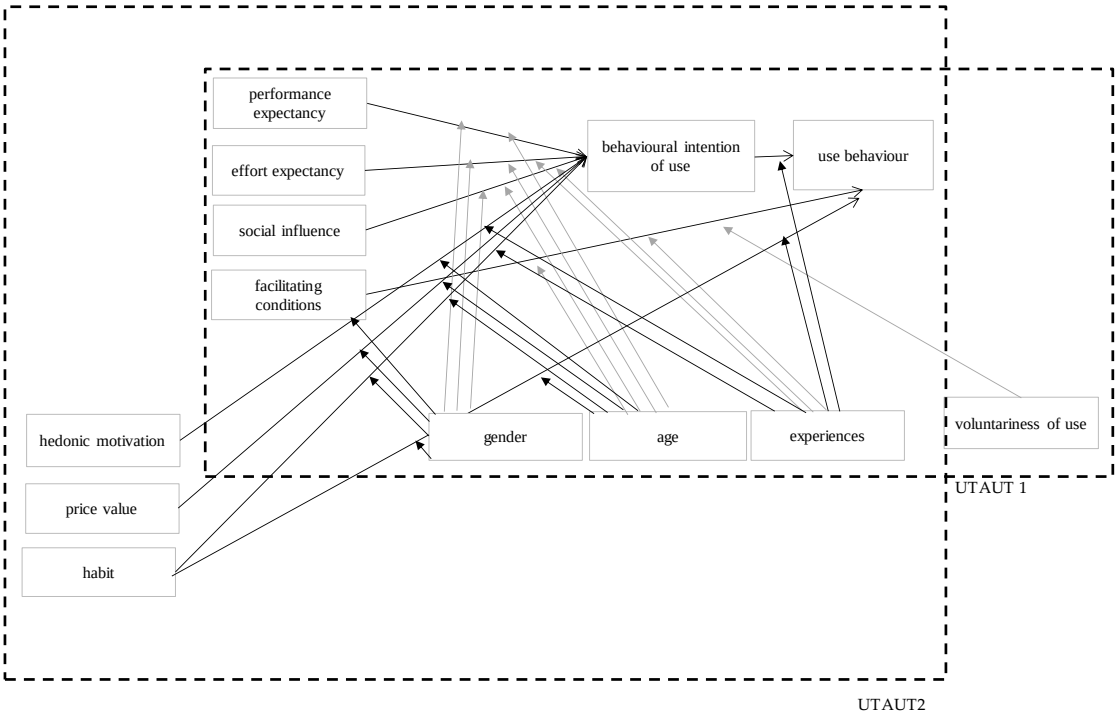

Illustration 19: The second unified theory of acceptance and use of technology (UTAUT2) model[207]

[206] Cf. Venaktesh et al. (2012), p. 160 ff.

[207] Author's illustration based on: Cf. Boughzala (2014), p. 170; Venkatesh et al. (2003), p. 425 ff.

3.2.3.5 The technology acceptance model 3

In 2008, Venkatesh and Bala presented the technology acceptance model 3 (TAM 3). The authors aimed to create implications for managerial decision making on IT implementation in organisations. Hence, they added additional factors that influence PEOU and PU.[208] TAM 3 extended TAM 2 by two groups of factors: anchor; four factors based on general information seeking and information-based knowledge; and adjustment, specifically perceived enjoyment and objective usability (Illustration 20). If additional information becomes available, the evaluation can be adapted (adjustment factors).[209]

The variable of computer self-efficiency is defined as the degree to which an individual perceives him- or herself as able to perform a specific task with the computer. The factor perception of external control describes the perception of an individual that organisational and technical resources exists to support usage of a system. The variable computer anxiety maps the fear an individual could have to be confronted to use technology. Computer playfulness is defined as the degree of cognitive spontaneity of interaction with the computer. Perceived enjoyment describes the perception of the extent of enjoyable activity of the system apart from the actual performance-related consequences. The factor of objective usability should define an objective comparison of systems in terms of effort level to complete a task, but this evaluation does not rely on perception.[210]

[208] Cf. Venkatesh et al. (2008), p. 273 ff.
[209] Cf. Venkatesh et al. (2000), p. 186 ff.; Venkatesh et al. (2008), p. 273 ff.
[210] Cf. Venkatesh et al. (2008), p. 273 ff.

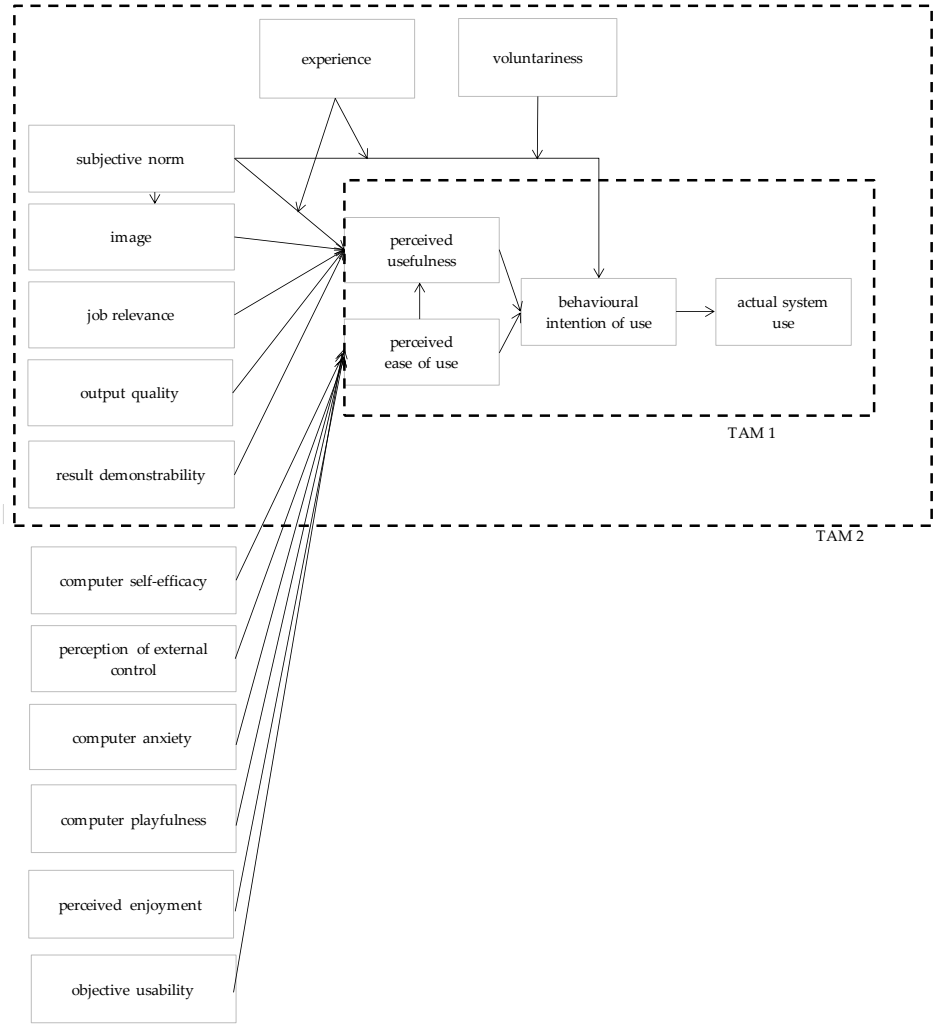

Illustration 20: The technology acceptance model 3 (TAM 3)[211]

3.2.4 Bringing adoption, acceptance and diffusion together

The process overview in Illustration 21 combines the above-mentioned models in an overall context of adoption and acceptance levels, which happen within each individual. Acceptors can be seen on the macro level when innovation diffusion occurs.

[211] Author's illustration based on: Cf. Boughzala (2014), p. 169; Dishaw et al. (1999), p. 9 ff.; Venkatesh et al. (2008), p. 273 ff.

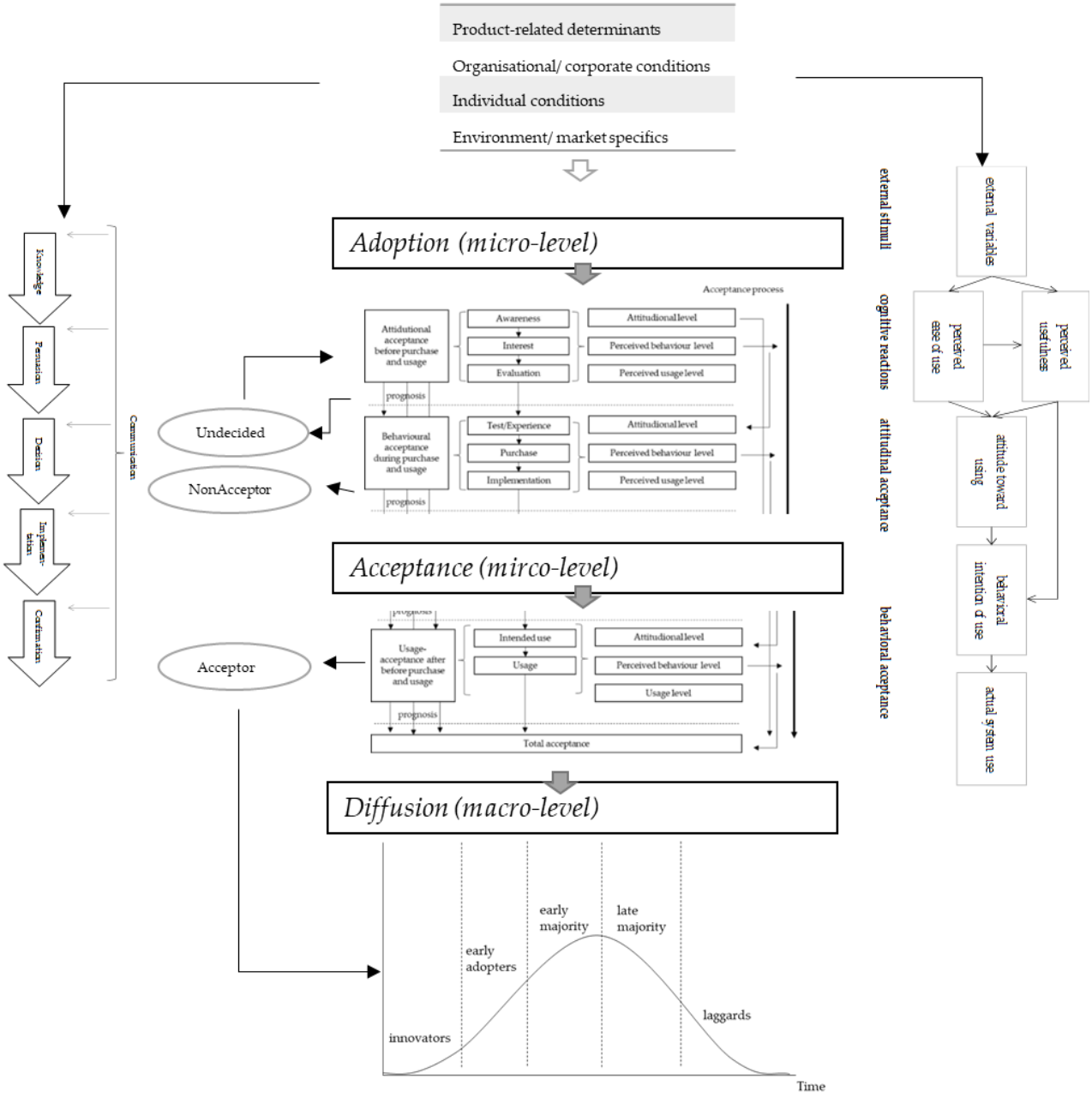

Illustration 21: The relationships of the fundamentals of adoption and acceptance models.[212]

[212] Author' illustration following: Davis (1989), p. 319 ff.; Kollmann (1999), p. 135; Rogers (2003), p. 170; Schmidt (2009): p. 21

Table 4 provides an overview of the named factors sorted in categories and sub-groups, with the names of included variables. The collection shows the wide range and heterogenous variety of factors that possibly moderate, mediate or directly influence technology acceptance.

The factors are divided in the following main four categories:

- Product related determinants
- Organisational / Corporate conditions
- Individual specifications
- Environment and market

The group show the sub-categories.

Influence factor cluster	Group	Details	Usage in studies
Product-related determinants	Technical design	• Hardware and software • Offer functions and features • Maturity • Response time • Data security • User friendliness/usability • Complexity • Perceived ease of use • Computer playfulness	Allerbeck et al. 1991; Anstadt 1994; Bandura 1982; Davis et al. 1989; Degenhardt 1986; Eidenmüller 1986; Goodhue 1995; Joseph 1990; Joseph et al. 1992; Kredel 1988; Lin 2003;Mesina et al. 1990; Müller-Böing et al. 1986; Reichwald 1978; Schönecker 1980; 1985; Silberer et al. 2002; Simon et al. 2001; Tornatzly et al. 1982; Venkatesh et al. 2000; 2003; 2008; Wehrmann 2004
	Introduction/launch/ implementation	• Trialability	Anstadt 1994; Hilbig 1984; Karahanna et al. 1999; Schönecker 1985
	Work structure	• Structure of tasks • Communication structure • Frequency of needed use	Allerbeck et al. 1991; Degenhardt 1986; Eidenmüller 1986 ; Lin 2003; Mesina et al. 1990; Reichwald 1978;
	Training and support	• Task-related training • Technical assistance	Schönecker 1985; Eidenmüller 1986; Igbaria 1993; Joseph 1990; Joseph et al. 1992;Mesina et al. 1990; Reichwald 1978
	Interaction with users	• Audience factors	Lin 2003
Organisational/corporate conditions	Work organisation	• Work safety • Ergonomics in the workplace • Working time	Anstadt 1994; Ajzen et al. 1980; Eidenmüller 1986; Joseph 1990; Joseph et al. 1992;

		• Perceived behavioural control • Voluntariness	Kollmann 1998; Mesina et al. 1990; Reichwald 1978; Venkatesh et al. 2000; 2003; 2008
	Company-related factors	• Size • Branch • Location • Economic situation	Kollmann 1998; Pohl 1996
	Decision-related factors	• Buying centre • Decider position and motivation • Risk appetite	Kollmann 1998; Pohl 1996
Individual specifications	Individual specifics	• Age • Gender • Nationality • Education/qualification • Technical skills • Profession • Family status • Geographical factors • Physiological factors (motorics; resilience)	Allerbeck et al. 1991; Anstadt 1994; Degenhardt 1986; Goodhue 1995; Gefen 1997; Joseph 1990; Joseph et al. 1992; Kollmann 1998; Mesina et al. 1990; Pohl 1996; Reichwald 1978; Venkatesh et al. 2008
	Behaviour/psychological factors	• Life style • Experiences • Motivation • Preferences • Expectations	Davis et al. 1989; Degenhardt 1986; Eidenmüller 1986; Fishbein et al. 1975; Gefen 1997; Hilbig 1984; Kollmann 1998; Lin 2003; Mesina et al. 1990; Pohl 1996; Reichwald 1978; Silberer et al. 2002; Venkatesh et al. 2000;

		• Values • Attitude • Price behaviour • Satisfaction • Media usage • Learning ability • Trust • Image • Habit • Computer anxiety • Perceived enjoyment	Venkatesh et al. 2000; 2003; 2008; Wehrmann 2004
	Work style/task relation	• Perceived usefulness/importance • Performance • Output quality • Result demonstration • Applicability • Job relevance • Perceived benefits	Davis et al. 1989; Degenhardt 1986; Goodhue 1995; Helmreich 1980; Karahanna et al. 1999; Lin 2003; Reichwald 1978; Schultz et al. 1975; Venkatesh et al. 2000; 2008; Wehrmann 2004
Environment/ market	Social environment	• Subjective norm • Influencing people • Network architecture • Data rate • Standards	Fishbein et al. 1975; Kollmann 1998; Lin 2003; Reichwald 1978; Venkatesh 2000; Venkatesh et al. 2000; 2003; 2008; Weiber 1992

	Macroeconomic environment	• Market structure • Economic climate • Financing • Welfare degree	Kollmann 1998; Weiber 1992
	Political/legal environment	• Laws on technique and data • Limited Competition • Influence of interest groups • Market entry restrictions	Kollmann 1998; Weiber 1992
	Technological environment	• Public opinion • Communication habits • Social norms • User groups	Kollmann 1998; Weiber 1992

Table 4: Collection and combination of determinants sorted by cluster

3.2.5 Validation of acceptance models and technology acceptance models

Some models show deficiencies in considering changing attitudes and behaviour. Several models try to forecast modifications in acceptance, but this prognosis is connected to complex measurements.[213] With regard to acceptance, the subject, object and context influence and change each other with feedback loops.[214] Thus, it can also be difficult to deduce dynamic need from attitude to behaviour and to achieve a prognosis.[215] However, with the help of the interim acceptance level, which creates the total acceptance considering the temporal framework acceptance or rejection, dynamic need can be identified within this decision process.[216] A dynamic context in regular measurement helps.[217]

In general, Davis' TAM 1 (1989) can be considered positively. Indeed, the main constructs and their relationships have been validated and confirmed in many studies and they are still used as a fundament for current research,[218] not least because the model is based on comprehensively proven and empirically confirmed results of socio-psychological behavioural research. In addition, the TAM 1 was developed to explain explicitly the factors that affect technology acceptance.[219]

A few studies have also attempted to consolidate the results of investigations. Starting in 2003, Legris et al. (2003) and Lee et al. (2003) conducted meta-analyses, followed by Ma et al. (2004), King et al. (2006), Sharp et al. (2006) and Yousafzai et al. (2007)[220] The analyses included a wide range of applications (from fax and e-mail up to decision support tools and telemedicine), in countries, study types and participants (from students to business people and HCPs). Most of the analyses

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[213] Cf. Filipp (1996), p. 17

[214] Cf. Filipp (1996), p. 30; Reichwald (1978), p. 35 f.

[215] Cf. Schnell (2009), p. 9

[216] Cf. Kollmann (1998), p. 134.

[217] Cf. Filipp (1996), p. 17.

[218] Cf. Schwenke (2008), p. 57.

[219] Cf. Ajzen et al. (1980), p. 5 ff.; Davis et al. (1989), S. 983.; Fishbein et al. (1975), p. 13 ff.; Lee et al. (2003), p. 752 ff.

[220] King et al (2006), p. 740 ff.; Lee et al. (2003); Legris et al. (2003); Ma et al. (2004); Sharp et al. (2006); Yousafzai et al. (2007)

confirmed the influence of PU on BI. There were mixed results in terms of the relationship of PEOU and BI. Nevertheless, all researches strongly supported the TAM for predicting system usage behaviour.[221] Given that these reviews confirmed the explanatory power of the TAM, it has become the gold standard and is widely known as a reliable model for analysing acceptance of individuals,[222] not least because of its simpleness and clearness.[223] Venkatesh (2003, p. 425) stated that the TAM is a 'useful tool for managers needing to assess the likelihood of success for technology introductions and help them understand the drivers of acceptance'.[224]

Although the TAM has become the gold standard in the English literature, the same is not true for the German literature. Indeed, many German studies published after 1989 have not built on the Davis model.[225]

Several revisions have been proposed to the TAM, and it has been questioned and additional determinants influencing the core constructs have been checked.[226] The results on factors, relationships and effects have differed by system types and users.[227] Thus, there is a need to prove the model in the specific technology and user environment.[228]

In addition to these issues in acceptance research, it is necessary to mention the innovation trilemma. When it comes to innovation, the user can be confused and lose orientation due the variety of innovations, ever-shortening innovation cycles, changes in values and scepticism in technologies.[229]

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[221] Cf. Chuttur (2009), n. pag.

[222] Cf. Holden et al. (2010), p. 159 ff.; Lee et al. (2003), p. 725 ff.; Momani et al. (2017), p. 51 ff.

[223] Cf. King et al. (2006), p. 740 ff; Mezni et al. (2008), n. pag.; Yang et al. (2004), p. 19 ff.

[224] Cf. Venkatesh et al. (2003), p. 425

[225] Cf. Schwenke (2008), p. 59

[226] Cf. Holden et al. (2010), p. 159 ff.

[227] Cf. King et al. (2000), p. 740 ff.; Monthy-Blanc et al. (2013), p. 326

[228] Cf. Verfürth (2020), n. pag.

[229] Cf. Schnell (2009), p. 9

The following have been learnt from behavioural theories and acceptance research:

- Acceptance has an attitudinal, a behavioural and a usage component.
- Acceptance development has a processual character.
- Intention leads to usage and can be a proxy for actual behaviour.
- Acceptance depends on several determinants. If relevant determinants (input factors) are considered, acceptance levels can be measured. There is a general agreement that the acceptance of technology is influenced by the system itself, the task and the organisational background.
- Output factors show the consequences of the acceptance and can also influence usage decisions.[230]
- Acceptance can give feedback for improving the technique and the organisational requirements
- Acceptance needs to be measured dynamically because it can change over time.

[230] Cf. Helmreich (1980), p. 22

3.2.6 Technology acceptance models in healthcare

In general, TAM has been the most used model in healthcare-related technologies.[231] Indeed, it has been validated as a questionnaire that aimed to clarify the reasons why a determined healthcare technology is utilised.[232]

Holden et al. (2010) published a systematic literature review that examined studies using the popular TAM models (See 3.2) for health technology acceptance by clinicians. They concluded that in healthcare, TAM can explain the substantial relationships of technology use and acceptance. However, the authors recommended modifying the model to the specifics of healthcare.[233] Rahimi et al. (2018) performed another review on technology acceptance of HCPs. The authors identified the usage of TAM in three main areas of technology application in health services: telemedicine, electronic health records and mobile applications. The reviewed literature had adapted the original TAM by adding additional variables of other theories or from the specific contextual health technology setting. Once more, the authors did not identify an ideal established model. Hence, they concluded that there is room for improvement in terms of the predictive character of the TAM in healthcare settings. [234] Overall, the difficulty in implementing technology in healthcare likely centres on the complexity of all indispensable settings.

[231] Cf. Hersh et al. (2001), n. pag.; Yarbrough et al. (2007), p. 650
[232] Cf. Finkelstein et al. 2011, p. 288 ff.
[233] Cf. Holden et al. (2010), p. 159 ff.
[234] Cf. Rahimi et al. (2018), p. 604 ff.

4 THE GERMAN TELEMONITORING MARKET FOR DIABETES

4.1 DIABETES

The number of diabetic patient in Germany has increased from 0.6 million in the 1960s to 6 million in 2014.[235] In 2017, there were 7.5 million diabetics in Germany, and there are approximately 500,000 new diabetes diagnosis per year.[236] In 2019, the *Diabetes Atlas* of the International Diabetes Federation (IDF) stated there are 9.5 million German people with diabetes.[237] Compared with other European countries, Germany currently has the highest rate of diabetic patients. In 2030, it is estimated that there will be 10.1 million diabetics in Germany.[238] Most of these patients – approximately 95% – have type II diabetes mellitus (T2DM). Experts have estimated that there are 2–4.5 million unrecorded cases of diabetes in Germany.[239] This estimate means that more than 10% of the German population likely has a diabetes diagnosis.[240]

There are differences in diabetes prevalence throughout Germany: the prevalence in eastern Germany has been estimated as 11.6%, 2.7% higher than the estimated prevalence in western Germany. People living in cities have a much higher risk (40%) of developing diabetes compared with people living in rural areas.[241]

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[235] Cf. http://www.zdf.de, PRAXIS täglich 13.11.2014

[236] Cf. Jacobs et al. (2019), p. 9 f.

[237] Cf. Diabetes-Atlas of International Diabetes Federation (IDF) 2019, p. 39; Tönnies et al. (2019), p. 1217 ff.

[238] Cf. Diabetes-Atlas of International Diabetes Federation (IDF) 2019, p. 39; Tönnies et al. (2019), p. 1217 ff.

[239] Cf. Diabetes-Atlas of International Diabetes Federation (IDF) 2019, p. 45; Siegel (2019), p. 179 ff.

[240] Cf. Jacobs et al. (2019), p. 20

[241] Cf. Jacobs et al. (2019), p. 20

4.1.1 Definition and classification

Diabetes mellitus is divided in different types. Type 1 diabetes mellitus (T1DM) arises from a heritable autoimmune phenomenon, but environmental factors also play an important role. T2DM comes from lifestyle effects such as overweight, malnutrition, lack of movement and consumption of nicotine and alcohol. Type 3 diabetes mellitus (T3DM) includes all rare types of diabetes. The reasons for T3DM are surgeries or medication, diseases of the adrenal gland or thyroid gland as well as monogenetic disorders. The fourth and a special type of diabetes is gestational diabetes (in German: Schwangerschaftsdiabetes). In this case, women have increased blood sugar levels during pregnancy due to hormonal changes.[242]

Diabetes is a chronic disease characterised by high levels of glucose in the blood. It occurs either because the pancreas stops producing the insulin hormone (Type 1 diabetes), or because the cells of the body do not respond properly to the insulin produced (Type 2 diabetes). People with diabetes are at greater risk of developing cardiovascular diseases such as heart attack and stroke if the disease is left undiagnosed or poorly controlled. They also have higher risks of sight loss, foot and leg amputation, and renal failure.[243]

4.1.2 Diabetes therapy

In Germany, diabetes treatment can be divided into three levels. The first level comprises care management from general practitioners (GPs). There are around 60,000 GPs in Germany. Around 80%–90% of all diabetic patients are advised by GPs. Only a few diabetics have diabetes advisors. The second level involves the 10%–20% of all diabetic patients who need permanent and intensive care. Those cases are supervised by specialised diabetes medical offices (in German: Diabetologische Schwerpunktpraxen [DSP]). There are around 1,100 of those medical institutions, mostly led my diabetologists. Each DSP takes care of an average 600 patients. Calculations have shown that the number of DSPs are appropriate to the number of diabetic patients in need of this special care, but there can be regional differences. The third level of care includes inpatient treatment in hospitals in cases

[242] Cf. Kabisch et al. (2014), p. 4 ff.
[243] Cf. OECD/EU (2018), p. 106

of emergencies or complications. Germany currently has around 390 specialised clinics. [244]

Around 40%–50% of T2DM patients are treated with hypoglycaemic pills, which lower blood sugar. More than 1.5 million patients are treated with insulin. There are three different types of insulin therapy: a combined treatment with pills, a conventional two-injection therapy or an intensified insulin therapy.[245]

Most patients use so-called insulin pens, which provide an easy way for insulin self-injection, along with classical syringes. Insulin may also be regularly delivered by an automatic pump placed on the skin or via a temporarily implanted sensor.[246] Diabetes technology (DT) is one of the main pillars of diabetes therapy. The systems employed for DT can be divided into diagnostic (e.g. blood glucose measurement) and the named therapeutic procedures. In the last 15 years, continuous glucose monitoring (CGM) with a pump application has increased.[247]

For the deployment of the different treatment types, there are evidence-based guidelines – which also influence the national treatment guidelines. These guiding principles are based on the reimbursement system defined in the so called Einheitlicher Bewertungsmaßstab (EBM). The EBM is a directory of the German healthcare system that sets standards for the accounting of ambulatory care of patients who have statutory health insurance. [248]

For diabetes care, a disease management programme (DMP) is crucial. The goal in caring for diabetics in those programmes are empowerment for self-care. Hence, the focus is not only on control of blood glucose, but also on lowering risks for other conditions – e.g. cardiovascular diseases – by lifestyle modifications such as physical activities.[249] The key in terms of self-care is training.[250] Around 50% of diabetic patients can be treated without medication; utilising training messaging to improve their nutrition and physical activities to lose weight renders medication unnecessary.[251]

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[244] Cf. Siegel (2019), p. 239
[245] Cf. Heinemann (2019), p. 176
[246] Cf. Heinemann (2019), p. 170
[247] Cf. Heinemann (2019), p. 170
[248] Cf. Siegel (2019), p. 240 ff.
[249] Cf. Kabisch et al. (2014), p. 21
[250] Cf. Kabisch et al. (2014), p. 21
[251] Cf. Siegel (2019), p. 240 ff.

The DDG (2019) fixes a diabetes surveillance plan in terms of a national diabetes strategy with four key areas:[252]

1. Ensuring high-quality, comprehensive, guideline-based, evidence-based and cross-sectoral care:
    - Encourage stronger activities in diabetology education in medical schools, further education of diabetologists, recognition of specific DDG qualifications;
    - Secure and expand independent diabetology departments in adult and paediatric clinics;
    - Establish a diabetic patient data register; and
    - Encourage a nationwide expansion and rapid implementation of the e-health law for the use of telemedical care and consultation models and adequate reimbursement for telemedical care services.
2. Reinforcement and promotion research in the field of diabetology:
    - Continue the German Centre for Diabetes Research (DZD);
    - Expand clinical studies; and
    - Use digital transformation in medicine, considering data protection and security as well as the right to informational self-determination of patients for the collection and use of big data.
3. Early diagnosis of diabetes mellitus:
    - Expansion of early detection measures for all forms of diabetes; and
    - Mandatory information about diabetes in preventive medical check-ups.
4. Prevention of diabetes mellitus and obesity:
    - Valued added tax (VAT) exemption for healthy food as well as clear nutrition labelling of food;
    - Limit advertising of unhealthy foods to children and young people; and
    - Establish standards for daily sports and school meals at school.

[252] Cf. DDG (2019), n. pag

4.2 THE GERMAN HEALTHCARE SYSTEM FOR DIABETES CARE

The following market examination incorporates a political, economic, social and technological (PEST) analysis. This macroeconomic view of a market is an environment analysis.[253]

4.2.1 Technological aspects

Among European countries, Germany leads in terms of telehealth revenue and number of companies working in telehealth.[254]

4.2.1.1 E-health and telehealth/telemedicine

For classification of the term telemonitoring, it is necessary to define e-health and telemedicine. The literature has provided different usages and definitions.[255] The World Health Organization (WHO) uses e-health as a collective term for health-related activities, services and systems that use information communication technology to overcome physical distance. The targets of e-health are diagnosis, health control and treatment, education, management and research in healthcare.[256] Overall, e-health represents a broad spectrum of ICT-supported applications, where electronic data is processed to support the care process of patients. One part of e-health is telemedicine.[257]

'Four elements are germane to telemedicine: 1. Its purpose is to provide clinical support. 2. It is intended to overcome geographical barriers, connecting users who are not in the same physical location. 3. It involves the use of various types of ICT. 4. Its goal is to improve health outcomes'.[258] In Germany, the German Medical Association (in German: Bundesärztekammer) treats telemedicine as a collective term of different medical treatment concepts that share the following commonality:

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[253] Cf. Kürble (2015), p. 23 ff.

[254] Cf. European Commission (2018), p. 36 ff.; Statista (2018)

[255] Cf. Fischer et al. (2016), p. 5

[256] Cf. http://www.emro.who.int/entity/ehealth/index.html; Fischer et al. (2016), p. 5

[257] Cf. https://www.bundesgesundheitsministerium.de/service/begriffe-von-a-z/e/e-health.html#c1494

[258] WHO (2010), p. 9

healthcare of the society in the field of diagnostic, therapy and rehabilitation as well as medical decision consultancy is provided over a distance with the help of ICT. ICT mean apps, medical devices, e-consult platforms or video technology.[259] Telemedicine contains many different components and corresponding combinations. Thus, it is necessary to show the different structures. [260]

In most cases, telemonitoring solutions can be defined as a product-platform-database combination. The product – e.g. a medical device (used in a medical framework by an HCP to diagnose, cure, treat or prevent a disease) – or a wearable device – e.g. implants or accessories worn on the body (mostly used for personal purposes to measure vital parameters such as during sport activity) – is used at the patient level to collect data. Another product can be an application used via a mobile phone, personal digital assistant (PDA) or any wireless device in terms of m-health (mobile health). An intermediary between a patient and HCPs is a platform that shares data. There is a database at the physician level to store and analyse data. The core of the connection is a software programme that supports defined work flows, data management and security. It can use big data, analytics or robotics to support the analysis and outcome.[261]

Other telemedicine services include call centres, online information platforms for patients, electronic home visits or video conferences.[262]

The forms of involvement and interaction of users are also crucial:[263]

- **doc2doc:** Contact between physicians or other care providers;
- **doc2patient:** Contact between physicians and patients;
- **doc2admin:** Use of ICT for administrative processes, e.g. communication with care providers or payers;
- **patient2patient:** exchange of experiences between patients, e.g. self-help groups; and
- **patient2admin**: Transfer of healthcare data to a supporting provider.

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[259] Cf. https://www.bundesaerztekammer.de/aerzte/telematiktelemedizin/telemedizin/

[260] Cf. Kommission der europäischen Gemeinschaften (2008), p. 4

[261] Cf. European Commission (2018), p. 28 ff.

[262] Cf. Kommission der europäischen Gemeinschaften (2008), p. 4

[263] Cf. Fischer et al. (2016), p. 10

4.2.1.2 Telemonitoring

One service of telemedicine is telemonitoring.[264] Telemonitoring has also been called smart home care, remote physiological monitoring, remote patient monitoring or home monitoring. Telemonitoring is defined as the deployment of health services via ICT in case of physical distance between the patient and HCPs. Telemonitoring requires a secure transfer of medical data and information for the prevention, diagnosis, therapy and further treatment of a patient in terms of text, sound, pictures or other types of data.[265] Telemonitoring is a service for monitoring the state of health of patients.[266] Data are collected automatically by means of a patient's electronic devices, which are portable or implanted. Data are monitored or collected with the active help of the patient. As soon as the data is forwarded, it can be used for optimisation of the patient's therapy protocols.[267] Illustration 22 shows the telemonitoring process and interaction of the main users of such a programme orientated at a project of the university hospital in Münster.[268] All data is based on a core telemedicine system. A patient gets a therapy initiated by the treating physician and monitored regularly by a telemedicine centre with medical experts.

[264] Cf. Kommission der europäischen Gemeinschaften (2008), p. 4.

[265] Cf. Kommission der europäischen Gemeinschaften (2008), p. 3.

[266] Cf. Kommission der europäischen Gemeinschaften (2008), p. 4.; Pare et al. (2007), p. 269 ff.

[267] Cf. Kommission der europäischen Gemeinschaften (2008), p. 4.

[268] Cf. diabetes-deutschland.de/archiv/archiv_3225.htm; Krüger-Brand (2005), p. 2.

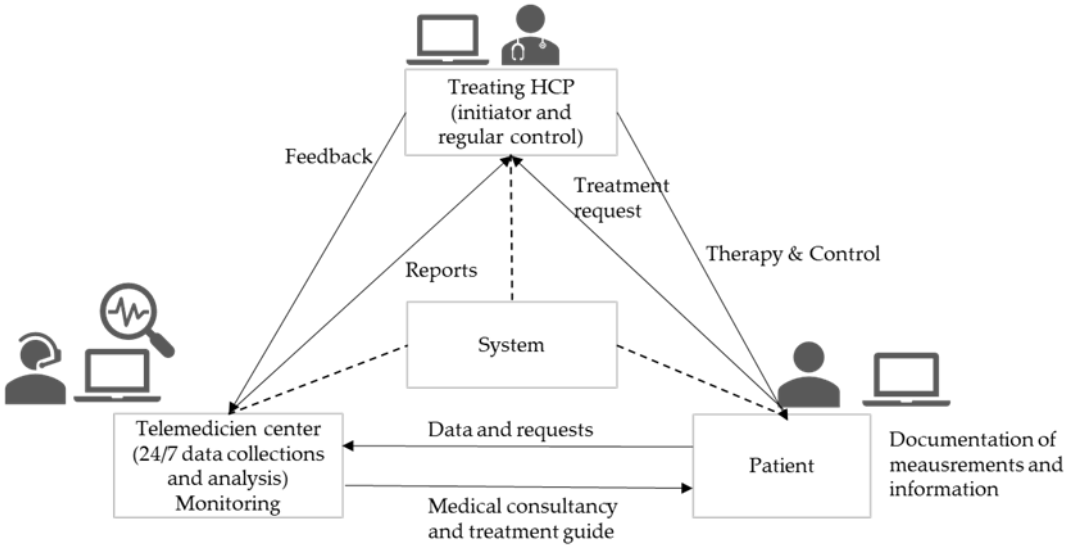

Illustration 22: The telemonitoring process and framework[269]

4.2.1.3 Evaluation and effectiveness of diabetes telemedicine

One of the most used telemedicine disciplines is telediabetology, which involves coaching patients.[270] Diabetes is also understood as a 'data management disease' due to its continuous need to monitor vital parameters, glucose levels and lifestyle data.[271] Many chronically sick diabetic patients can be monitored due to the long disease duration and the state of health. Diabetics may only need to visit health institutions on rare occasions and their quality of life is positively influenced due to a better state of health and a secure feeling.[272] Clinical studies with meta analyses for telemedicine support in diabetes care have shown significant clinical benefits in terms of glycaemic control. Young patients (< 55 years) and patients with a shorter diabetes disease history (< 8.5 years) benefit the most from telemedicine.[273] An important advantage is the individual supervision of the patient. At any time

[269] Cf. In line with: diabetes-deutschland.de/archiv/archiv_3225.htm
[270] Cf. European Commission (2018x), p. 21
[271] Cf. Waschkau et al. (2019), p. 917
[272] Cf. Kulzer et al. (2018), p. 200 ff.
[273] Cf Lee et al. (2017), ePub; Wu et al. (2018), p. 825 ff.; Zhai et al. (2014), ePub

the patient can ask for the professional advice of a medical specialist without visiting a physician in person.[274] HCPs also benefit from telemedicine. Symptoms or abnormal medical parameters can be detected early compared with routine checks or in emergency care; thus, countermeasures can be taken earlier.[275]

4.2.2 Economic aspects

In addition to GPs, the main medical HCPs who are in charge of diabetes therapy are diabetologists as well as diabetes advisors (Diabetesberater).[276] The qualification of a diabetologist includes two additional years of education based on general, internal medicine or paediatric medicine.[277] In addition to GPs and diabetologists, diabetes advisors play an essential role in therapy and training diabetic patients.[278] A diabetes advisor aims to take care of and consult with patients with diabetes as well as pregnant women with gestational diabetes. Diabetes advisors may be employed at a medical institution or self-employed.[279] According to the 2019 report of the DDG and diabetes DE, there are currently 4,270 diabetologists and 4,350 diabetes advisors working in Germany. For diabetologists, 1,400 are working in the resident sector and the rest in the clinical area.[280]

Health services are financed in the German healthcare system as follows: statutory health insurance (in German: Gesetzliche Krankenversicherung [GKV]) is funded by contribution payments from insured members based on an employee's share of his or her salary or by a pensioner's pension insurance as well as the employment agency for unemployed people. GKV also receives subsidies from public funds. These sources of income go into a health fund.[281] Physicians in ambulatory care (resident physicians, who are the research subject in this thesis) invoice their treatments on the basis of the EBM (See 4.1.2). This invoicing is organised via

[274] Cf. http://www.zdf.de, PRAXIS täglich 13.11.2014

[275] Cf. Kommission der europäischen Gemeinschaften (2008), p. 4

[276] Cf. Siegel (2019), p. 237

[277] Cf. Siegel (2019), p. 237

[278] Cf. Siegel (2019), p. 237

[279] https://www.deutsche-diabetes-gesellschaft.de/weiterbildung/diabetesberaterin-ddg.html

[280] Cf. Siegel (2019), p. 237

[281] Cf. Bannenberg (2013), p. 84 ff.; Wernitz et al. (2015), p. 42 f.

the Kassenärztliche Vereinigung (KV), which further organises payment with insurance companies.[282] Physicians or associations can also have direct, selective contracts with an insurance company (in German: Selektivvertrag). In that case, members of an insurance company are confined to a physician when using a health service regulated in this contract.[283]

Statutory health insurance finances more than half of all health services and thus represents the main payer in the German healthcare system. Around 85% of the German people are insured with statutory insurance. The rest of the German population are insured with private health insurance (in German: Private Krankenversicherung [PKV]). This insurance is mandatory for officials, freelancers and self-employed people, but it is also voluntary for an insurance holder who makes more than a defined annual income.[284] Since 2004, it has been possible to have an additional private insurance package for specific health services or products in addition to statutory health insurance.[285] In contrast to GKV, a private insurance holder gets a cash payment as reimbursement and no payment in kind.[286] Another type of payment for health services is individual healthcare service (in German: Individuelle Gesundheitsleistungen [IGel]). The patient pays for specific services – for which there are not enough evidence of their necessity – privately without reimbursement to receive the treatment.[287]

Most costs of diabetes are associated with secondary diseases. The largest share of costs belongs to hospitalisation. 288 According to ZDF (second public service national television program), the treatment of diabetic patients in 2014 cost more than EUR 30 billion. In Germany, T2DM leads to around 28,000 foot amputations, around 2,000 new cases of blindness, around 6,000 new dialysis patients, around 27,000 heart attacks and around 44,000 strokes per year.[289]

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[282] Cf. Baumann et al. (2013), p. 123

[283] Cf. Wernitz et al. (2015), p. 85

[284] Cf. Wernitz et al. (2015), p. 56 ff.

[285] Cf. Wernitz et al. (2015), p. 40 f.

[286] Cf. Wernitz et al. (2015), p. 56 ff.

[287] Cf. Wernitz et al. (2015), p. 89

[288] Cf. Linnekamp et al. (2019), p. 21 ff.

[289] Cf. http://www.zdf.de, PRAXIS täglich 13.11.2014; Linnekamp et al. (2019), p. 21 ff.

Approximately 16% of all deaths are associated with T2DM, although there may be an underestimation of the mortality risk.[290]

Given that major triggers and risk factors of T2DM are overweight, high blood pressure, dyslipidaemia due to incorrect or inadequate nutrition and limited physical activity, a change in lifestyle can improve health, but there are less contact points for intensive support with HCPs. Experts are convinced that the use of telemonitoring can save billions in costs because medical services and quality of life can be improved significantly. Indeed, studies have shown that better treated patients can have 90% reduced care costs than patients with permanent high blood glucose levels. These costs imply secondary complications and hospital treatments.[291]

Telemedicine for diabetes is not yet a standard benefit of health insurance: whether costs are borne by the patient or reimbursed is currently decided on a case-by-case basis. Nevertheless, the standard benefit is a future target. So far, only partial aspects of telemonitoring have been analysed, but the benefit of complete medical coverage and networks needs to be shown.[292]

4.2.3 Political aspects

In terms of the political environment, specific legislation regarding healthcare needs to be considered.[293] Since 2004, the German legislature has been working on the basis of telematics infrastructure and the electronic health card,[294] based on the Healthcare Modernization Act (Gesundheitsmodernisierungsgesetz [GMG]).[295] Telematics includes telecommunication and informatics and describes the networking of different IT systems and the possible linkage of information from different sources. The telematics infrastructure (TI) should connect all market players

[290] Cf. Jacobs et al. (2019), p. 20

[291] Cf. http://www.zdf.de,PRAXIS täglich 13.11.2014

[292] Cf. http://www.zdf.de,PRAXIS täglich 13.11.2014

[293] Cf. Kürble (2015), p. 23 f.

[294] Insurance ID card with a chip for data transmission

[295]Cf.https://www.bundesaerztekammer.de/aerzte/telematiktelemedizin/earztausweis/e-health-gesetz/

in the healthcare system to ensure secure transfer of information:[296] this is the fundament for telemedicine solutions. The structure also defines who is authorised to access data. Therefore, the *gematik*[297] are integrating certified components into the systems.[298]

Extensive technological structures and applications for telemedicine have not yet been implemented due to gaps in nationwide Internet broadband supply.[299] The **E-Health-Law** (Gesetz für sichere digitale Kommunikation und Anwendungen im Gesundheitswesen sowie zur Änderung weiterer Gesetze), which was passed in 2016, aims to begin establishing a telemedicine framework, including data security. The patient's competence to decide about his or her personal and health data is strengthened. All relevant data are saved in one place and are provided to multidisciplinary HCPs.[300] In 2017, a new resolution established that **video consulting** hours (in German: Online Video-Sprechstunde [OVS]) can be invoiced. The agreement was further extended, so that after one physical face-to-face contact, basic invoicing is possible and no in-person contacts are required.[301] Furthermore, the prohibition on remote treatment (in German: **Fernbehandlungsverbot**) was removed from the medical code of conduct (Musterberufsordnung [MBO]) in 2018.[302] However, advertising only remote treatment without necessary personal contact with a HCP is still not allowed.[303]

The digital provision law (in German: Digital-Versorgungs-Gesetz [DVG)]) was passed in November 2019.[304] In addition, the DVG the Digital Health Applications Regulation (in German: Digitale-Gesundheitsanwendungen-Verordnung [DiGAV]) was passed. With this regulation, digital health applications, which are

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[296]Cf. https://www.gematik.de/telematikinfrastruktur/

[297] Gesellschaft für Telematikanwendungen der Gesundheitskarte mbH assigned to introduce the electronic health card and its infrastructure in Germany, www.gematik.de

[298]Cf.https://www.telematikinfrastruktur.de/index.de.jsp

[299]Cf.https://www.bundesaerztekammer.de/aerzte/telematiktelemedizin/earztauswe is/e-health-gesetz/, BmWi (2018), p. 53 f.

[300] Cf. E-Health-Law, Deutscher Bundestag (2015), 2408 ff., Beermann (2017), p. 36

[301] Cf. Kassenärztliche Bundesvereinigung (2017), n. pag.; Kassenärztliche Bundesvereinigung (2019), n. pag.

[302] Cf. Bundesärztekammer (2018), p. 1 ff.

[303] Cf. Hahn (2019), p. 49 f.; HWG § 9

[304] Cf. DVG (2020)

class I or IIa medical devices,[305] can be approved by the Federal Office for Drugs and Medical Devices (BfArM) by a standard process to ensure that digital applications marketed as medical devices meet high quality standards.[306]

Data are also managed within a remote treatment; thus, the current German regulations in data security (DSGVO and BDSG) must be considered. Health data are subject to a special protection and can only be transferred to other HCPs for the purpose of the fulfilment of health services in consideration of professional secrecy.[307]

4.2.4 Social aspects

Diabetes changes a person's lifestyle, so he or she can be limited in several areas of life and perceive a reduction in quality of life. Continuous therapy, training (See 4.1.2) and adaption of activities to one's healthcare status is required by every diabetic patient.[308] There are a wide range of aspects that make a person's diabetes management difficult: acceptance at having a lifetime disease, motivation for a permanent therapy, worries and fears about secondary disease or complications, complexity of therapy in terms of self-control and feelings of helplessness.[309] In this regard, self-help is essential. Large patient self-help groups and organisations[310] are platforms to exchange information with other patients.[311]

The tendency for hypoglycaemic complications must be given a special consideration because it might affect performance – usually only for minutes, but in rare cases it can also lead to an impairment of consciousness. The occurrence can therefore put other people or the diabetic him- or herself at risk. The risk of developing severe hypoglycaemia can be reduced by metabolic adjustment and possibly hypoglycaemia perception training.[312]

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[305] See the German medical device law (MPG) categorising medical products
[306] Cf. https://www.bfarm.de/DE/Medizinprodukte/DVG/_node.html
[307] Cf. Hahn (2019), p. 47 f.; DSGVO; BDSG
[308] Cf. Finck et al. (2019), p. 164 ff., Kulzer (2019), p. 160 f.
[309] Cf. Kulzer (2019), p. 159 f.
[310] See https://www.ddf.de.com/, https://www.diabetesde.org/
[311] Cf. Finck et al. (2019), p. 164 ff.
[312] Cf. Ausschuss Soziales der DDG (2004), p. 7

The German healthcare report for diabetes 2019 highlighted that there is still a kind of discrimination for diabetics in their working life. Diabetics are still excluded from several jobs and roles even though modern diabetes therapy can enable them to do a lot of work.[313] The DDG lists jobs that can become dangerous in terms of hypoglycaemia like passenger transport, sole security functions, usage of weapons or dangerous work. Other jobs or activities without a daily routine or plan can make adequate treatment with regular mealtimes, limited physical strains or metabolic self-control difficult.[314]

Overall, there is limited nationwide awareness on the chronic disease of diabetes in German society. The DDG is missing an open-minded approach and realistic presentation of this disease in public.[315]

4.3 DIABETES TELEMEDICINE IN GERMANY

4.3.1 Programmes in Germany

There is a wide range of available apps for patients, but only a few have been certified as a medical device. The company Dia Digital shows certified apps.[316] However, only a few have an interactive component with HCPs. Most are targeted for self-documentation, like a diary for a diabetic patient.

The platform digimedia gives an overview on trusted and safe evaluated medical e-projects in Germany (see https://digimeda.de/digitale-medizin-apps/diabetes-mellitus). Table 5 provides information about the currently available diabetes programmes with telemedicine components:

[313] Cf. Finck et al. (2019), p. 164 f.

[314] Cf. Ausschuss Soziales der DDG (2004), p. 7 ff.

[315] Cf. Finck et al. (2019), p. 164 f.

[316] Cf. https://www.diadigital.de/apps-mit-siegel/; Gießelmann (2018), ePub; Waschkau et al. (2019), p. 917

Logo	Project name	Provider	Description
TeLiPro	TeliPro (Telemedizinisches Lebensstil-Interventions-Programm für Typ-2-Diabetiker) https://www.telipro-aok.de/	AOK Partner: Deutsche Diabetes Zentrum (DDZ); DITG; inav; Kassenärztliche Versorgung Nordrhein (KVNO), VDBD financed by the innovation fund of the German federal government[317]	The diabetic has a telemedicine device at home (e.g. blood sugar measurement device, scale). Measured data are transferred via an online portal, where the patient can see his or her development. The patient is accompanied by a health coach, who consults the diabetic via telephone. The project is part of a clinical study.[318]
PatientConcept	Patient Concept https://patientconcept.app/	NeuroSys GmbH, a private company, promotes the concept as a medical device; funded by the Bavarian state ministry of economics.	The programme includes an app for patients and a web-based portal for medical offices. Patients of participating physicians can use the app to manage their disease: diary function, activity monitoring, therapy control, alarms for medication, ordering prescriptions and appointment requests. The medical office can include news of their activities, upload labour results and control incoming data and requests. Special function usage needs to be paid by the medical office.[319]

[317] Cf. https://www.ditg.de/wp-content/uploads/2018/11/PM-Innovationsfonds-TeLIPro-1.pdf

[318] Cf. https://www.telipro-aok.de/ueber-das-projekt

[319] Cf. https://patientconcept.app/#praxis; https://neurosys.de/anwendungsfelder/

Emperra Digital Diabetes Care	ESYSTA https://www.emperra.com/de/ueber-uns/	Emperra GmbH E-Health Technologies, a private company, promotes the concept in combination with the medical devices. These product can be prescribed by the physician.	The diabetic has a telemedicine device at home (e.g. blood sugar measurement device, insulin pen). Measured data are transferred via an online diary accessible via the app, a tablet or a computer, where the patient can see his or her development, which can be shared with a treating physician by the patient. Adaption of therapy can be discussed via telephone.[320]

Table 5: Diabetes telemedicine projects in Germany in 2020

Of the current listed projects provided by the gematik of the official nationwide e-health projects in Germany, there is only one telemedicine project for diabetes:[321] TeleDIAB® (Telemedizinisches Informationssystem KADIS®[322]-basierter Gesundheitsdienstleistungen für Diabetes). It is one of the first projects in diabetes telemedicine, started in 2006 as Diabetiva. TeleDIAB as a telemedical information system is a database and communication system that considers the specific needs of the care process for diabetics and also enables interactive online access to KADIS-based health services.[323]

There are currently no diabetes telemedicine programmes that include a telemedicine centre with external experts. Even the existing programmes only allow a one-sided communication and physicians need to gather necessary data from different sources or have no access to other relevant data as physical activity and nutrition of a patient.[324]

[320] Cf. https://www.emperra.com/de/esysta/

[321] Cf. https://www.informationsportal.vesta-gematik.de/projekte-anwendungen/

[322] Karlsburger Diabetes Management System (Kadis) describes a structured test of patient glucose profile for identifying treatment weak points and developing therapy recommendations http://www.kadis-online.de/

[323] Cf. http://www.kadis-online.de/; https://www.informationsportal.vesta-gematik.de/projekte-anwendungen/detail/projects/telediabr-telemedizinisches-informationssystem-kadisr-basierter-gesundheitsdienstleistungen-fuer-di/

[324] Cf. https://www.dut-report.de/2020/01/14/telemedizin-update-2020/

Table 6 provides an overview of the main telecentre programmes in Germany and their characteristics. This list only includes 24/7 remote doctor offerings, with a focus on the largest centres and German insurance companies. These centres do not diagnose or offer acute care; they only clarify medical questions. So-called telemedicine centres of medical institutes for transfer of healthcare data or networking of market players are outside the focus. The teleservices are financed by contracts with the insurance companies (for their members) and/or employers (for their employees). No teledoctor centre has a specialised area for diabetes or a monitoring function.

Name	**Insurance companies**	**Services/specialties**
IFE Telearzt[325]	None involved (80 physicians in the centre)	Teledoctor centre for consultation in all medical specialties; answered by physicians via post, fax, SMS, e-mail or phone and exchange with treating physicians if required
Clarimedis[326]	AOK insurance (approximately 27 million members)	Teledoctor centre for consultation in all medical specialties; answered by physicians, nurses and pharmacists via e-mail or phone
TK-Ärzte Zentrum[327]	TK insurance (approximately 10 million members)	Teledoctor centre for consultation in all medical specialties; answered by physicians via e-mail or phone.
Teledoktor[328]	Barmer insurance (approximately 9 million members); provider is the almeda GmbH[329]	Teledoctor centre for consultation in all medical specialties; answered by physicians and psychologists via e-mail, chat function, video calls or phone; an app is available

[325] Cf. www.telearzt.de/

[326] Cf. https://www.aok.de/pk/uni/inhalt/medizinische-informationen-am-telefon-aok-clarimedis/

[327] Cf. https://www.tk.de/techniker/leistungen-und-mitgliedschaft/informationen-versicherte/leistungen/arzt-und-krankenhausbesuch/haeufige-fragen-zur-aerztlichen-behandlung/tk-aerztezentrum-2009666

[328] Cf. https://www.barmer.de/unsere-leistungen/online-services/teledoktor

[329] Cf. https://www.shl-telemedizin.de/almeda/

Medizin-Hotline[330]	DAK (approximately 5.5 million members)	Teledoctor centre for consultation in all medical specialties; answered by physicians; special hotlines, e.g. for medication, are installed.

Table 6: The largest teledoctor centres in Germany[331]

4.3.2 View of German medical diabetes societies on telemedicine

The German Diabetes Association of Physicians (Deutsche Diabetes Gesellschaft [DDG]) named digitalisation as one of 10 strategic areas of activity until 2025. The DDG demands **mandatory standards** for the implementation of digitalisation. The quality definition should be transferred to the digital world. The association should also be involved in technical standards. E-health offerings need to be evaluated based on evidence, so transparency with regard to algorithms is obligatory. The DDG requests a committee for digitalisation and **data security** to consider patient centricity and data security in terms of legal, ethical and research aspects. Offerings need to be designed to ensure individual treatment: every patient must have access to and understand the service. Diabetologists and the cooperating teams need to be educated systematically to answer future requirements.[332]

The DDG has published a Code of Conduct with seven concrete fields of action:[333]

1. **Data and information protection**: The DDG demands the necessary requirements for self-determination of patients about their data. The DDG demands a balance of restriction in data security to allow patients to participate in research-based diabetes (technology) development.

2. **Data security**: In addition to the rules of the EU basic regulation of data protection, the DDG requires that IT systems should be connected; this connection currently doesn't exist. The DDG expects more

[330] Cf. https://www.dak.de/dak/kontakt/medizin-hotline-2074972.html#/

[331] Cf. https://www.krankenkasseninfo.de/test/aerztehotline; www.telearzt.de/; www.videoclinic.de; https://www.krankenkassen.de/krankenkassen-vergleich/statistik/versicherte/aktuell/

[332] Cf. Breitbach et al. (2016), p. 14 f.

[333] Cf. Ickrath (2018), p. 450 f; Müller-Wieland et al. (2017), n. pag.

efforts towards Internet security to protect patient data from the government and industry, as well as data structures of medical offices.

3. **Interoperability**: The DDG welcomes the e-health law and the creation of a telematics infrastructure but criticises the inadequate implementation. The DDG demands that companies working in the field of diabetology system development are committed to integrate technical standards, so that the digitisation of patient care allows trans-sectoral collaboration.

4. **Digital treatment standards**: The DDG plans to establish a German electronic health ID card for diabetes (in German: elektronische Diabetesakte [eDA]) to leverage structured, guideline-orientated and patient-centred diabetes treatment and build a register for diabetes data for research.

5. **Effective physician-patient relationship** (in German Sprechende Medizin): In terms of personalised medicine, the DDG requires more focus on therapy talks and adequate compensation, which are key elements in diabetes treatment to analyse behaviour and create motivation.

6. **Training:** The DDG is committed to work on training related to data protection, security and technology.

7. **Algorithms and transparency:** The DDG demands a national framework for an algorithm of diabetes health data, so that the interpretation serves the well-being of the patient.

The German committee Zukunftsboard Digitalisierung (future board digitalisation) has initiated the first survey targeting German diabetologists; it asks participants to evaluate digitalisation and new technologies. The German diabetes research institute FIDAM[334] conducted the study and distributed the survey as an

[334] https://www.fidam.de/

online survey via different clinical diabetes-focused channels. The results are summarised in the 2019 and 2020 digitalisation and technology report diabetes (DUT; in German: Digitalisierungs- und Technologiereport Diabetes) reports, which published the results of the survey from the prior year.[335] The main findings in terms of technoligisation and telemedicine are:[336]

- In 2019, 63.7% of diabetes physicians described their attitude towards digitalisation as positive. In 2020, the share increased to 75.8%.[337]
- The biggest advantages of digitalisation and technology in 2020 is seen in the improved communication between physician and patient and a higher support in therapy decisions. In 2019, the highest scores were on ensuring greater patient safety and a better treatment quality. Better communication between medical colleagues as well as a better economic efficiency received lower scores.[338]
- Although telemedical possibilities have been increasingly discussed in recent years, there was a marked shift in how diabetologists rank the importance of telemedical care: from 30.7% in 2018 to 9.6% in 2019. It seems that the topic of telemedicine has not yet reached diabetologists, as they prognose a greater increase in importance for the next 5 years (37.7 %) than in 2018 (27.2%). Only 10% have ever offered a video consultancy hour.[339]
- Almost half (44.3%) of the respondents named unsolved data security difficulties as the main barrier for implementation of technology.[340]

In 2008, the Commission of the European Communities had named three essential interventions to support countries with the useful implementation of telemedicine, all of which are still valid:[341]

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[335] Cf. Hochstadt et al. (2019), p. 74 ff.; https://www.dut-report.de/2020/01/16/aerzteumfrage-2020/

[336] Cf. https://www.dut-report.de/2020/01/16/aerzteumfrage-2020/;

[337] Cf. https://www.dut-report.de/2020/01/16/aerzteumfrage-2020/#toggle-id-34; https://www.dut-report.de/2019/01/14/einstellungen-zur-digitalisierung/

[338] Cf. https://www.dut-report.de/2019/01/14/vor-und-nachteile-der-digitalisierung-bei-diabetes/; https://www.dut-report.de/2020/01/16/aerzteumfrage-2020/#toggle-id-34

[339] Cf. https://www.dut-report.de/2020/01/16/aerzteumfrage-2020/#toggle-id-34

[340] Cf. https://www.dut-report.de/2020/01/16/aerzteumfrage-2020/#toggle-id-39

[341] Cf. Kommission der europäischen Gemeinschaften (2008), p. 4

(1) Create **trust** in telemedicine services and build acceptance;
(2) Establish **legal** clarity; and
(3) Clarify **technical** questions and facilitate market development.

Findings

- There is a great need to manage diabetic patient and their data.
- The market analysis showed a lack of telehealth specification, financing infrastructure, evidence of cost effectivness and social awareness of diabetes.
- There is currently no 24/7 telemedicine diabetes monitoring via a collaboration of a teledoctor centre and treating HCPs on the German market.

5 STUDIES OF TELEMEDICINE ACCEPTANCE: LITERATURE REVIEW

The review of the technology acceptance research and the German diabetes market has been combined to determine what is already known in the technology literature about telemedicine in healthcare, preferably for diabetes care in Germany. It should be investigated whether there are specific TAMs for the German healthcare environment, the telemedicine service interaction and diabetes related contexts. Therefore, the following section presents the results of a **systematic literature review** that has been conducted.

For choosing relevant acceptance factors for telemonitoring technologies in the healthcare environment, this study reviewed the datasets from previously conducted studies with quantitative tests on telemedicine acceptance of attending medical professionals. The systematic review considered international studies published between 01 January 2000 and 01 January 2018 from **PubMed**[342] and **ScienceDirect**[343] with specific keywords. PubMed, with access to Medline, ranks among the most popular meta search databases in the medicine field.[344] ScienceDirect from Elsevier, a major biomedical publisher, is one of the leading databases for scientific literature focussed on medicine among other topics.[345] Only peer-reviewed papers have been included. The main search keywords were (telemedicine OR telehealth) AND technology acceptance model.[346] The search encompassed telemedicine and telehealth, not limited to telemonitoring, to have a larger study basis. The review approach and findings are presented in Illustration 23. Only studies that utilised TAM constructs and variables or its extensions have been considered to ensure comparability among studies.

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[342] Cf. https://www.ncbi.nlm.nih.gov/pubmed

[343] Cf. https://www.sciencedirect.com/

[344] Cf. https://www.ncbi.nlm.nih.gov/pubmed

[345] Cf. https://www.elsevier.com/de-de/solutions/sciencedirect

[346] Cf. Verfürth (2020), n. pag.

After manually reviewing 276 abstracts and full texts, the following types of publications were excluded:[347]

- Clinical trials;
- Conference abstracts;
- Summaries, pure literature reviews or secondary analyses;
- Exploratory studies;
- Qualitative research, e.g. interviews;
- Analysis of patient acceptance or other non-healthcare target groups;
- **Research on healthcare IT without interactive telemedicine aspects – meaning communication with colleagues, a telemedicine centre and or patients –** e.g. documentation software, single devices, electronic patient records or general technology/IT/ICT adoption/acceptance to primarily store or only transfer data or give decision support only to a physician;
- Research on technology assessment (e.g. effectiveness and feasibility);
- Studies without open access or full text availability;[348]
- Studies on other methodologies based on TAM, UTAUT or extensions; and
- Studies in languages other than German and English.

Moderating factors, especially in terms of sociodemographics, have been excluded. The included papers are all primary studies (with or without prior literature review) with clear telemedicine aspects. The screening phase concentrated on studies with telehealth service character to explore specific view on tele-aspects with interactions, feedback and access from different sides.

The most common reason for the exclusion of the study was the patient orientation.

[347] Cf. Verfürth (2020), n. pag.

[348] Access via Universität Duisburg/Essen, Germany licenses: https://www.uni-due.de/ub/kataloge.shtml

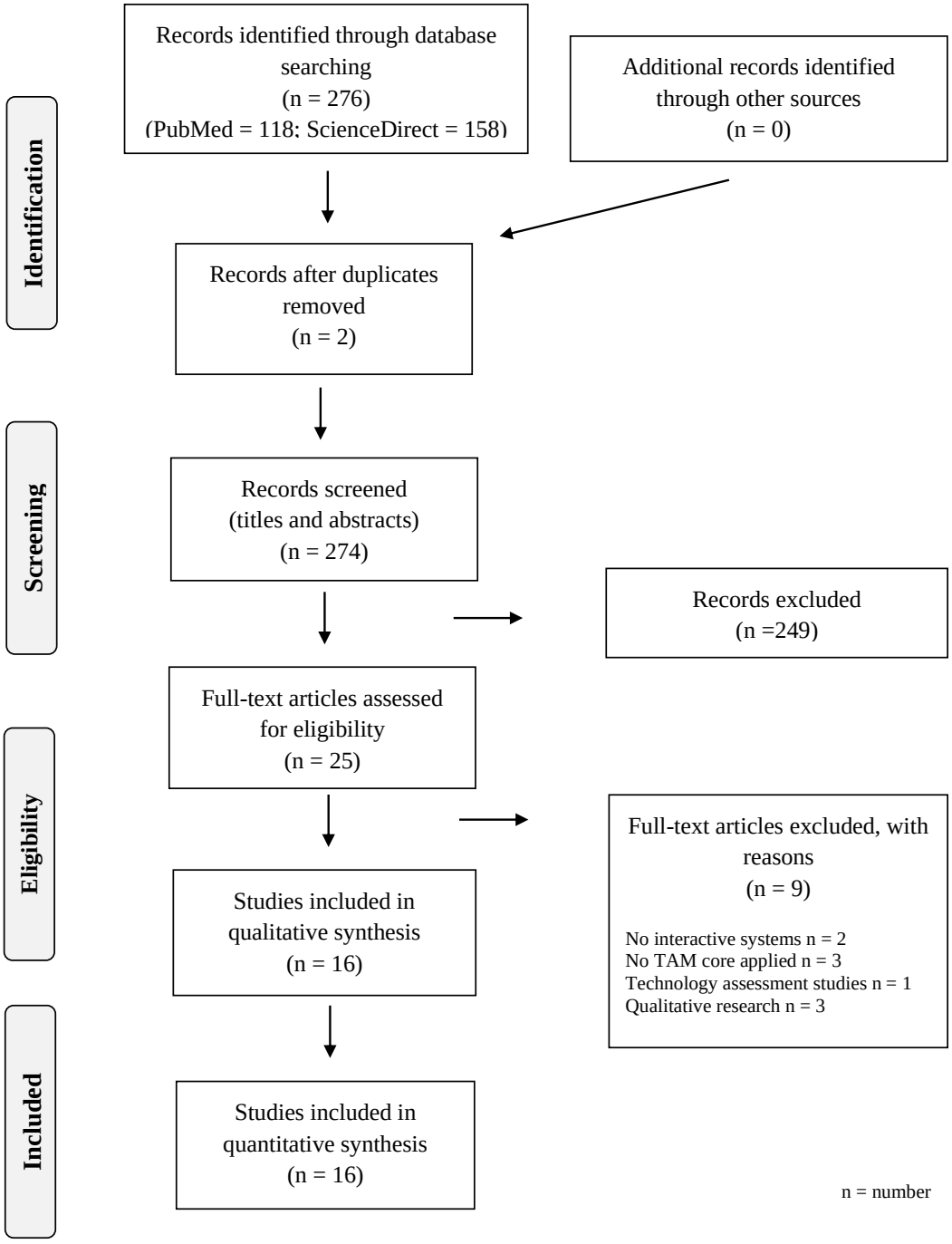

Illustration 23: Literature review flowchart

Although the review had strong exclusion rules, it was not suitable for a quantitative or qualitative meta-analysis[349] because of existing heterogeneity in terms of technologies, medical fields and especially samples in telemedicine regarding country and medical professionals. Table 7 presents on overview of the studies included in the systematic review.

[349] Statistical analysis of summarised primary studies based on meta data

Title	First author	Year	Type of system and environment	Sample	Constructs used	Moderator variables/ Sample characteristic request	Model basis
Acceptance of telemedicine among respiratory HCPs	Segrelles-Calvo et al.	2017	Not specified: telemedicine in general	Members of the Spanish Respiratory Society	PU, PEOU, BI	Experience	Original TAM
Towards reinforcing telemedicine adoption amongst clinicians in Nigeria	Kayode et al.	2017	Monitoring service for patients in their homes: chronically ill patients with hypertension, diabetes and congestive heart failure	Physicians and nurses in hospitals in Nigeria	BI, performance expectancy, effort expectance, facilitating condition, reinforcement	Age, gender and profession	Extended UTAUT
Predictive factors of telemedicine service acceptance and behavioural intention of physicians	Rho et al.	2014	Monitoring service for patients at home with hypertension, diabetes and congestive heart failure accessed physicians in hospitals via an online platform	Physicians of medical centres and hospitals from Seoul and the capital area of South Korea	PEOU, PU, BI, incentives, self-efficacy, accessibility of records, accessibility of patients	Age, gender, department, career (experience), institution type, location	Modified TAM

Determinants of physicians' technology acceptance for e-health in ambulatory care	Dünnebeil et al.	2012	Telemedicine testbed in ambulatory care	German ambulatory physicians in Bavaria using test telemedicine: primary care physicians and medical specialists	PEOU, PU, BI, intensity of IT utilisation, importance of security, importance of documentation, e-health knowledge, importance of standardisation, process orientation	Age, gender, primary care or specialist, number of physicians working in practice, patients consultations per day, patient visits per day, average time spent on patient contact, number of employees	TAM, UTAUT modified
The adoption of mobile healthcare by hospital's professionals: An integrative perspective	Wu et al.	2011	General mobile wireless healthcare devices for monitoring patient parameters	Physicians and nurses of accredited medical centres, regional hospitals and district hospitals in Taiwan	PEOU, PU, BI, attitude, perceived service availability, personal innovativeness, per-	Type of hospital, bed size, position, gender, work experience, education level, age	TAM, TPB

					ceived behavioural control, subjective norm		
An adaptation of the theory of interpersonal behaviour to the study of telemedicine adoption by physicians	Gagnon et al.	2003	RQTE: extended provincial telemedicine network of Quebec (Canada) focused on specialised consultations in paediatric cardiology	General practitioners and specialists of the hospitals actively practicing RQTE	BI, perceived consequences, affect, personal normative belief, self-identity, facilitating conditions, habit	Gender, physician type, region, age, years in practice	Components of TAM, TPB
Investigating HCPs' decisions to accept telemedicine technology: an empirical test of competing theories	Chau et al.	2002	Telemedicine project with services including provision opinions of a second physician or a specialist, evaluation of patient transfer, admission requests, urgent care in emergencies and cross-organisational patient management	Physicians in public acute care tertiary hospitals in Hong Kong out of 10 medical specialties: internal medicine, geriatrics, paediatrics, obstetrics, gynaecology, surgery,	PEOU, PU, BI, attitude, social norm, perceived behavioural control	Age, experience, location of medical education	Components of TAM, TPB

				emergency and intensive care, psychiatry, pathology and radiology			
Factors that influence the acceptance of telemetry by emergency medical technicians in ambulances: an application of the extended technology acceptance model	Hwang et al.	2014	Real-time telemetry system (RTS) measuring patient vital parameters in emergencies and transferred to physicians upon arriving in the ambulance	Emergency medical technicians in ambulances experienced in using RTS in Korea	PEOU, PU, BI, attitude, subjective norm, clinical factors, non-clinical factors, expectation confirmation, loyalty incentives, job fit, organisational facilitation	Gender, attainments in scholarship, EMT grade, experiences in years	TAM and extensions
Drivers of telemedicine use: comparative evidence from samples of Spanish, Colombian and Bolivian physicians	Saigí-Rubió	2014	CICUS project: network for the discussion on latest knowledge on new forms of healthcare based on ICT integration for Spanish and Latin American Collaboration	Physicians and medical professionals in hospitals and health care centres of the urban and rural districts of the	PEOU, PU, usage, user's optimism, user's propensity to innovate, ICT user profile in personal life	Gender, age, workplace, occupation	TAM

				municipality of Sucre, Bolivia, medical professionals of all profiles affiliated with health care within the Canary Islands Health Service in Spain and			
Using a modified technology acceptance model to evaluate HCPs' adoption of a new telemonitoring system	Gagnon et al.	2012		Physicians of the Society of Surgery Service at San José Hospital of Bogota	PEOU, PU, BI, habit, attitude, compatibility, facilitators, subjective norm	Gender, age, medical specialty, years in practice, educational grade	TAM, TPB, TRA,
Determinants of the intention to use telemedicine: evi-	Saigi-Rubió et al.	2016	Not specified: different telemedicine-related projects for the management of patients with chronic diseases	Primary care medical professionals from a healthcare	PEOU, PU, BI, security and confidentiality, ICT user profile,	Gender, age, years in practice	TAM, TPB, TRA

dence from primary care physicians				institution, including the university hospital and nine centres in Barcelona, Spain	subjective norm, perceived usefulness		
The acceptance of mobile teledermoscopy by primary care nurse practitioners in the state of Arizona	Stratton et al.	2016	Primary care teledermoscopy focusing on teleconsultation with analysis of patients' skin images	Nurses from the Coalition of Arizona Nurses in Advanced Practice, the Southeastern Arizona and Advanced Practice Nurse/Nurse Practice Society and nursing student faculty at the University of Arizona College of Nursing	PEOU, PU, BI, habit, attitude, compatibility, facilitators, subjective norm	gender, age, nurse practice certification, type of nurse practice, highest degree, years in clinical practice	TAM, TeleTAM (Orruno 2011)

Factors influencing mental health providers' intention to use telepsychotherapy in First Nations communities	Monthuy-Blanc et al.	2013	Telepsychotherapy: therapy via videoconferencing	Mental health service providers in First Nations reserves in Quebec: nurses, psychologists and community elders	PU, PEOU, BI, attitude	Language, gender, age, schooling, employment, years in employment, place of employment, years in field	TAM
Evaluation of teledermatology adoption by health-care professionals using a modified technology acceptance model	Orruño et al.	2011	Teledermatology pilot study: system between the dermatology department of the Galdakao-Usansolo Hospital and the primary health centre of Landako	Dermatologists, family physicians and paediatricians in the named Spanish region	PEOU, PU, BI, habit, attitude, compatibility, facilitators, subjective norm	Gender, age, medical specialty, years in practice, educational grade	TAM, TIB, UTAUT
HCP acceptance of telemonitoring for chronic care patients in primary care	Asua et al.	2012	TELBIL study: a pilot of a telemonitoring system for chronic care patients with heart failure and chronic lung disease with regular vital parameter measurement at	Nurses, general practitioners and paediatricians	PEOU, PU, BI, habit, attitude, compatibility, facilitators, subjective norm	Gender, age, medical specialty, years in practice, educational grade	TAM, TIB, TRA

			home in Bilbao Primary Care Health in Spain				
Diabetes educators' intended and reported use of common diabetes-related technologies: discrepancies and dissonance	James et al.	2016	Diabetes-related technology: applications, continuous glucose monitoring system, continuous subcutaneous insulin infusion, video conferencing	Australian Diabetes Educators Association members	PEOU, PU, BI, habit, attitude, compatibility, facilitators, subjective norm	Age, experience in profession, experience in diabetes, gender, profession, highest qualification, area	TAM

Table 7: Overview of selected studies[350]

[350] Cf. Verfürth (2020), n. pag.

There is specific evidence on German telemonitoring combined with diabetes in the literature, with a variety of different variables sets and test environments. However, one study showed an impact on the German market. Dünnebeil et al. (2012) performed a quantitative study with German ambulatory physicians – in primary care and several specialties – who participated in a Bavarian telemedicine testbed. The core construct relationships were: PEOU influenced BI and PU, which also influenced BI. In addition, there was a strong influence of **standardisation** in the telemedicine setting. The authors concluded that high IT-related knowledge promoted a lower perception of effort to use e-health.[351]

James et al. (2016) conducted a study where Australian diabetes educators were asked about their intention and use of diabetes-related monitoring systems, IT applications and telehealth video conferencing. The strongest influence on the usage of the technologies were the confidence and competence to operate with the technologies.[352]

[351] Cf. Dünnebeil et al. (2012), p. 746 ff.

[352] Cf. James et al. (2016), p. 1277 ff.

Findings

- The literature has shown a prominent focus on patient acceptance research in telehealth.
- The literature on acceptance research of HCPs in telehealth has shown high heterogenity in terms of system settings and approaches.
- Given that there is no clear, suitable model for the TSS in the German healthcare system for diabetes, a specific model needs to be developed.

6 DEVELOPMENT OF RESEARCH DESIGN

6.1 CAUSAL ANALYSIS

An overview of determinants that influence the acceptance of telemonitoring implementations is needed; it can be built upon the variables used in the reviewed studies (See 5). As determined by the systematic review (chapter 5), there is no existing TAM that can be utilised to examine telemedicine for diabetes care in Germany. Therefore, variables need to be analysed and adapted; the results will be transferred in an integrated model**.** This methodology is recommended by Pedersen and Methlie (2002). A focus on one model would ignore important context information.[353] The core problem of behaviour-oriented models is they provide a theoretical description without the direct ability to perform empirical measurements. A process for conceptualisation and operationalisation must be developed to measure the behaviour indirectly.[354]

For this endeavour, a causal analysis, which tests assumed effects between latent variables (unobservable variables) in a structure model, is conducted.[355] A structure model is created considering theoretical and logical aspects on interrelations of effects between hypothetical constructs in a path model.[356] A causal analysis is done step by step, as described below.[357]

1. Determination of latent variables: conceptualisation of the model;
2. Specification of structure model (inner model):
    a. Item mapping and
    b. Hypothesis building;
3. Specification of measurement model (outer model):
    a. Test of reliability of constructs in a pretest and
    b. Adaption of measurement model;

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[353] Cf. Pedersen et al. (2002), n. pag.

[354] Cf. Jockisch, M. (2010), p. 250.

[355] Cf. Weiber et al. (2014), p. 24 f.

[356] Cf. Backhaus et al. (2006), p. 341.

[357] Cf. Jockisch (2010), p. 241.; Homburg et. al. (2008), p. 548 ff.; Weiber et al. (2014), p. 37 ff.; Hair et al. (2017)

4. Empirical study: data collection;
5. SEM with a path model:
    a. Estimation and assessment of path model and
    b. Evaluation of measurement model: confirmatory factor analysis; and
6. Interpretation of results

6.2 MODEL SPECIFICATION

In this thesis, the term *variable* has been used in several contexts. When developing the structure and later the measurement model, it is important to understand how the term is defined: a variable is a symbol of the set of characteristics of an attribute. Variables can be independent or dependent. Thereby, a change in a dependent variable can be explained by an influence of an independent variable.[358] A path analysis of a model via a path diagram is used to investigate the relationship between variables explained by hypotheses.[359]

6.2.1 Development of a structure model

A structure model builds the theoretical assumption of the relationships of variables.[360]

6.2.1.1 Analysis of variable relations

To build a structure model, the investigated variables of the reviewed studies were collected and summarised. Table 8 provides an overview of the relationships of variables and the results from the papers considered in the systematic review (see Table 7). There was a trend for statistically significant relationships for the key factors in TAM and the related models in most reviewed sets.

[358] Cf. Bortz et al. (2006), p. 2 f.
[359] Cf. Bortz et al. (2006), p. 520.
[360] Cf. Weiber et al. (2014), p. 36.

Relations	Segrelles et al. (2017)	Kayode et al. (2017)	Rho et al. (2014)	Dünneebeil et al. (2012)	Wu et al. (2011)	Gagnon et al. (2013)	Chau et al. (2002)	Hwang et al. (2014)	Saigí-Rubió et al. (2016)	Gagnon et al. (2003)	Saigi-Rubio et al. (2014)	Stratton et al. (2016)	Monthuy-Blanc et al. (2013)	Orruno et al. (2011)	Asua et al. (2012)	James et al. (2016)
AF → BI						R										
AP → PU			S													
AR → PEOU			S													
AR → PU			R													
ATT → BI					S		S	S				S	S			S
C → ATT								S								
C → PU								S								
COMP → BI												S			S	S
COMP → PU										R				R		
EE → BI		S														
FAC → ATT								S		S		S		S		
FAC → BI		S			S	Ex	S			S		S		S	S	S
FAC → PU								R								
FIN → ATT								S								
FIN → BI		S	S								R					
FIN → PU								R								
HAB → AF						S										
HAB → BI						R						S			S	S

Relations	Segrelles et al. (2017)	Kayode et al. (2017)	Rho et al. (2014)	Dünnebeil et al. (2012)	Wu et al. (2011)	Gagnon et al. (2013)	Chau et al. (2002)	Hwang et al. (2014)	Saigí-Rubió et al. (2016)	Gagnon et al. (2003)	Saigi-Rubio et al. (2014)	Stratton et al. (2016)	Monthuy-Blanc et al. (2013)	Orrunno et al. (2011)	Asua et al. (2012)	James et al. (2016)
HAB → PEOU										R				R		
IMPL → US									S							
IQ → BI											R					
JF → ATT								S								
JF → PU								S								
KE → PEOU				S												
LICT → US									S							
LS → PEOU				S												
NC → ATT								R								
NC → PU								R								
OPT → US									S							
PC → BI						R										
PE → ATT								R								
PE → BI		S														
PE → PU								R								
PEOU → ATT					R		R	S		R			R	R		
PEOU → BI	S		S	S							R	S			S	S
PEOU → PU	S		S	S	S		R	S					S			

Relations	Segrelles et al. (2017)	Kayode et al. (2017)	Rho et al. (2014)	Dünnebeil et al. (2012)	Wu et al. (2011)	Gagnon et al. (2013)	Chau et al. (2002)	Hwang et al. (2014)	Saigí-Rubió et al. (2016)	Gagnon et al. (2003)	Saigi-Rubio et al. (2014)	Stratton et al. (2016)	Monthuy-Blanc et al. (2013)	Orrunno et al. (2011)	Asua et al. (2012)	James et al. (2016)
PEOU → US									R							
PID → PU				S												
IOD → BI										S				S		
IOD → PU				S												
PII → ATT					R											
PII → PBC					S											
PII → PEOU					S											
PII → US									R		R					
PIU → PU				S												
PO → PEOU				S												
PSA → PEOU					R											
PSA → PU					S											
PU → ATT					S		S	S		S			S	S		
PU → BI	S		S	S			S	S		S		S	S	S	S	S
PU → US									R							
RC → BI											S					
SE → PEOU			S													
SE → PU			S													

Relations	Segrelles et al. (2017)	Kayode et al. (2017)	Rho et al. (2014)	Dünnebeil et al. (2012)	Wu et al. (2011)	Gagnon et al. (2013)	Chau et al. (2002)	Hwang et al. (2014)	Saigí-Rubió et al. (2016)	Gagnon et al. (2003)	Saigi-Rubio et al. (2014)	Stratton et al. (2016)	Monthuy-Blanc et al. (2013)	Orrunno et al. (2011)	Asua et al. (2012)	James et al. (2016)
SEI → BI						S										
SUB → ATT								S								
SUB → BI		R			S	S	R			R	S	S		R	S	S
SUB → PU								S								

Note. S = supported the hypothesis due to a significant relationship in the study: the first variable positively affects the second named variable; R = rejected the hypothesis due to a non-significant relationship in study; Ex = construct was excluded before statistical analysis Abbreviations: AF = affect; AP = accessibility of patients; AR = accessibility of medical records; ATT = attitude; C = clinical patient factors; COMP = compatibility; EE = effort expectancy; FAC = facilitating condition/organisational facilitation, perceived behavioural control; FIN = reinforcement factor, perceived, loyalty incentives; HAB = habit/confidence and competence; IMPL = implementation status; IOD = perceived importance of data security, information security and confidentiality; IQ = improved quality; JF = job fit; KE = knowledge about e-health; LICT = level of ICT use/ICT user profile; NC = non-clinical patient factors; OPT = optimism; PC = perceived consequences; PE = performance expectancy/expectation confirmation; PEOU = perceived ease of use; PID = perceived importance of documentation; PII = personal innovativeness in IT/propensity to innovate; PIU = perceived importance of IT utilisation; PO = process orientation; PSA = perceived service availability; PU = perceived usefulness; RC = reduced costs; SE = self-efficacy; SEI = self-identity; STAN = level of standardisation in healthcare practices; SUB = social influence/subjective norm/personal normative belief; US = usage

Table 8: Overview of high coefficients of determination effects in tested relationships

6.2.1.2 Variable selection

The significance of the results of acceptance research depends on the quality of the instruments used for measurements. One challenge is the variety of acceptance variables and moderating factors.[361] Hence, this thesis only selected those variables with significant relationships that showed an effect that was more than twice except variable relationship. From the 16 studies (Table 7), there were 57 construct relationships (Table 8).

The review clearly showed relationships between the **core** constructs from the original models: ATT impacted BI, and PEOU and PU influence BI. The variables can be clustered into five contexts:[362]

- The **technological context** explains system handling, including **PEOU,** and the performance impact, including **PU**.
- The **organisational context** is covered by the variable **facilitator**; this includes suitable resources and environment for the clinical task and system implementation as well as **compatibility**, which describes the fit to the current tasks. Facilitators are influenced on the behavioural level by the variable **perceived behavioural control** and can be merged.
- The **individual context** includes confidence and competence in a system handling by the use of the variable **habit**.
- The **social context** is covered by the variable **subjective norm**, which describes the influence of the others to the user.
- The review also highlighted the influence of **market-related factors**: economically influenced variables that focus on **financing** look at rewards via financial support or medical fee compensation.[363] Another market factor is the regulatory or legal context, where **the perceived importance of data security** affects BI.[364]

[361] Cf. Helmreich (1980), p. 22
[362] Cf. Verfürth (2020), n.pag.
[363] Cf. Hwang et al. (2014); Kayode et al. (2017); Rho et al. (2014)
[364] Cf. Dünnebeil et al. (2012); Gagnon et al. (2012); Orruno et al. (2011)

The reviewed studies provide a reliable fundament for TAM and individual, social, organisational and technological aspects on the level of the system handling and operating in the medical office are covered in those studies. However, the review revealed that there is a gap when looking at the interaction framework and the service context.[365]

6.2.1.3 Extended variable development

To provide a comprehensive and specific view on the telemonitoring service, several variables must be **adapted to the German environment** and new ones need to be added, especially the **interactive component** with the telemonitoring centre as well as with the patient needs additional consideration. Illustration 24 provides a conceptual picture of the interaction framework.

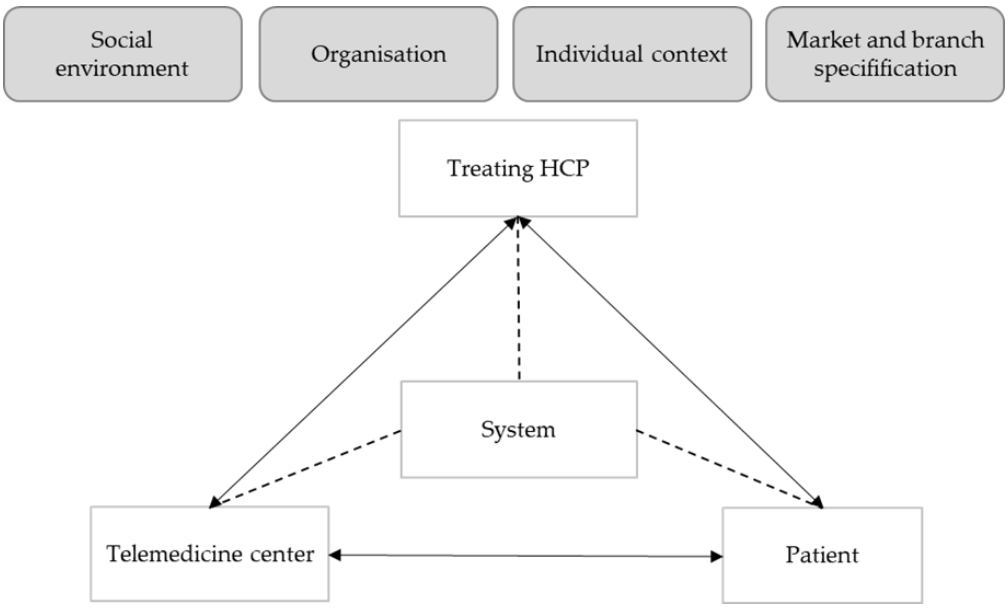

Illustration 24: Interaction framework in Telemonitoring

An **idea collection** was performed to create a **dimension pool** to develop the new variables. The different dimensions are subsequently transferred as items into the model. A pool of items must be collected to develop a scale; these items

[365] Cf. Verfürth (2020), n.pag.

should build the theoretical construct. A myriad of sources can be collected for the statements: theories, questionnaires and other literature. One's experiences or observations from daily life can also be included. A prestudy is also utilised to shape the construct. There should be enough item dimensions for testing so that a suitable amount remain after revision.[366]

A crucial influence for the idea collection was the DGG statements about telemedicine and digitalisation.[367]

- **Standardisation**

  One field of action in the DGG's position paper was the importance of developing **digital standards** to **ensure the quality of patient care**.[368] The **items for importance of standardisation** could be oriented towards the ideas of Dünnebeil, as well as one item regarding the development of an **evidence-based standard** (later: STAN 4).[369] That study also considered the level of standardisation and found a moderate relationship on PEOU.[370]

- **Importance of data security**

  Based on protocol requirements from medical societies, the **security of patient data** is key,[371] as well as required technical standards and transparency in data handling towards patients and mandatory adherence to the principles of data management. In this context, two other dimensions have been added to cover the assurance of treatment quality in the digital environment (later IOD3) as well as the responsibility of the association to discuss the legal, ethical and scientifical framework of data (later IOD4) in such service systems.[372]

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[366] Cf. Möhring et al. (2010), p. 69 ff.; Verfürth (2020), n.pag.

[367] Cf. Ickarth (2018), p. 449 ff.

[368] Cf. Ickarth (2018), p. 449 ff.

[369] Cf. https://www.zukunftsboard-digitalisierung.de/dut-report, Verfürth (2020), n.pag.

[370] Cf. Dünnebeil et al. (2012), p. 751 ff.

[371] Cf. Ickarth (2018), p. 449 ff.

[372] Cf. Dünnebeil et al. (2012), p. 755 ff., Verfürth (2020), n.pag.

- **Financing** (See 4.2.2)

  There has been a call for **clarifying the financing** of treatments.[373] The variable constructions from the reviewed studies are insufficient to fulfil the appropriate market-related parameter of financing. In addition to the ideas of Hwang (2014),[374] aspects specific to the German market environment and financing specifics have been added. Leppert et al. (2015) specifically examined economic influences on acceptance and rejection of e-health with German outpatient physicians based on a literature review; they found that economics strongly influence the dimension development.[375] It is assumed that the financial evaluation of digital service compared with analogue services (later FIN3) is an influence factor.[376] Specific for German healthcare is the question of including the service in standard care financing (later FIN6). The payment scheme of patients (later FIN5) has also not been well clarified: if it needs to be paid privately (later FIN7) or covered by reimbursement of an insurance (later FIN8). Finally, the cost for implementation in a medical facility (later FIN9) could be an indicator.[377]

  An interactive system has many players, including patients and HCPs in a telemedicine centre; **few studies have concentrated on this factor**, which might be a determinant of a physician's BI. First, due to a change in communication between treating HCPs and patients, the **relationship** might be altered, and responsibilities of the treatment decision and pathway need to be adapted. This factor is important because patients become more and more informed and the physician–patient relationship will change accordingly.[378] Second, there are new means of communications with medical colleagues in the telemedicine centre. The literature has described aspects on this digital collaboration, including eConsult platforms, where medical colleagues exchange knowledge about patient cases via a digital platform

[373] Cf. Ickarth (2018), p. 449 ff.
[374] Cf. Hwang et al. 2014
[375] Cf. Leppert et al. (2015), ePub
[376] Cf. Ickrath (2018), p. 449 ff.
[377] Cf. Leppert et al. (2015), ePub, Verfürth (2020), n.pag.
[378] Cf. Ickrath (2018), p. 449 f.

to collect different multidisciplinary opinions and find the best therapy. The electronic way is a new approach to replace face-to-face medical consults. These new aspects of collaboration are considered for the dimension development.[379] Thus, the model has incorporated two new constructs: relationship to the patient and trust in the telemedicine centre.[380]

- **Relationship to the patient**

  The relationship between patient and physician is an important part of the medical practice and gets special attention in research.[381] Even in digital times this relationship will remain central and can only be an additional part of diagnosis and therapy up to certain limitations.[382] Web information and diabetes technology allows participatory communication and personalisation. A diabetic patient is more empowered to analyse his or her health status on his or her own, but this possibility can also lead to false findings and complicate patient–physician communication.[383]

  It is assumed that the **perceived change in the patient relationship** is determined by either a fear of losing the patient (later REL1) or control of the clinical treatment pathway (later REL3) due to the integration of additional HCP contacts at the centre (later REL2) or the hope to strengthen the patient relationship (later REL4) due to increasing contact points in the mix of analogue and digital communication (later REL5). Quick monitoring of unsociable (later REL7) and immobile patients (later REL8) may be advantages for the patient–physician relationship. A target would be to increase treatment adherence (compliance) of a patient (later REL6).[384]

[379] Cf. Lee et al. (2017), ePub; Osman et al. (2019), ePub
[380] Cf. Verfürth (2020), n.pag.
[381] Cf. Füchsl (2019), p. 148; Jeserich (2013), p. 425 f.
[382] Cf. Füchsl (2019), p. 148
[383] Cf. Ickrath (2018), p. 449 f.; Kulzer (2015), n. pag.
[384] Cf. Ickarth (2018), p. 449 ff.; Osman et al. 2019, ePub, Verfürth (2020), n. pag.

- **Trust in the telemedicine centre**
  Trust is an important emphasis of social capital with regard to interactions among people.[385] Based on the social capital theory and transfer to healthcare by Tsai (2014), the construct of trust includes aspects of social and institutional trust.[386] Bourdieu and Coleman (1990) are the **founding** theorists of **social capital**; they introduced the term **social capital** for the first time. 'Social capital is defined as those features of social structures such as levels of interpersonal trust, norms of reciprocity and mutual aid which constitute resources which may facilitate interaction between individuals and groups of individuals to achieve collective action'.[387] 'Trust may be defined as the belief that the other party will behave responsibly and will not attempt to exploit the vulnerabilities of the user'.[388] Here the biggest vulnerability is assumed as loose in patient contact.

  Trust in a telemedicine centre is assumed to be regulated by general trust[389] (later TRU1), following the model from Yagamashi et al. (1994) that people candidly pass on responsibility to colleagues. Trust can also be created by a certification (later TRU2) and standard processes (later TRU8) as well as fixed and stable personal contacts (later TRU4) to the involved HCPs (later TRU5). On the other hand, distrust can come up when there is the fear of losing control of the treatment (later TRU6) or not getting extensive information (later TRU7).[390]

The construct for attitude has been extended by the aspects of the generic attitude to general telemedicine usage (later ATT3) and the expansion of the nationwide digitalisation. (later ATT4). The identification and choice of items can be

[385] Cf. Felício et al. (2012), p. 395 ff.; Mohseni et al. (2007), p. 1373 ff.; Schweer et al. (2003)

[386] Cf. Mohseni et al. (2007), p. 1373 ff.; Tasi (2014), p. 4905 ff.

[387] Kawachi et al. (2007), p. 271; Coleman (1990); Kawachi et al. (2000), p. 174 ff.; Putnam (1993)

[388] Schall et al. (2015), p. 467; Pavlou (2003), p. 101 ff.

[389] Cf. Yagamashi et al. (1994), p. 129 ff.; Mohseni et al. (2007), p. 1373 ff.

[390] Cf. Lee et al. 2018, ePub; Osman et al. (2019), ePub; Verfürth (2020), n. pag.

done using already existing scales or can be based on one's considerations that have been tested in advance in a separate pretest.[391]

6.2.1.4 Specification of the structure model and building hypotheses

Five studies supported that PEOU influences BI[392] and has a relationship to PU.[393] PU seems to influence attitude, which influences BI.[394] Attitude is influenced by the facilitating condition/organisational facilitation, also described as perceived behavioural control, and impacts BI,[395] in addition to perceived importance of data security, information security and confidentiality.[396] Several studies have reported that social influence/subjective norm/personal normative belief affects BI.[397] Rho et al. and Kayode et al. (2017) have shown that reinforcement factors and loyalty incentives, also influence BI. Two other variables show relationships to BI: habit and compatibility.[398] The variables of relations to patient and trust in telemedicine may influenced directly BI and attitude. Illustration 25 presented the proposed path model; it shows the relationships of the constructs and provides a template for further investigation on the relationships of the variables.

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[391] Cf. Hildebrandt et al. (2006), p. 619; Homburg et al. (2006), p. 732; Verfürth (2020), n. pag

[392] Asua et al. 2012; Dünnebeil et al. 2012; James et al. 2016; Rho et al. 2014; Stratton et al. 2016

[393] Dünnebeil et al. 2012; Hwang et al. 2014; Monthuy-Blanc et al. 2013; Stratton et al. 2016

[394] Gagnon et al. 2003; Hwang et al. 2014; Monthuy-Blanc et al. 2013; Orruno et al. 2011

[395] Asua et al. 2012; Gagnon et al. 2013; Hwang et al. 2014; James et al. 2016; Kayode et al. 2017; Orruno et al. 2011; Stratton et al. 2013

[396] Gagnon et al. 2003; Orruno et al. 2011

[397] Asua et al. 2012; Gagnon et al. 2012; James et al. 2016; Saigi-Rubio et al. 2014; Stratton et al. 2016

[398] Asua et al. 2012; James et al. 2016; Stratton et al. 2016

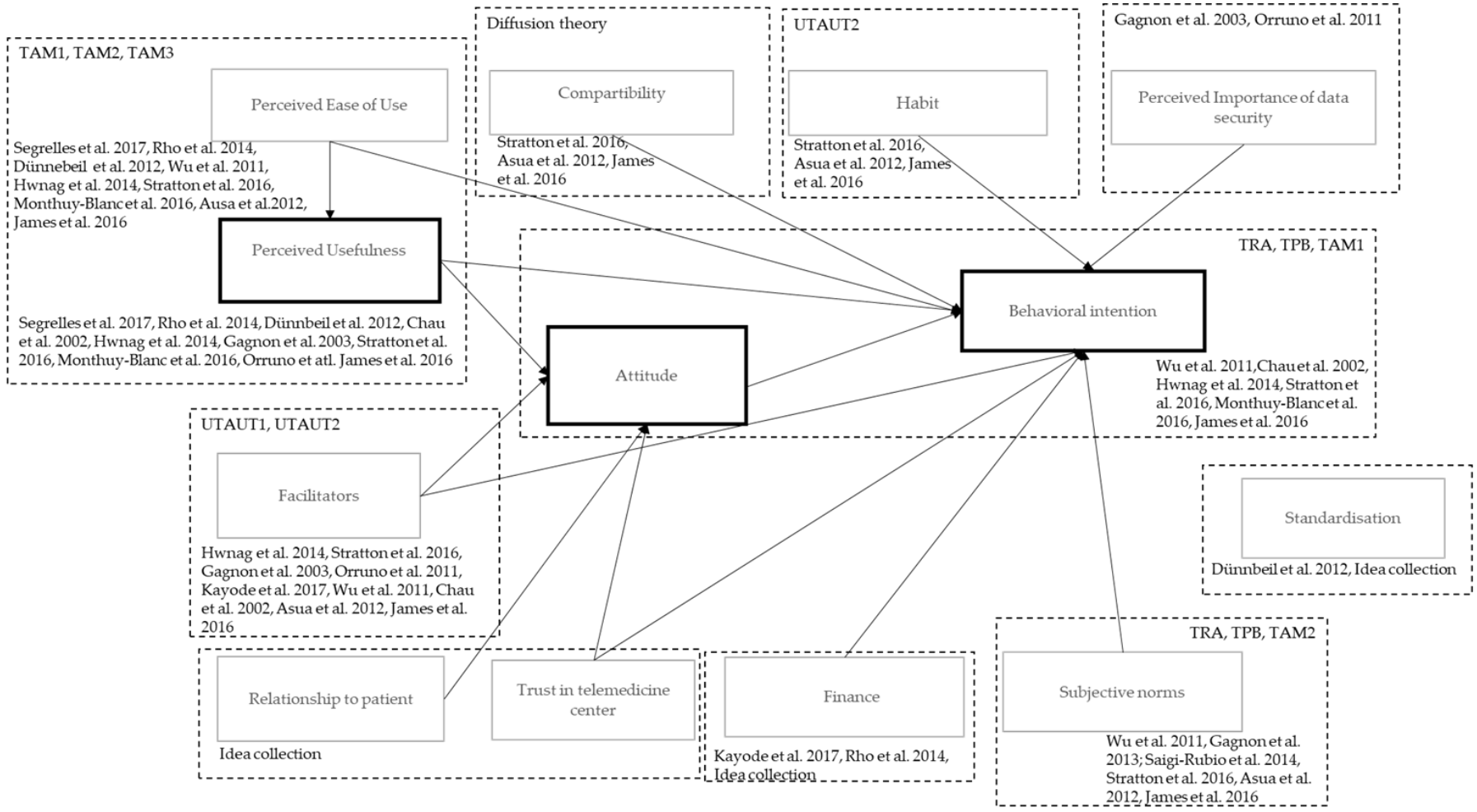
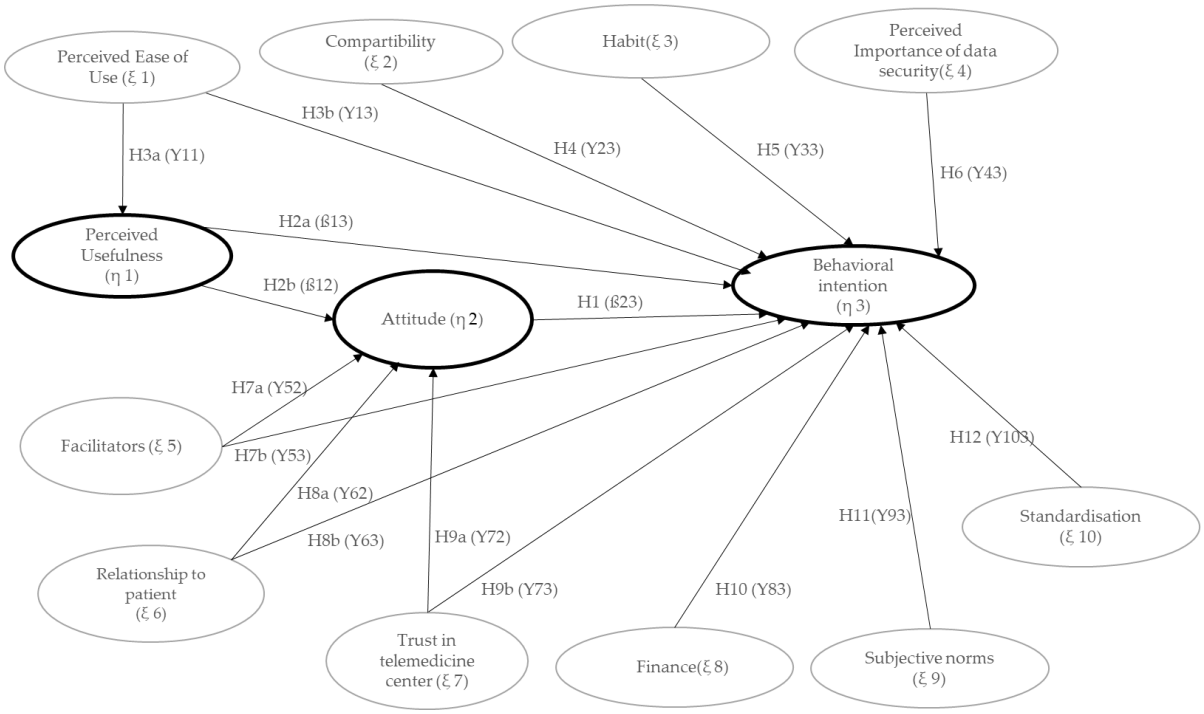


Illustration 25: The origins of the model variable

The developed model has been named the **telemonitoring service acceptance model**. The endogenous variables are marked with a bold-type ellipse in Illustration 26; all other variables are exogenous. Exogenous variables point towards the appropriate endogenous variables with an arrow.[399] Hypotheses β and γ have graphically built the structure model. The latent variables are shown as ellipses. The assumed causal relationships are shown as arrows from a exogenous (ξ) to a endogenous (η) variable.[400]



ξ	Latent exogenous variable explained in the model
η	Latent endogenous variable explained in the model
γ	Hypothesis between a exogenous and endogenous variable
β	Hypothesis between exogenous variables

Illustration 26: The structure of the telemonitoring service acceptance model and the related hypotheses

[399] Cf. Weiber et al. (2014), p. 39

[400] Cf. Weiber et al. (2014), p. 39 f.

The variables must also be considered with errors, which are displayed with the symbol ζ .[401] Illustration 27 provides an example of this error for PU, ATT and BI:

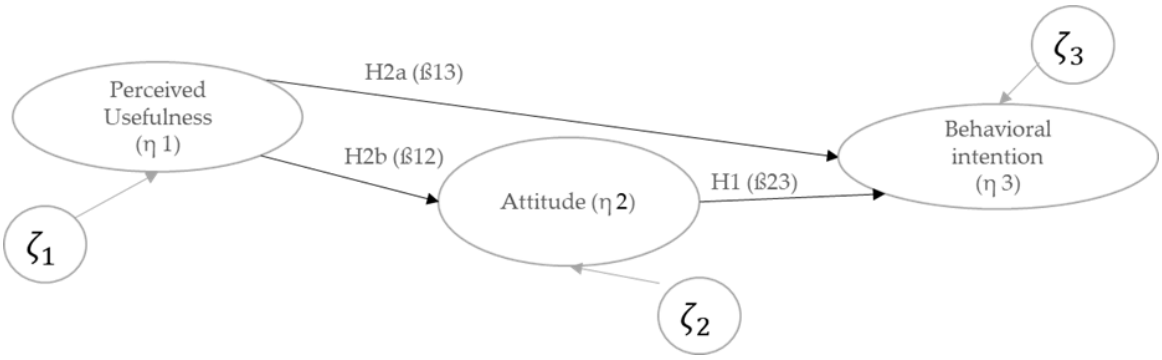


Illustration 27: Errors for select variables of the telemonitoring service acceptance model

The approach to prove a hypothesis utilises a so-called null hypothesis (H_0) and an alternative hypothesis (H_1). The research hypothesis is usually the alternative hypothesis whilst the null hypothesis contradicts the alternative hypothesis. A null hypothesis would state that there is no effect.[402] Table 9 shows the corresponding alternative hypotheses (see Illustration 26 for their placement in the telemonitoring acceptance model).

[401] Cf. Weiber et al. (2014), p. 39 f.
[402] Cf. Bortz et al. (2006), p. 24

Hypothesis No	*Hypothesis statement*
H1	Attitude will have a positive effect on BI.
H2a	PU will have a positive effect on BI.
H2b	PU will have a positive effect on ATT.
H3a	PEOU will have a positive effect on PU.
H3b	PEOU will have a positive effect on BI
H4	COMP will have a positive effect on BI.
H5	HAB will have a positive effect on BI.
H6	IOD will have a positive effect on BI.
H7a	FAC will have a positive effect on ATT.
H7b	FAC will have a positive effect on BI.
H8a	REL will have a positive effect on ATT.
H8b	REL will have a positive effect on BI
H9a	TRU will have a positive effect on ATT.
H9b	TRU will have a positive effect on BI.
H10	FIN will have a positive effect on BI.
H11	SN will have a positive effect on BI.
H12	STAN will have a positive effect on BI.

Table 9: Hypotheses of the telemonitoring service acceptance model

6.2.2 Development of the measurement model

Acceptance as well all consulted determinants are latent constructs: these factors are not observable and thus they cannot be measured directly. Direct measurement can be realised by operationalisation of the constructs with the help of a questionnaire and can be measured by empirically collected figures.[403] A latent variable describes a hypothetical construct and can be conceptualised by a concrete specification of characteristics to obtain a construct definition.[404] Therefore, a measurement model is created. The result will be seen via an observable measurement variable.[405] For observations, suitable indicators that describe the construct need to

[403] Cf. Weiber et al. (2014), p. 41 f.
[404] Cf. Weiber et al. (2014), p. 95 ff.
[405] Cf. Weiber et al. (2014), p. 41 f.

be assigned to a latent variable. The indicators are facts and circumstances of the variable context and should deduce characteristics of the latent variable.[406] The measurement model needs to be defined for operationalisation of a construct and the estimation of the relationships.[407] This thesis utilised a **reflective measurement model**. The measurement variables (indicators) are defined as interchangeable, which leads to a reflective approach. Furthermore, the indicators are forms of appearance of the construct, and changes in indicator dimensions would lead to changes of construct characteristics and concepts.[408]

Indicators are shown as boxes in the model; indicators of endogenous latent variables are labelled with y; measurement variables of exogenous variables are labelled with an x; and the connections between the latent variables and the indicators include the symbol λ.[409] Incessant error terms of indicators need to also be considered in a measurement model: ε for endogenous variables and δ for exogenous variables.[410] The measurement model for BI as a endogenous variable and for PEOU as an exogenous variable are shown in Illustrations 28 and 29, respectively.

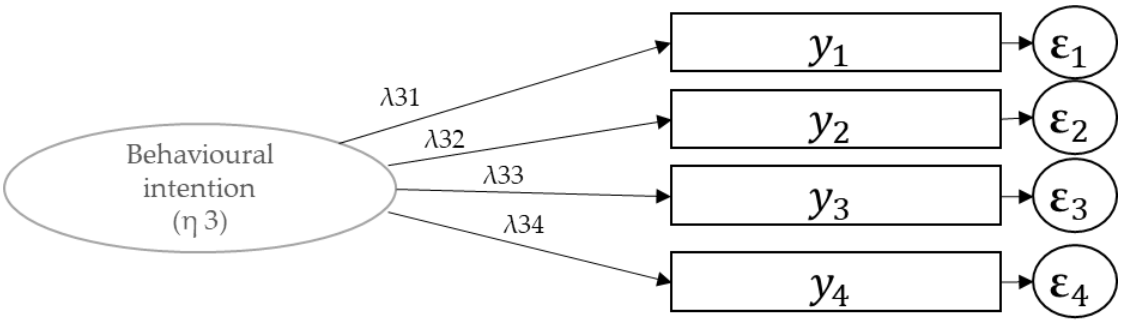


Illustration 28: Indicators and related errors for an endogenous variable (behavioural intention)

[406] Cf. Kroeber-Riel et al. (2003), p. 31
[407] Cf. Weiber et al. (2014), p. 43 f.
[408] Cf. Jarvis et al. (2003), p. 203; Weiber et al. (2014), p. 42 f.;
[409] Cf. Weiber et al. (2014), p. 44 f.
[410] Cf. Weiber et al. (2014), p. 43 ff.

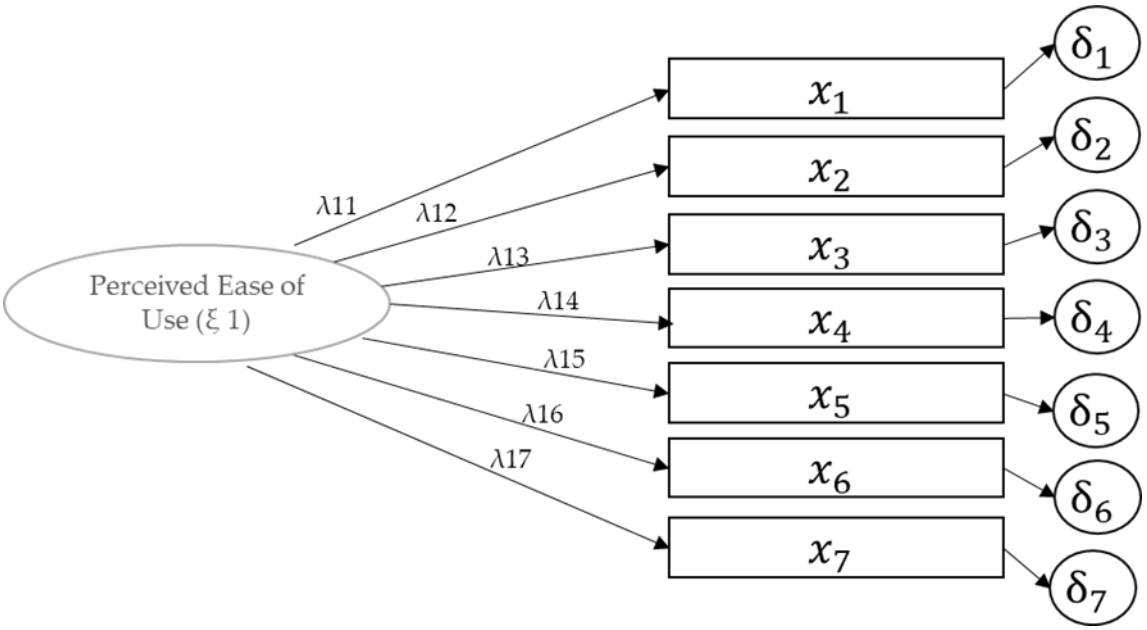


Illustration 29: Indicators and related errors for an exogenous variable (perceived ease of use)

6.2.2.1 Questionnaire development

A questionnaire based of the measurement model allows proving the relations between the determinants. The scientific background and the process of modelling is described below. Operationalisation of factors of questions for the questionnaire rely on established and validated wordings, which have proven in studies. This thesis considered the wordings from the original TAMs and extensions. Other constructs were orientated on the collected statements from the reviewed studies. (See 13 Appendix)

Table 10 shows the origin of the items and the definition for each construct in the telemonitoring service acceptance model. However, in some cases, the reviewed studies did not contain sufficient item overviews and the new constructs needed to be operationalised with the help of their collected dimensions based on the idea collection (see 6.2.1.3). Thus, the constructs were checked for essential ad-

ditions. Each construct needed to have four or more items for testing. New constructs were developed with more than eight items to allow item revision after the pretest.

Regarding the formulation of the items and their different dimensions, the following recommendations were considered:[411]

- A statement in a sentence is built to stick to the already existing wordings. Attitudes, opinions and perceptions can be better identified with statements and judgements of the degree of consent rather than questions.
- The statements are directly formulated: It is important to me …; I like …
- The scale rating is adapted to the originally used scales.[412]
- Some statements should differ in their direction to minimise the effect of always scoring the question in the same way.
- The items should have a simple structure.
- The items should be worded as clearly as possible.
- The statement should not include any intensities and frequencies.
- The items should not suggest an answer.
- Acceptance and rejection should be possible and must be rated with scales.
- No presuppositions of the participants should be made.

The corresponding statements were subsequently translated into German (See 13 Appendix). In terms of translation issues, the pretest assesses possible contortions or difficulties in comprehension. German wordings from BI, PEOU, PU and subjective norm were aligned with matching proposals from Olbrecht.[413] All statements were formulated as indicative.

The survey was generated in three parts (see appendices). First, the survey ratings and instructions are explained; participants are told completing the survey is anonymous; and it is emphasised that there are no right or wrong answers. The participants are told to score the statements as close to their opinion as possible.

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[411] Cf. Möhring et al. (2010), p. 69 ff; Ollermann (2007), p. 102 ff.

[412] Cf. Davis (1989), p. 340

[413] Cf. Olbrecht (2010)

Second, a potential TSS is described in general to give the respondent an idea about the functionality and interaction with system and service offerings. The statements are listed with visual interruption to show the next variable topic.

The third part of the questionnaire asks about basic information about respondents' characteristics: gender, age, employment status, work experience and postal code. For the pretest, the respondents provided information on their institution (clinical or in a medical office). For the field study, the respondents indicated their profession.

All respondents also had the opportunity for comments in a free text area that asked about further aspects that could influence their attitude.

A standard 5-point Likert scale, which is applied from the original TAM approaches, was used for the questionnaire:

1. Strongly disagree;
2. Disagree;
3. Neither agree nor disagree/neutral;
4. Agree; and
5. Strongly agree.

The principal of a Likert scale is to ask for consent or rejection of statements. The possible answers should be developed so that they are equidistant and interpretable.[414] The literature has recommended scales that are from 1 to 5 or 1 to 7 points. Fewer points hinders differentiation possibilities while too many points can overstrain the respondents.[415] Questions about one topic should be combined in a block of questions. Each set should have a visual border to ensure a clear and smooth transfer to the next block.[416]

[414] Cf. Bortz et al. (2006), p. 177; Hollenberg (2016), p. 19 f.

[415] Cf. Franzen (2014), p. 701; Hollenberg (2016), p. 14 f.; Porst (2014), p. 77 ff.

[416] Cf. Klöckner et al. (2014), p. 677 f.

6.2.2.2 Operationalisation of the model

Construct	**Definition**	**Item**	**Dimensions of added items from idea collection**	**Items and their operationalisation in a questionnaire**	**Origin**
Attitude	A HCP's positive or negative feelings about using TSS (Fishbein and Ajzen 1975)	ATT1		I think positively about TSS.	Fishbein and Ajzen 1975
		ATT2		Using TSS in patient care and management is a good idea.	Fishbein and Ajzen 1975
		ATT3	General attitude to telemedicine	I endorse the establishment and expansion of telemedicine systems.	Idea collection of present study
		ATT4	General attitude to digitalisation	Digitalisation is an important topic for patient treatment in future.	Idea collection of present study
Behavioural intention	A HCP's willingness to use the system	BI1		Assuming I have access to TSS, I intend to use it.	Venkatesh and Davis 2000; Venkatesh and Bala 2008

	(Venkatesh and Davis 2000)	BI2		I intend to use TSS regularly.	Davis et al. 1989; Venkatesh and Bala 2008
		BI3		I consider referring my clients to TSS.	Monthuy-Blanc et al. 2013
		BI4		I integrate TSS in my patient care actively.	Venkatesh and Bala 2008
Perceived Usefulness	The degree to which a HCP believes using TSS would enhance his or her patient care and management (performance/service) (Davis et al. 1989)	PU1		Using TSS in my job enables me to accomplish tasks more quickly.	Davis et al. 1989
		PU2		Using TSS improves my patient care and management.	Venkatesh and Davis 2000; Venkatesh and Bala 2008
		PU3		Using TSS in my job increases my productivity.	Davis et al. 1989; Venkatesh and Davis 2000; Venkatesh and Bala 2008
		PU4		Using TSS in my job enhances my effectiveness on the job.	Davis et al. 1989; Venkatesh and Davis 2000; Venkatesh and Bala 2008
		PU5		Using TSS makes it easier to do my job.	Davis et al. 1989

		PU6		I find TSS useful in my job.	Davis et al. 1989; Venkatesh and Davis 2000; Venkatesh and Bala 2008
Perceived ease of use	The degree to which a HCP believes that using TSS would be free of efforts/is difficult to use (Davis et al. 1989, Monthuy-Blanc et al. 2013); the perceived ease or difficulty of usage/performing the behaviour (Ajzen 1985)	PEOU1		Learning to operate TSS is easy for me.	Davis et al. 1989
		PEOU2		I find TSS easy to use.	Davis et al. 1989; Venkatesh and Davis 2000; Venkatesh and Bala 2008
		PEOU3		I think using TSS is easy for my patients.	Davis et al. 1989
		PEOU		I find TSS to be flexible to interact with.	Davis et al. 1989
		PEOU		My interaction with TSS is clear and understandable.	Davis et al. 1989; Venkatesh and Davis 2000; Venkatesh and Bala 2008
Facilitators	The degree to which a HCP believes that	FAC1		I have the resources necessary to use the system.	Venkatesh and Bala 2008
		FAC2		I use TSS if I receive appropriate training.	Gagnon et al. 2012

	organisational and technical resources and environment exist to support the implementation and use of the system (Venkatesh and Bala 2008; Venkatesh et al. 2003)	FAC3		I use TSS if I receive the necessary technical assistance.	Gagnon et al. 2012
		FAC4		Given the resources, opportunities and knowledge it takes to use the system, it is be easy for me to use the system.	Venkatesh et al. 2008
Compatibility	The degree to which TSS is perceived as being consistent with the existing needs, values and past experiences of potential adoptions of a HCP (Rogers 2003)	COMP1		Using the TSS is compatible with all aspects of my work.	Venkatesh et al. 2003
		COMP2		I think that using the system fits well with the way I like to work.	Venkatesh et al. 2003
		COMP3		Using the system fits into my work style.	Venkatesh et al. 2003
		COMP4		The use of TSS implies major changes in my clinical practice.	Gagnon et al. 2003; 2012; James et al. 2016
		COMP5		The use of TSS promotes my clinical practice.	James et al. 2016

Subjective Norm	A HCP's perception that most people who are important to him or her think he or she should or should not perform the behaviour in question (Fishbein and Ajzen 1975)	SUB1		People who influence my behaviour think that I should use the system.	Venkatesh and Davis 2000; Venkatesh and Bala 2008
		SUB2		People who are important to me think that I should use the system.	Venkatesh and Davis 2000; Venkatesh and Bala 2008
		SUB3		Patients welcome me using TSS.	James et al. 2016
		SUB4		Other colleagues welcome me using TSS.	James et al. 2016
Habit	Degree of IT affinity and perceived competence according to what constitutes the level of routinisation of IT usage (Gagnon et al. 2012, Stratton and Loescher 2016)	HAB1		I have used telemedicine in the past.	Gagnon et al. 2012
		HAB2		I already use telemedicine technologies.	Gagnon et al. 2012
		HAB3		I feel comfortable with information and communication technology.	Gagnon et al. 2012; Stratton and Loescher 2016
		HAB4		I feel comfortable with usage and consultancy of technology of patient in daily business.	Gagnon et al. 2012; Stratton and Loescher 2016
		IOD1		Technical standards for the handling of patients' medical data are necessary.	Dünnebeil et al. 2012

Importance of data security	Degree of perceived importance of security of patient data without loss of therapy quality, ethics and transparency of information (Gagnon et al. 2012)	IOD2		Committing standards for the handling of patients' medical data are necessary for my practice.	Dünnebeil et al. 2012
		IOD3		It is important to me to be able to extensively inform my patients about the use of their medical data.	Dünnebeil et al. 2012
		IOD4	Digital treatment quality	Definitions of quality need to be transferred from the analogue treatment into the digital world.	Idea collection
		IOD5	Legal, ethical and scientifical framework	Expert associations must consider legal and ethical questions when it comes to data security and clarify the usage of data for research.	Idea collection
Financing	Degree of monetary motivation and attitude to the responsibility of financing of TSS in healthcare systems for patients (Hwang et al. 2014, Kayode	FIN1		Incentives for physicians needs to be offered for a continued and frequent use.	Hwang et al. 2014
		FIN2	Bonus	I should get rewarded additionally for using TSS.	Hwang et al. 2014
		FIN3	Financial evaluation of digital service	Digital service via TSS must be evaluated and paid differently compared to the analogue service.	Idea collection
		FIN4	Funding	The usage of TSS is particularly worthy of support in regards of refund.	Idea collection

	et al. 2017, Rho et al. 2017)	FIN5	Reimbursement	It is important that TSS is reimbursed for my patients.	Idea collection
		FIN6	Standard financing	TSS needs to be managed with a selective agreement (not standard care).	Idea collection
		FIN7	Private pay	It is fine if patients need to pay for the service privately.	Idea collection
		FIN8	Incentives	It depends on the treatment service, if TSS is payed privately or is reimbursed via insurance.	Idea collection
		FIN9	Investment	For the additional service the cost of initial equipment needs to be paid as an investment by the medical office.	Idea collection
Importance of standardisation	Degree of perceived importance to conduct and record the treatment in a standardised way without quality loss (Dünnebeil et al. 2012)	STAN1		I am in favour of standardised documentation for medical practices.	Dünnebeil et al. 2012
		STAN2		In case of standardised treatment processes, the administrative effort exceeds the medical benefits.	Dünnebeil et al. 2012
		STAN3		Daily work in medical practices is too heterogeneous to standardise important processes.	Dünnebeil et al. 2012
		STAN4	Evidence basis	The TSS needs to analyse evidenced-based data and needs to show that transparency.	Idea collection

Relationship to patient	Degree of fear losing contact and a relationship with the patient due to altered communication ways and involvement of telemedicine experts	REL1	Loss of patient	I fear losing patients due to TSS, because they do not need me anymore.	Idea collection
		REL2	Shift of reference point/contact loss	With TSS, my patients will need less help because a lot can be clarified with the centre.	Idea collection
		REL3	Loss of treatment paths	I fear losing control over the treatment pathway because I am not primarily involved anymore.	Idea collection
		REL4	Intensity of patient relationship	The relationship to my patients will be more intense because of the extensive support.	Idea collection
		REL5	Treatment mixture effect	The treatment mix of analogue and digital will strengthen the patient–physician relationship.	Idea collection
		REL6	Compliance	My patients' treatment adherence will increase.	Idea collection
		REL7	Accessibility of patients	Due to TSS, I have better contact with all patients no matter how far away.	Idea collection
		REL8	Reachability of patients	I have a better connection to patients who visit me rarely.	Idea collection

Trust in telemedicine centre	Degree of personal trust in the contact person of the telemedicine centre as well as organisational trust in the centre treating patients as necessary and appropriate to the standards (Schweer and Thies 2003, Yamagashi and Yamagashi 1994)	TRU1	General trust	Generally, I can trust other people.	Yamagashi and Yamagashi 1994
		TRU2	Certification of service centre	I trust a certified service centre, which consults with my patients.	Idea collection
		TRU3	Trust in other HCPs	I have a good feeling when patients are monitored/treated by another therapist/ physician	Idea collection
		TRU4	Constancy in contact	It is important to me to have fix contact person at the centre.	Idea collection
		TRU5	Personal contact	It is important to me to have personal contact with the treating experts in advance.	Idea collection
		TRU6	Loss of treatment control	I fear that expert colleagues would treat a patient differently than me.	Idea collection
		TRU7	Information asymmetry	I fear I will not get all information to my patient in time.	Idea collection
		TRU8	Standard processes	I like to be previously informed about standard processes and algorithms.	Idea collection

Table 10: Operationalisation of questionnaire[417]

[417] Cf. Verfürth (2020), n. pag.

6.2.2.3 Pretest

A pretest was conducted to prove the constructs, their operationalsation and the survey design. According to the literature, the primary purpose of a pretest is:[418]

1. To check the comprehensibility of the questions;
2. To reduce translation distortion;
3. To test the clarity of the questionnaire and context;
4. To determine the variability in responses;
5. To check the theoretical validity of the questionnaire;
6. To identify difficulties in identifying the target persons who should answer;
7. To observe the emergence of responses;
8. To anticipate field conditions in order to ensure the proposed designs will function appropriately; and
9. To check the interest, attention and well-being of respondents in individual questions and the questionnaire as a whole to to determine how long it takes to complete the survey

If difficulties or problems arise during the pretest, the questionnaire is adapted and improved.

The questionnaire was developed as an online survey using the platform-limesurvey.com [419] A domain was set up: https://akzeptanz-tele-medizin.limequery.net/1, and the survey was subsequently put on the platform of the institute Quopinion. [420] Quopinion owns a database with a pool of members who get compensation for participating in online market research.

For both platforms, once a participant completed the survey, an electronic cookie prevented multiple submissions from the same computer. While the settings did not allow the participants to not answer a question, they could go backwards to a previous question and saw a progress bar. The results could neither be saved nor published.

The pretest commenced 2 March 2020. The goal to qualify the survey was to get 30 answers for participants with medical experience, preferably physicians and medical students with first-hand practical experiences.

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[418] Cf. Häder (2010), p. 396 f.; Porst (2011), p. 191.

[419] https://www.limesurvey.org/de/

[420] https://quopinion.com/

In phase 1, the author distributed the link via personal networks on XING.de, Linkedin.com and Facebook; Quopinion shared the link with 10 identified physicians in their database. By the end of March, there had been only 13 responses; thus, the survey period was extended to 16 April 2020. The author sent reminders through all channels and opened the target audience for therapists who actively plan treatments of patients themselves (therapists can be considered equal with diabetes advisors in terms of professional level, patient contact and treatment responsibility). In addition, the author requested that surveycircle.de[421] post the survey link through their channels XING.de, Linkedin.com and Facebook as well as Twitter. In discussion with Quopinion, the company could identify 62 therapists in their data base. The survey was installed on the Quopinion platform and assigned to the members.

At the end of the pretest, there were 40 datasets, including 27 additional responses from the Quopinion platform. Thirty-six respondents came from Quopinion and 4 from the author's networks. This pretest period revealed that the target group of HCPs are more willing to participant when they are paid and already committed to a survey platform. The distribution via social networks for a specific target group only worked when single contacts were asked directly. Data were protected from unauthorised access and stored securely.

6.2.2.3.1 Dataset analysis

Two datasets needed to be excluded because the participants answered that they do not work in a medical field. The question on working experience in years needed to be removed because the answer options were incorrect. Two adjustments of the entire dataset were necessary: BI2 was inserted twice on the Quopinion platform. The second answer was eliminated, because all statements should be considered with their first evaluation. Looking at the LimeSurvey platform, the settings showed an additional 19 accesses that were not completed. All dropouts happened at the introduction text or, at the latest, the fifth question.

In terms of respondents' characteristics, the age distribution was between 21 and 63 (mean 40) years. Thirty-five per cent of the participants were male, 63%

[421] www.surveycircle.de

women and 1 participant answered other. Most test persons (75%) were employed; the rest were self-employed. Twenty-two worked in a medical office, 17 in a clinic and 1 in another institution. The HCPs worked in different medical disciplines: most in physiotherapy, psychology as well as general medicine; some focussed on nutrition/diabetes.[422]

6.2.2.3.2 Item and construct analysis

SPSS (IBM Watson Studio Desktop & SPSS Modeler and Statistics Version) was used for statistical item analysis to evaluate all constructs. Cronbach's alpha is measured to check the reliability of each construct as well as of the entire model; it shows the internal consistency of the constructs.[423] All cases (i.e. all 40 datasets) could be included for reliability analysis and item statistics (Table 11).[424]

Valid	**40**	**100%**
Excluded	0	0%
Total	40	100%

Table 11: Datasets included in the pretest

Statistical analysis commenced after uploading the coded data a descriptive. The answers were put in an Excel file and coded 1 (*fully agree*) to 5 (*fully disagree*). The settings included showing the median and standard deviation of the items and item variances. If an item was not considered for calculation of the scale value, then median, variance of scale value and Cronbach's alpha is shown.[425] The goal was to get 4–6 items per construct. A Cronbach's alpha above 0.7 is acceptable. Items are eliminated while ensuring there are a minimum of four items per construct and the reliability improves to > 0.5. Table 12 shows the adaptation of items in each construct to improve the reliability.[426]

[422] Cf. Verfürth (2020), n.pag.
[423] Cf. Bühl (2019), p. 587 ff.; Hair et al. (2017), p. 96
[424] Cf. Bühl (2019), p. 587
[425] Cf. Bühl (2019), p. 592, Verfürth (2020), n. pag.
[426] Cf. Bühl (2019), p. 594 ff.; Hair et al. (2017), p. 96 f., Verfürth (2020), n. pag.

Construct	**Construct Cronbach's alpha before item revision**	**Items eliminated**	**Cronbach's alpha of construct after item revision**	**Items kept for the construct**	**Cronbach's alpha of construct if item would be deleted**
Attitude	0.784	None	0.784	ATT1	0.682
				ATT2	0.653
				ATT3	0.757
				ATT4	0.799
Behavioral intention	0.783	None	0.783	BI1	0.704
				BI2	0.648
				BI3	0.836
				BI4	0.685
Perceived usefulness	0.875	None	0.875	PU1	0.843
				PU2	0.857
				PU3	0.851
				PU4	0.829
				PU5	0.885
				PU6	0.856
Perceived ease of use	0.806	None	0.806	PEOU1	0.764
				PEOU2	0.723
				PEOU3	0.779
				PEOU4	0.789
				PEOU5	0.780
Facilitators	0.751	None	0.751	FAC1	0.852
				FAC2	0.646
				FAC3	0.661

				FAC4	0.633
Compatibility	0.346	COMP5 removed	0.751	COMP1	0.771
				COMP2	0.559
				COMP3	0.666
				COMP4	0.742
Subjective norm	0.760	None	0.760	SUB1	0.756
				SUB2	0.627
				SUB3	0.736
				SUB4	0.687
Habit	0.731	None	0.731	HAB1	0.672
				HAB2	0.655
				HAB3	0.698
				HAB4	0.633
				HAB5	0.742
				HAB	0.735
Importance of data security	0.713	IOD4 re-moved, as improve-ment is > 0.05	0.763	IOD1	0.637
				IOD2	0.667
				IOD3	0.764
				IOD5	0.761
Financing	0.466	FIN5, FIN1, FIN4, FIN2 removed	0.691	FIN1	0.680
				FIN2	0.637
				FIN3	0.637
				FIN4	0.603
				FIN5	0.637
Importance of standard-isation	0.345	No improve-ment	Eliminated	STAN 1-4	none

		possible			
Relationship to patient	0.432	REL1, REL2, REL3 removed	0.729	REL4	0.728
				REL5	0.580
				REL6	0.699
				REL7	0.663
				REL8	0.724
Trust in telemedicine centre	0.565	TRU3, TRU2, TRU1, TRU7 removed	0.700	TRU4	0.516
				TRU5	0.666
				TRU6	0.650
				TRU7	0.696

Table 12: Item revision analysis[427]

Due to the item revision analysis, the construct of importance of standardisation (STAN) had to be removed because internal consistency was < 0.7. A separate analysis of all experienced participants older than 30 years also showed only a slightly higher reliability of 0.386. All other constructs showed high reliability after necessary amendments. After removing those items, the total reliability showed a Cronbach's alpha of 0.914.[428] Exploratory factor analysis was not necessary because the construct's relationships are orientated towards the literature review findings.

After the reliability check, items were inspected regarding their median and standard deviation values (Table 13). The median is a characteristic of the value distribution and shows the middle of the value distribution.[429] The standard deviation is the square root from the variance of the item. A high standard deviation value indicates that the values of an item are spread out over a wide range around the median.[430]

[427] Cf. Verfürth (2020), n. pag.
[428] Cf. Verfürth (2020), n. pag.
[429] Cf. Bortz et al. (2006), p. 745 f.; Holland et al. (2010), p. 45
[430] Cf. Holland et al. (2010), p. 53 f.

The lowest median values – which specifies high agreement with the statement – were for item ATT4 (describes a positive attitude towards the importance of digitalisation in the telemedicine future) and IOD1 (indicates the need of technical standards of handling patients' data). IOD1 also showed the lowest standard deviation, meaning that the participants answered similarly. FIN7 and FIN8 showed high median values: there is a tendency for disagreement of whether patients should privately pay for telemedicine services. HAB1 showed the highest standard deviation; this item evaluates the usage of telemedicine in the past and the existing resources for using telemedicine systems. This outcome indicates great heterogeneity in facilities and experience of telemedicine system in the participant pool.

Item	Median	Standard deviation
ATT1	2.33	0.764
ATT2	2.13	0.791
ATT3	1.98	0.733
ATT4	**1.58**	0.549
BI1	2.35	0.921
BI2	2.50	0.934
BI3	2.30	0.723
BI4	2.63	0.868
PU1	2.68	0.917
PU2	2.55	0.749
PU3	2.60	0.841
PU4	2.75	0.927
PU5	2.70	0.939
PU6	2.50	1.013
PEOU1	2.48	0.905
PEOU2	2.55	0.749
PEOU3	2.75	0.776
PEOU4	2.60	0.591
PEOU5	2.50	0.506

FAC 1	2.68	**1.309**
FAC 2	2.33	0.859
FAC 3	2.30	0.853
FAC 4	2.30	0.791
COMP1	3.03	0.947
COMP2	2.85	0.921
COMP3	2.80	0.992
COMP5	2.40	0.841
SUB1	3.30	0.791
SUB2	3.10	0.744
SUB3	2.70	0.823
SUB4	2.90	0.900
HAB1	3.43	**1.357**
HAB2	3.45	1.260
HAB3	2.35	0.864
HAB4	2.60	0.928
HAB5	2.30	0.823
HAB6	1.70	0.823
IOD1	**1.35**	**0.533**
IOD2	1.68	0.888
IOD3	1.75	0.927
IOD5	1.63	0.807
FIN3	2.42	0.781
FIN6	3.00	0.934
FIN7	**3.63**	0.925
FIN8	3.05	1.197
FIN9	2.98	1.050
STAN1	2.00	0.716
STAN2	2.60	0.841
STAN3	2.68	0.797
STAN4	2.45	0.876
REL4	2.88	0.966
REL5	2.58	0.844
REL6	2.73	0.751

REL7	2.35	0.864
REL8	2.30	0.823
TRU4	1.75	0.776
TRU5	1.98	0.698
TRU6	2.55	0.986
TRU8	1.83	0.844

Table 13: Median and standard deviation values for each item; bold values indicate either the lowest median or the highest standard deviation

The mean, minimum and maximum values of the constructs were calculated on the basis of the item mean and item variance (Table 14). The range is the difference between the smallest and largest value in the dataset.[431] The variance shows how strongly the answers to the items of a construct are scattered in the sample.[432] This construct overview provided similar results to the median and standard deviation calculations for each item. There was less agreement in the SUB factor (the external influence of other people) and in the FIN factor (private finance of services for patients and investments for medical institutions).

	Mean	**Minimum**	**Maximum**	**Range**	**Maximum / minimum**	**Variance**	**Number of items**

[431] Cf. Holland et al. (2010), p. 51 f.
[432] Cf. Holland et al. (2010), p. 53 f.

ATT	Item mean	2.000	1.575	2.325	0.750	1.476	0.101	4
	Item variance	0.512	0.302	0.625	0.323	2.070	0.021	4
BI	Item mean	2.444	2.300	2.625	0.325	1.141	0.022	4
	Item variance	0.749	.0523	0.872	0.349	1.667	0.025	4
PU	Item mean	2.629	2.500	2.750	0.250	1.100	0.009	6
	Item variance	0.813	0.562	1.026	0.464	1.826	0.025	6
PEOU	Item mean	2.575	2.475	2.750	0.275	1.111	0.012	5
	Item variance	0.518	0.256	0.820	0.563	3.198	0.049	5
FAC	Item mean	2.400	2.300	2.675	0.375	1.163	0.034	4
	Item variance	0.951	0.626	1.712	1.087	2.737	0.260	4
COMP	Item mean	2.769	2.400	3.025	0.625	1.260	0.070	4
	Item variance	.0859	0.708	0.985	0.277	1.391	0.013	4
SUB	Item mean	3.000	2.700	3.300	0.600	1.222	0.067	4
	Item variance	0.667	0.554	0.810	0.256	1.463	0.012	4
HAB	Item mean	2.637	1.700	3.450	1.750	2.029	0.471	6
	Item variance	1.065	0.677	1.840	1.163	2.719	0.264	6
IOD	Item mean	1.600	1.350	1.750	0.400	1.296	0.030	4
	Item variance	0.646	0.285	0.859	0.574	3.018	0.065	4
FIN	Item mean	3.015	2.425	3.625	1.200	1.495	0.181	5
	Item variance	0.974	0.610	1.433	0.824	2.351	0.096	5
REL	Item mean	2.565	2.300	2.875	0.575	1.250	0.060	5
	Item variance	0.726	0.563	0.933	0.369	1.655	0.018	5
TRU	Item mean	2.025	1.750	2.550	0.800	1.457	0.131	4
	Item variance	0.693	0.487	0.972	0.485	1.997	0.043	4

Table 14: Item mean and variance for each construct

Illustration 30 presents the adapted structure model after the pretest. Note that the variable of standardisation (STAN) has been removed.

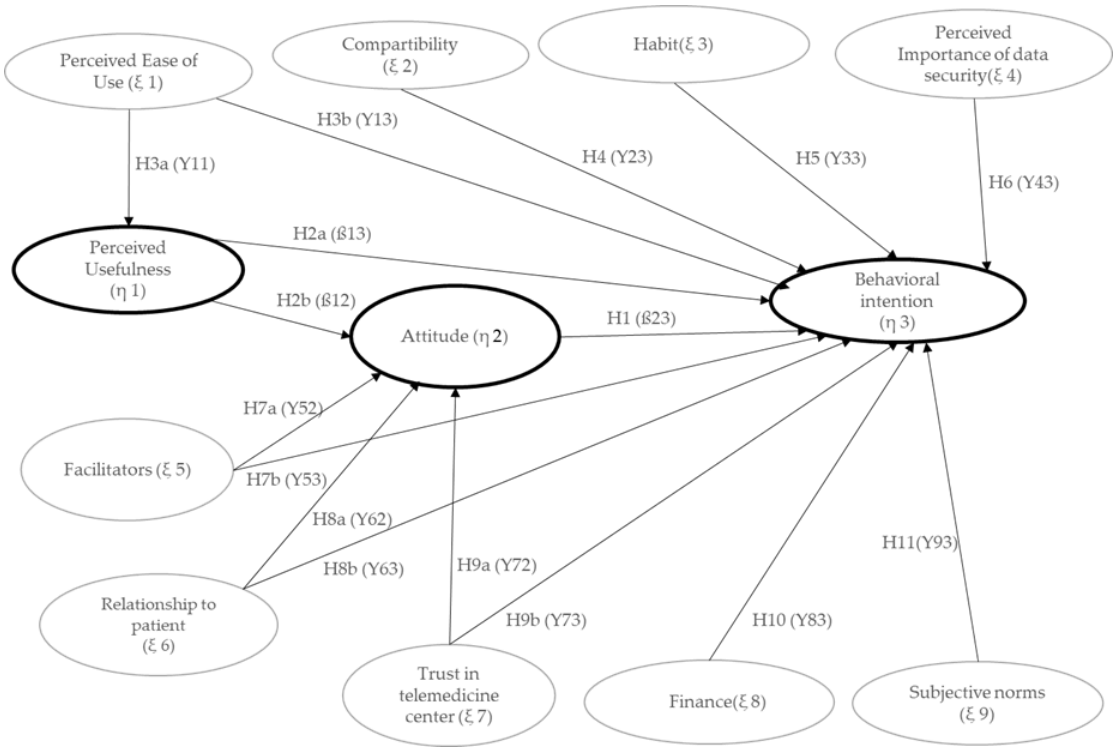

Illustration 30: Structure model adapted after the pretest

Findings

- Telemonitoring acceptance constructs needed to be adapted to provide a high reliability.
- Consequently the structure model was changed.

7 SURVEY AND FIELD RESEARCH

7.1 SAMPLE DESCRIPTION

The fundamental idea of a study is to show reality as accurately as possible. Evidence should reveal observations for a total population. The population is the total quantity of observation units (N) on which a statement is made. Asking the total population in a so-called full census is often complex. Hence, a sample (n) that can represent the population needs to be defined. It is often unclear whether samples of behaviour surveys are really representative.[433]

Sampling techniques are grouped into probabilistic and non-probabilistic techniques. When using a non-probabilistic method, some members of the population do not have a chance to be selected, because it is based on the researcher beliefs.[434] The study at hand used a partial cluster sampling similar to a case study.[435] The cluster is chosen by the region defined by the health insurance areas. The resident medical diabetes community of Westphalia-Lippe was consulted to select participants. The diabetes offices in Westphalia-Lippe have been forerunners over the past few years in several diabetes treatment areas. Indeed, compared with Germany, on average 90% of all GPs in Westphalia-Lippe participate in the disease management programme (See 4.1.2), which is the highest quota in Germany. Furthermore, Westphalia-Lippe has the highest penetration of specialised diabetes medical offices, with 1.3 offices per 100,000 inhabitants.[436] Westphalia-Lippe shows a mixture of rural and urban areas; it is located in western Germany, in the east part of the federal state North Rhine-Westphalia, and contains approximately 8.3 million inhabitants (approximately 10% of total German population).[437]
The data of the diabetes specialised offices (Diabetologischen Schwerpunkten Praxen) in Westphalia-Lippe (https://www.bdswl.de/) were last publicly accessible

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[433] Cf. Bortz (2006), p. 395 ff.

[434] Cf. Bortz (2006), p. 402 ff.

[435] Cf. Hollenberg (2016), p. 26.; Mossig (2012), p. 4

[436] Cf. Nagel et al (2006), ePub; Weber et al. (2005), n. pag.

[437] Cf. https://www.lwl.org/de/LWL/Der_LWL/Der-LWL-im-Ueberblick/Westfalen-Lippe/

at the Kassenärztliche Vereinigung Westfalen-Lippe (KVWL).[438] The list of resident German physicians is ordered alphabetically. The list of medical offices seems complete because it is a list of official German institutions; there is no obvious pattern. The list was extended to include all published, employed diabetologists in those medical office (See 44.1.2):

Contacts	Number identified
Medical offices (KVWL)	114 (10% of all German offices)
Identified diabetologists	153 (11% of all resident diabetologists)

Table 15: Identified diabetes medical offices and diabetologists

The calculation of the sample size considering the KVWL follows Mossig (Formula 1):[439]

$$n \geq \frac{N}{1 + \frac{(N-1) * \varepsilon^2}{z^2 * p * q}}$$

n = minimum required sample size for a finite population
N = number of elements in the population
ε = targeted error accuracy (tolerated error)
z = quantile of the standard normal distribution
p = percentage share of the population
q= 1 – p

Formula 1: Sample size calculation

[438] Cf. https://www.kvwl.de/arzt/qsqm/genehmigung/teilnehmerlisten/dsp.pdf

[439] Cf. Mossig (2012), p. 21

The population size (N) is 1400. The margin of error is 5%. The confidence level is 95%. Considering N = 1400, ε = 5%, z = 1.96, p = 0.11 (cluster includes 11% share of resident diabetologists in Germany) and q = 0.89, n is calculated as follows:

$$n \geq \frac{1400}{1 + \frac{(1400 - 1) * 0{,}05^2}{1{,}96^2 * 0{,}11 * 0{,}89}} = 135$$

The recommended sample size (n) is 135 for diabetologists. To cover the aspect of therapy responsibility and touch points with patients, diabetes advisors were also included. Thus, available data from diabetes advisors were added: there were 116 advisors identified from 48 offices (a complete list could not be generated). In the course of sample selection, several obstacles might occur; a disadvantage of this technique is that there might be hidden patterns in the list, which are not yet visible, and the incomplete availability of diabetes advisor data might not reflect the real situation.

The literature has discussed 10-times rules, which states that the minimum sample size needed to estimate a partial least squares (PLS) path model should be 10 times higher than the number of a structural paths in the construct with the most paths (here: BI with 11 structure paths). In this calculation, the sample should be greater than 110 respondents.[440]

Further research is required to ensure that this cluster is representative, or the results will be distorted due to the lack of random selection.[441] Nevertheless, cluster sampling has two advantages:

1. The study can be limited to a regional area, a factor that reduces the cost.[442]
2. A full census is possible. No full list of the total population is freely available.[443]

[440] Cf. Hair et al. (2017), p. 270
[441] Cf. Bahrenberg et al. (2010), p. 23
[442] Cf. Mossig (2012), p. 5
[443] Cf. Atteslander (1971), p. 209 f.

7.2 SURVEY INSTRUMENT AND DATA COLLECTION

Several distribution channels were considered and evaluated. Diabetes-related associations could not be utilised due to their refusal: their field of activity was either patient and clinic related or distributing a survey was incompatible with professional policy. An oral or written survey execution at a diabetes conference or congress would have been considered appropriate. Medical address databases and distribution services were rejected due to costs outside the project's budget. Collaboration with an industry partner was excluded because it would not have been neutral.

Thus, the available list of the regional association of statutory health insurance (https://www.kvwl.de/arzt/qsqm/genehmigung/teilnehmerlisten/dsp.pdf; KVWL) of all approved specialised diabetes medical offices in Westphalia-Lippe was the basis for identifying all active diabetologists. A manual website search served to confirm each office and to add the gender and first name of the physician as well as additional diabetologists employed in these offices. Furthermore, due to the homepage search, all named diabetes advisors were gathered and listed.

The identified diabetologists and diabetes advisors received personalised correspondence that included a cover letter with a personal salutation and background of the project; two double-sided papers that represented the questionnaire, including instructions; and a pre-paid reply envelope (see appendix). This personalised and free-of-charge approach should motivate the contacted HCPs to answer. No incentives for participation were offered. The cover letter indicated that the questionnaire could be answered by completing the paper-based questionnaire or answering the online-based survey. Therefore, a QR code was generated and printed on the cover letter. A domain was set up for the online survey (https://akzeptanz-telemedizin.limequery.net/2). The platform was again LimeSurvey, and the same pretest settings were used.

For questionnaire return, a business mailbox at the post office named *research project telemedicine* was created and put on the reply envelope. This approach should emphasise the serious research background and should not raise any

advertising impressions. Table 16 presents the advantages and disadvantages of online and postal surveys.[444]

The statements in the questionnaire were adapted according to the pretest results (See 6.2.2.3). The survey was anonymous, and there was no tracking of letters with codes or online addresses.

Online survey	**Postal survey**
Advantages • Answers can be set as mandatory • Costs • Lower effort to reach more people Disadvantages • GDPR difficulties: meet data protection regulations[445]	Advantages • Haptic experience • Ideal for selected and regional based surveys • Easy handling in terms of GDPR[446] • Response rate between 10%–60% Disadvantages • High costs: o Design, approximately EUR 90 o Printing, approximately EUR 200 o Envelopes, approximately EUR 50 o Postage, approximately EUR 220 o Return postage, approximately EUR 40 • Preparation efforts • Less control with regard to participation

Table 16: Advantages and disadvantages of online versus postal surveys

[444] Cf. Javob et al. (2014), p. 117 f.
[445] Cf. DSGVO Art. 6
[446] Cf. DSGVO Art. 6

The online study was open and accessible to respondents from 14 May 2020 until 2 June 2020. Letters were sent out at the 14 May. Two sent questionnaires could not be delivered. Looking at the online questionnaire, the first page was opened 12 times and fully completed 10 times. On average, the complete survey took around approximately 10 minutes. Forty-seven postal surveys were returned. Hence, there were 57 datasets generated.

Table 17 shows on overview of the participants age and work experience. There was a wide range in terms of age as well as experiences in the diabetes field.

Code	Description	Quantity	Missing	Average	Min	Max
AGE1	Age (years)	57	5	44	28	65
WORK2	Experience (years)	57	0	12	0	32

Table 17: Field test participants characteristics: age and experiences

As shown in Table 18, most participants were physicians and male; the greater number of men was expected because most of the diabetologists who received the survey were male. As the survey concentrated on HCPs in medical offices, the majority of respondents were self-employed. Most of the employed respondents were diabetes advisors. Most response came from the postal code 4, which contains the largest pool of diabetes offices.

Code	Description	Quantity	Missing	Distribution
GEN1	Gender	57	1	18 female 38 male
DIS1	Profession	57	2	45 physicians 10 advisors
WORK 1	Employment	57	0	38 self-employed 19 employed
PLZ 1	Postal code	57	11	10 postal code 3 25 postal code 4 11 postal code 5

Table 18: Field test participants characteristics: gender, profession, employment and region

8 DATA ANALYSIS

The first step of analysis involved listing each item with the judgements of the statements in a descriptive way. There were some missing values: two participants did not recognise the double-sided print and it seemed that the statement around subjective norm was perceived as not appropriate. Based on the rating system from 1 (*strongly agree*) until 5 (*strongly disagree*) – there was in general a positive trend because the median was below 3 (Table 19). With a rating of 1.491, which is the lowest value, the highest agreements were in ATT4, meaning that digitalisation will be important in the future patient treatment; IOD5, describing that medical societies need to influence the framework of data security regulations and management; and TRU8, meaning the requirement to be informed about the medical decision processes in the telemedicine centre. Of note, several constructs showed no disagree answers above 3 (minimal and maximal value): attitude, BI and data security. This finding again shows a high agreement and importance. FIN7–9 showed higher values because those statements have another direction: a negative cost load on the patient or the medical office.

Item	Missing	Average	Median	Min	Max	Standard Deviation
ATT1	0	2.035	2.000	1.000	3.000	0.674
ATT2	0	2.000	2.000	1.000	3.000	0.496
ATT3	0	1.895	2.000	1.000	3.000	0.519
ATT4	0	1.491	1.000	1.000	3.000	0.679
BI1	0	1.947	2.000	1.000	3.000	0.394
BI2	0	2.105	2.000	1.000	3.000	0.552
BI3	0	2.018	2.000	1.000	3.000	0.577
BI4	0	2.053	2.000	1.000	3.000	0.510
PU1	0	2.439	2.000	1.000	4.000	0.795
PU2	0	2.123	2.000	1.000	4.000	0.703
PU3	0	2.368	2.000	1.000	5.000	0.851

PU4	0	2.474	2.000	1.000	5.000	0.900
PU5	0	2.579	2.000	1.000	5.000	0.857
PU6	0	2.105	2.000	1.000	4.000	0.583
PEOU1	0	2.684	3.000	1.000	4.000	0.798
PEOU2	0	2.789	3.000	1.000	4.000	0.585
PEOU3	0	3.175	3.000	2.000	5.000	0.625
PEOU4	0	2.825	3.000	1.000	5.000	0.704
PEOU5	0	2.860	3.000	2.000	4.000	0.634
FAC 1	2	2.018	2.000	1.000	5.000	1.120
FAC 2	2	1.836	2.000	1.000	4.000	0.848
FAC 3	2	2.055	2.000	1.000	4.000	0.553
FAC 4	2	2.073	2.000	1.000	4.000	0.710
COMP1	2	2.673	3.000	1.000	4.000	0.788
COMP2	2	2.345	2.000	1.000	4.000	0.836
COMP3	2	2.491	3.000	1.000	5.000	0.892
COMP5	2	1.873	2.000	1.000	3.000	0.605
SUB1	3	2.444	2.000	1.000	4.000	0.786
SUB2	5	2.519	2.000	1.000	4.000	0.843
SUB3	2	2.709	3.000	2.000	4.000	0.652
SUB4	3	2.481	2.000	1.000	5.000	0.764
HAB1	2	2.582	2.000	1.000	5.000	1.171
HAB2	2	2.491	2.000	1.000	5.000	1.060
HAB3	2	2.473	3.000	1.000	5.000	0.783
HAB4	2	2.327	2.000	1.000	4.000	0.715
HAB5	2	2.182	2.000	1.000	4.000	0.542
HAB6	2	1.618	1.000	1.000	4.000	0.798
IOD1	2	1.109	1.000	1.000	3.000	0.365
IOD2	2	1.182	1.000	1.000	3.000	0.471
IOD3	0	1.509	1.000	1.000	3.000	0.728
IOD5	0	1.456	1.000	1.000	3.000	0.623
FIN3	0	2.649	3.000	1.000	4.000	0.737
FIN6	0	2.386	2.000	1.000	4.000	0.894
FIN7	0	3.421	3.000	1.000	5.000	0.878
FIN8	0	3.018	3.000	1.000	5.000	1.017
FIN9	0	3.526	3.000	1.000	5.000	0.881
REL4	0	2.386	2.000	1.000	5.000	0.743
REL5	0	2.193	2.000	1.000	5.000	0.736
REL6	0	2.667	3.000	1.000	5.000	0.658
REL7	0	2.298	2.000	1.000	5.000	0.837
REL8	0	2.316	2.000	1.000	5.000	0.958
TRU4	1	1.625	2.000	1.000	3.000	0.670

TRU5	1	2.036	2.000	1.000	3.000	0.533
TRU6	1	2.268	2.000	0.000	4.000	0.813
TRU8	1	1.339	1.000	1.000	4.000	0.606

Table 19: Results of field tests: the average, median, minimum and maximum values and standard deviation for each item

8.1 MODEL ESTIMATION

SEM is used to examine and evaluate the causal relationships of the constructs. The research model was tested using PLS[447] in SmartPLS Version 3.2.9.[448] SmartPLS is used when the sample is small.[449] It is recommended to use PLS-SEM if the objective of a model is to determine the main factors that drive the target construct, if the structure model is complex with a lot items and if the constructs will be used in future studies.[450] A linear SEM describes the mutual causal relationships of the parameters and the hypothesis of the latent non-observable parameters. Thus, this approach combines path analysis that investigates the causal relationship as well as the hypothesis.[451]

The PLS approach includes two steps. First, concrete estimated values are calculated for the latent variables (score construct values) based on the empirical data. Second, these values are used for the estimation of the parameters in the structure model with the help of a regression analysis.[452] This method is a variance-based approach because the objective is the minimisation of the variance of the error variables in the measurement as well as the structure model to get the most precise picture of the basic empirical data.[453]

[447] Cf. Haavelmo (1943); Wold (1982); Wright (1923)
[448] Cf. Ringle et al. (2015)
[449] Cf. Weiber et al. (2014), p. 74 ff.
[450] Cf. Weiber et al. (2014), p. 19
[451] Cf. Bortz et al. (2006), p. 521
[452] Cf. Weiber et al. (2014), p. 25, 67
[453] Cf. Weiber et al. (2014), p. 67

The analysis in SmartPLS comprised the following these steps, which are explained in the next parts:[454]

1. Data preparation;
2. Creation of a path model;
3. Reliability and validity analysis of constructs;
4. Confirmatory factor analysis: discriminant validity;
5. Collinearity statistics (VIF);
6. Significance analysis via bootstrapping procedure;
7. Quality and prognosis analysis of model;
8. Multigroup analysis (MGA); and
9. Prognosis effect analysis.

In terms of data preparation, the answers were put in an Excel file and coded 1 (*fully agree*) to 5 (*fully disagree*). Gender (GEN1) was coded with 1 for female and 2 for male. DIS1 showed working as a physician with code 1 and as an advisor with code 2. Work 1 described the employment status: 1 for self-employed and 2 for employed. Item Work 2 captured the years of experience. PLZ1 showed the first number of the postal code and OFFON described 1 for offline survey (paper-based response) and 2 for the online survey. Missing data were uncoded. The datasets was imported as a .csv file in a new SmartPLS project for analysis.

A path model is developed in SmartPLS according to the developed measurement and structure model (See 6.1). The appropriate path model in SmartPLS is shown in Illustration 29. The constructs were all created as a reflective models, which is indicated by the arrow direction towards the indicators.

The PLS algorithm was calculated. Three essential settings were required prior to this endeavour; therefore, settings were adapted so that all missing values are replaced by the average item value. The weighting scheme showed the standard settings of path, maximum of 300 iterations and a stop criterion of 7, meaning that the algorithm stops if 300 processes are done or if (1×10^7) processes are

[454] Cf. Hair et al. (2017), p. 31 ff.; Weiber (2014), p. 66 ff.

reached. Furthermore, no weighting vector is set.[455] The method of PLS path modelling was developed by Wold (1982).[456] The PLS algorithm is a sequence of regressions in the form of weighted vectors. After convergence of the algorithm, the weighted vectors fulfil a fixed point equation.[457]

After the PLS algorithm calculation, the loadings were analysed. The items FIN7, FIN8, FIN9 and TRU 6 showed a negative sign and required a recoding in opposite direction by transferring them: Number of scales (here 5) + 1 – actual rating. The new codes were named with _i for the inverse coding. The corresponding items also showed another direction in their in the statement content.

Illustration 30 shows the loadings of all measurement models (arrows from variable to indicators), the path coefficients of the structure model (arrows between the constructs) and the R^2 of the endogenous variables PU, ATT and BI.

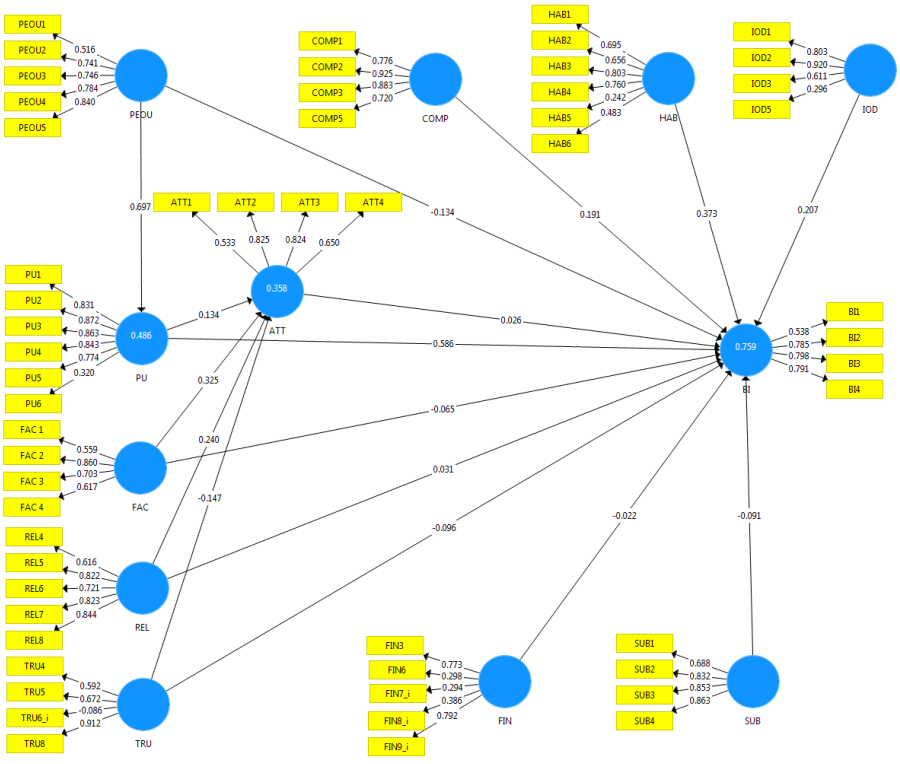

Illustration 31: SmartPLS path model with inner and outer loadings of the com plete original dataset

[455] Cf. Hair (2017), p. 107

[456] Cf. Wold (1982)

[457] Cf. Dijkstra (2015), p. 297 ff.

Looking at the current measurement, the influencing construct PEOU explains 48.6% of PU. Additionally, to PU facilitators, relationship to patient and trust explain 35.8% of attitude. The constructs that influence BI explain 75.9% of this variable. PU (0.586) and habit (0.373) have the highest influence on BI. Attitude is most affected by the construct FAC (0.325). Path coefficients > 0.2 are usually significant: PU → BI; PEOU → PU, FAC → ATT; REL → ATT; IOD → BI; and HAB → BI. However, this needs to be proven in further analysis of the structure model, and for a valid interpretation of the data, the model needs to be evaluated and assessed further.

8.2 QUALITY ASSESSMENT OF THE MODEL

In the next step, the loadings need to be checked regarding their relevance. For the assessment of reflective measurement models, the composite reliability for evaluating the internal consistency (Cronbach's alpha) and the indicator reliability as well as the average variance extracted (AVE) to evaluate the convergence validity are used. These terms are explained below.

8.2.1 Reliability and validity analysis of constructs

Cronbach's alpha evaluates internal consistency; it describes the reliability of a construct based on the intercorrelations between the indicators. It is defined as (Formula 2):[458]

Cronbach's $\alpha = \left(\frac{M}{M-1}\right) * 1 - \left(\frac{\sum_{t=1}^{M} s_i^2}{s_t^2}\right)$

M = number of indicators (i = 1,…, M)
i = indicator variable/items
s_i^2 = variance of indicator variable i
s_t^2 = total variance of all M of a construct

Formula 2: Cronbach's alpha

[458] Cf. Hair et al. (2017) p. 96; Netemeyer (2003)

Following Djkstra et al. (2015), **rho_A** is the most important reliability measure because it is the only consistent measure of construct scores. Other measure refer to sum scores.[459] The key figure **composite reliability** (construct reliability) considers the different loadings of the items. It measures the internal consistency of the scale items (Formula 3).[460]

$$p_c = \frac{\left(\sum_{i=1}^{M} I_i\right)^2}{\left(\sum_{i=1}^{M} I_i\right)^2 + \sum_{i=1}^{M} var(e_i)}$$

Formula 3: Composite reliability

M = number of indicators (i = 1,…, M)
i = indicator variable/items
I_i = standardised loadings of i of a specific construct
e_i = measurement error of i

AVE is the mean value of the squared loading of all items included in a construct. AVE is measured as follows (Formula 4):[461]

$$AVE = \frac{\left(\sum_{i=1}^{M} {I_i}^2\right)}{M}$$

Formula 4: AVE

M = number of indicators (i = 1,…, M)
i = indicator variable/items
I_i = standardised loadings of i of a specific construct

An AVE value ≥ 0.5 means that the construct is explained by more than half of the variance of the indicators.[462]

It is necessary to examine the composition of all these measures and take them all into account to assess the quality of a model. It is important as a precondition to adapt the constructs to have an acceptable reliability and validity. Table 20

[459] Cf. Djkstra et al. (2015), p. 297 ff.; Latan et al. (2017)
[460] Cf. Hair et al. (2017) p. 96
[461] Cf. Hair et al. (2017) p. 99
[462] Cf. Hair et al. (2017) p. 99

shows these measures of the developed model. Dispensable items can have negative effects on the content validity and can create errors, so items need to be minimised.[463]

Construct	Cronbach's alpha	RHO_A	Composite reliability	AVE
ATT	**0.68**	0.71	0.81	0.52
BI	0.71	0.75	0.82	0.54
COMP	0.85	0.85	0.90	0.69
FAC	**0.64**	0.67	0.78	**0.48**
FIN	**0.53**	**0.32**	0.65	**0.31**
HAB	0.74	0.79	0.79	**0.40**
IOD	0.83	0.32	0.77	**0.49**
PEOU	0.79	0.82	0.85	0.54
PU	0.85	0.88	0.89	0.60
REL	0.83	0.84	0.88	0.59
SUB	0.84	**0.95**	0.88	0.66
TRU	**0.39**	0.91	0.65	**0.41**

Table 20: Internal consistency of variable: Cronbach's alpha, composite reliability and AVE before item revision

Following the recommendation from Hair et al. (2017), loadings > 0.708 stay in the measurement model, while loadings between > 0.40 and < 0.70 should only be eliminated if that action implies an increase of the composite reliability above 0.70 or AVE above 0.5. Loadings < 0.40 should be eliminated considering the content validity, meaning a subjective but systematic evaluation of the content coverage of the items in a construct.[464] The composite reliability should not be higher than 0.95 because that phenomenon would indicate that the indicators are measuring the same dimension and so do not affect the validity measurement. It is also important to measure Cronbach's alpha together with the composite reliability because Cronbach's alpha is a conservative measure of reliability and composite reliability tends to overestimate the internal consistency. Optimal Cronbach's alpha

[463] Cf. Hayduk et al. (2012); Rossiter (2002), p. 305 ff.

[464] Cf. Hair et al. (2017), p. 98 f. and p. 277

values are between 0.7 and 0.9; a value under 0.6 is not acceptable.[465] Furthermore, one construct should not be explained by less than 2–3 items. Of note, the literature has warned about modifying models until they have the 'perfect fit'. A model should reveal whether hypotheses are supported; indeed, it is desirable to generate new adapted models with samples that test corresponding hypotheses.[466]

Table 21 shows the results of checking all loadings and necessary eliminations.

Construct	Item loadings outside the acceptable range	Adaption of items
ATT	ATT1: loading > 0.4 and < 0.7 ATT4: loading > 0.4 and < 0.7	**No elimination** due to no positive effect on Cronbach's alpha and AVE
BI	BI1: loading > 0.4 and < 0.7	**Elimination of BI1** due to improvement of reliability and AVE
COMP	Loadings all > 0.7	**None**
FAC	FAC1: loading > 0.4 and < 0.7 FAC4: loading > 0.4 and < 0.7	**Elimination of both items** due to improvement of reliability and AVE
FIN	FIN 6: loading < 0.4 FIN7_i: loading > 0.4 and < 0.7 FIN8_i: loading > 0.4 and < 0.7	**Elimination of total construct** due to unacceptable reliability and AVE
HAB	HAB5: loading < 0.4 HAB6: loading > 0.4 and < 0.7	**Elimination of both items**
IOD	IOD5: loading < 0.4	**Elimination**
PEOU	PEOU1: loading > 0.4 and < 0.7	**Elimination** due to improvement of reliability and AVE
PU	PU6: loading < 0.4	**Elimination**
REL	REL4: loadings > 0.4 and < 0.7	**Elimination** due to improvement of reliability and AVE
SUB	Loadings all > 0.7	**Elimination of SUB1** because composite variability is above 0.95

[465] Cf. Hair et al. (2017), p. 97

[466] Cf. Backhaus et al. (2008); Bortz et al. (2006), p. 196 ff.

TRU	TRU6_i: loading < 0.4 TRU4: loading > 0.4 and < 0.7	**Elimination of TRU6_i** due to improved reliability; TRU4 stays because there is no improvement and the item is important for content validity

Table 21: Item revision analysis and procedure

Table 22 shows the final internal consistency variables after checking the loadings and eliminating items based on Cronbach's alpha, composite reliability, and AVE. All values were acceptable for further analysis.

	Cronbach's alpha	**RHO_A**	**Composite reliability**	**AVE**
ATT	0.68	0.72	0.80	0.51
BI	0.73	0.73	0.85	0.65
COMP	0.85	0.85	0.90	0.69
FAC	0.69	0.70	0.86	0.76
HAB	0.75	0.79	0.81	0.53
IOD	0.80	0.88	0.88	0.70
PEOU	0.79	0.82	0.86	0.61
PU	0.90	0.91	0.93	0.72
REL	0.83	0.83	0.89	0.66
SUB	0.82	0.88	0.89	0.73
TRU	0.65	0.85	0.78	0.55

Table 22: Cronbach's alpha, composite reliability and AVE after item revision

At this stage, 72.8% of BI is explained by the remaining influencing constructs (Illustration 32). PU and habit have the greatest influence on BI.

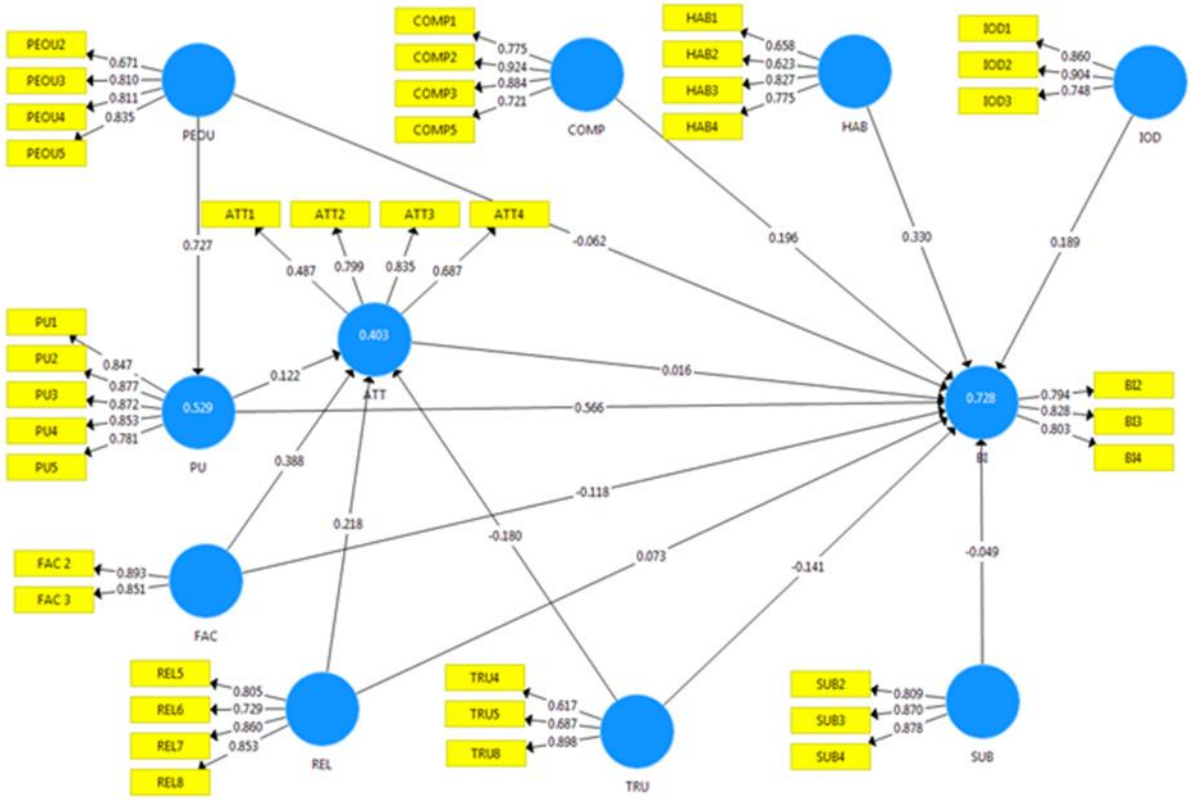

Illustration 32: Inner and outer loadings in the path model after item revision analysis.

8.2.2 Discriminant validity: confirmatory factor analysis

It is crucial to measure discriminant validity to perform a confirmatory factor analysis (CFA). Discriminant validity is a part of construct validity and needs to be measured at the construct and item levels. The concept was introduced by Campbell and Fiske in 1959.[467] Discriminant validity indicates whether a construct is empirically independent and is different from the other constructs. This endeavour utilised the Fornell–Lacker criterion and analysis of cross loadings.[468]

[467] Cf. Campbell et al. (1959), p. 81 ff.
[468] Cf. Hair et al. (2017), p. 99 f.

The Fornell–Lacker criterion tests whether a construct shares the most variance with its own indicators compared with every other construct in the model. The value of the square root of a construct (diagonal line) needs to be higher than the correlation with the other constructs (non-diagonal lines).[469] Table 21 shows the Fornell–Lacker criterion values for each construct. Overall, the main loads of each construct on itself are the highest. Nevertheless, there are high loadings on other constructs, and these need to be analysed in detail by analysing the cross loadings (Table 23).

	ATT	*BI*	*COMP*	*FAC*	*HAB*	*IOD*	*PEOU*	*PU*	*REL*	*SUB*	*TRU*
ATT	**0.71**										
BI	0.39	**0.81**									
COMP	0.41	0.50	**0.83**								
FAC	0.54	0.25	0.42	**0.87**							
HAB	0.27	0.57	0.38	0.17	**0.73**						
IOD	0.09	0.24	0.01	0.18	0.26	**0.84**					
PEOU	0.38	0.53	0.20	0.33	0.35	0.11	**0.78**				
PU	0.40	0.69	0.35	0.35	0.24	0.01	0.73	**0.85**			
REL	0.51	0.48	0.35	0.57	0.35	0.18	0.41	0.48	**0.81**		
SUB	0.23	0.21	0.21	0.33	0.40	0.11	0.23	0.18	0.23	**0.85**	
TRU	-0.19	-0.27	-0.10	0.10	-0.06	0.23	-0.13	-0.21	-0.09	0.03	**0.74**

Table 23: Fornell–Lacker criterion values for each construct

Table 24 presents analysis of cross loadings as part of discriminant validity.

[469] Cf. Hair et al. (2017), p. 99 f.

	ATT	*BI*	*COMP*	*FAC*	*HAB*	*IOD*	*PEOU*	*PU*	*REL*	*SUB*	*TRU*
ATT1	0.49	0.21	0.41	0.16	0.30	-0.11	0.02	0.09	0.16	0.23	-0.10
ATT2	0.80	0.37	0.35	0.27	0.26	0.22	0.24	0.30	0.40	0.17	-0.05
ATT3	0.84	0.34	0.23	0.35	0.12	0.09	0.40	0.40	0.45	0.23	-0.31
ATT4	0.69	0.20	0.27	0.65	0.17	0.00	0.29	0.27	0.38	0.07	-0.05
BI2	0.26	0.79	0.37	0.10	0.38	0.07	0.43	**0.66**	0.34	0.14	-0.30
BI3	0.28	0.83	0.38	0.13	0.46	0.19	0.36	**0.50**	0.41	0.17	-0.23
BI4	0.41	0.80	0.46	0.38	0.54	0.32	0.48	**0.51**	0.42	0.19	-0.13
COMP1	0.13	0.40	0.78	0.08	0.42	-0.03	0.18	0.23	0.13	0.21	-0.14
COMP2	0.35	0.44	0.92	0.32	0.37	0.02	0.13	0.25	0.24	0.24	-0.05
COMP3	0.48	0.40	0.88	0.55	0.23	-0.03	0.24	0.41	0.39	0.13	-0.10
COMP5	0.39	0.40	0.72	0.45	0.23	0.09	0.10	0.28	0.38	0.11	-0.06
FAC 2	**0.51**	0.22	0.38	0.89	0.17	0.23	0.26	0.28	0.56	0.34	0.08
FAC 3	0.42	0.21	0.35	0.85	0.11	0.07	0.33	0.33	0.43	0.23	0.10
HAB1	0.16	0.20	0.18	0.21	0.66	0.10	0.06	-0.06	0.23	**0.54**	-0.22
HAB2	-0.02	0.20	0.08	0.07	0.62	0.16	0.02	-0.08	0.16	0.42	-0.14
HAB3	0.41	0.56	0.39	0.20	0.83	0.16	0.47	0.35	0.45	0.19	-0.11
HAB4	0.07	0.48	0.31	0.02	0.78	0.30	0.23	0.20	0.12	0.29	0.14
IOD1	0.05	0.19	-0.04	0.09	0.18	0.86	0.07	0.00	0.17	-0.04	0.25
IOD2	0.08	0.25	0.04	0.18	0.31	0.90	0.08	0.00	0.12	0.21	0.12
IOD3	0.11	0.12	0.03	0.17	0.12	0.75	0.14	0.05	0.22	0.05	0.24
PEOU2	0.23	0.39	0.19	0.30	0.50	0.23	0.67	0.31	0.32	0.23	0.06
PEOU3	0.31	0.39	0.18	0.26	0.16	-0.04	0.81	**0.72**	0.39	0.14	-0.20
PEOU4	0.25	0.28	0.09	0.33	0.19	-0.01	0.81	**0.61**	0.30	0.20	-0.04
PEOU5	0.37	0.58	0.17	0.19	0.33	0.21	0.83	**0.57**	0.30	0.18	-0.14

PU1	0.25	**0.57**	0.28	0.26	0.06	-0.08	**0.62**	0.85	0.40	0.00	-0.18
PU2	0.31	**0.62**	0.32	0.29	0.25	-0.08	**0.66**	0.88	0.47	0.20	-0.13
PU3	0.38	**0.66**	0.29	0.35	0.16	0.15	**0.57**	0.87	0.42	0.17	-0.17
PU4	0.48	**0.60**	0.36	0.36	0.25	0.06	**0.65**	0.85	0.40	0.22	-0.24
PU5	0.25	**0.48**	0.23	0.18	0.32	0.00	**0.58**	0.78	0.35	0.15	-0.15
REL5	0.41	0.36	0.27	0.51	0.31	0.08	0.39	0.41	0.80	0.36	-0.15
REL6	0.44	0.41	0.29	0.34	0.18	0.06	0.31	0.40	0.73	0.05	-0.12
REL7	0.43	0.43	0.36	0.51	0.31	0.20	0.27	0.33	0.86	0.18	-0.06
REL8	0.39	0.35	0.18	0.50	0.36	0.26	0.40	0.43	0.85	0.16	0.04
SUB2	0.12	0.11	0.09	0.20	0.33	0.09	0.16	0.07	0.05	0.81	0.12
SUB3	0.25	0.17	0.20	0.24	0.31	0.04	0.24	0.18	0.17	0.87	0.00
SUB4	0.19	0.22	0.21	0.37	0.38	0.14	0.17	0.17	0.29	0.88	-0.01
TRU4	-0.09	-0.07	-0.07	0.07	-0.04	0.11	-0.13	-0.17	0.00	0.03	0.62
TRU5	-0.08	-0.16	-0.04	0.11	0.08	0.21	-0.04	-0.11	0.02	0.14	0.69
TRU8	-0.20	-0.29	-0.10	0.06	-0.12	0.18	-0.12	-0.19	-0.14	-0.04	0.90

Table 24: Cross loadings; bold values indicate high loadings from other constructs

Cross loadings, which are higher than the actual corresponding indicator loadings on a construct, can show a deficit in discriminant loadings. Based on Table 24, several indicator loadings from other constructs show high loadings (marked in bold type), but there are no critical loadings that are higher than each construct's own loadings.

Quality measures for cross loadings have been strongly discussed in the literature because it has shown less reliability in variance-based SEMs.[470] Thus, additional measurements are also considered, namely the heterotrait-monotrait ratio of correlations (HTMT). Voorhees et al. proposed the combination of the Fornell–Lacker criterion and the HTMT approach.[471] Thus, the HTMT method of Henseler et al. (2015) was conducted.[472] The HTMT criterion describes the relationship between two correlations: the between-trait correlation and the within-trait correlation. In literature, the correlation is called a disattenuated correlation; a value near 1 shows a lack of discriminant validity.[473] Henseler et al. (2015) proposed a threshold value of 0.85.[474] The present dataset did not contain any critical values (Table 25).

	ATT	*BI*	*COMP*	*FAC*	*HAB*	*IOD*	*PEOU*	*PU*	*REL*	*SUB*	*TRU*
ATT											
BI	0.56										
COMP	0.59	0.63									
FAC	0.73	0.35	0.56								
HAB	0.42	0.64	0.41	0.24							
IOD	0.21	0.33	0.09	0.25	0.31						
PEOU	0.47	0.68	0.25	0.47	0.38	0.24					
PU	0.47	0.84	0.41	0.44	0.30	0.12	0.83				
REL	0.65	0.61	0.41	0.75	0.42	0.25	0.52	0.56			
SUB	0.34	0.25	0.24	0.41	0.60	0.15	0.29	0.21	0.28		
TRU	0.28	0.33	0.15	0.16	0.28	0.33	0.22	0.27	0.14	0.16	

Table 25: Heterotrait-monotrait ratio of correlations (HTMT)

[470] Cf. Henseler et al. (2015) p. 115 ff.; Voorhees et al. (2016), p. 119 ff.
[471] Cf. Voorhees et al. (2016), p. 119 ff.
[472] Cf. Henseler et al. (2015), p. 115 ff.
[473] Cf. Hair et al. (2017), p. 102 f.
[474] Cf. Henseler et al. (2015), p. 115 ff.

8.2.3 Collinearity statistics (VIF)

Collinearity occurs if two indicators are strongly correlated; this phenomenon could distort the results.[475] Collinearity is checked via the VIF statistic; all values need to be less than the limit of 5.[476] All values in this study are < 5 (Table 26), so there was no critical measure on collinearity.[477]

ITEM	VIF	ITEM	VIF
ATT1	1.30	**PU1**	2.77
ATT2	2.00	**PU2**	2.82
ATT3	1.80	**PU3**	2.95
ATT4	1.19	**PU4**	2.45
BI2	1.38	**PU5**	1.99
BI3	1.59	**REL5**	1.88
BI4	1.46	**REL6**	1.36
COMP1	2.15	**REL7**	2.22
COMP2	4.21	**REL8**	2.31
COMP3	3.10	**SUB2**	2.03
COMP5	1.56	**SUB3**	2.16
FAC 2	1.38	**SUB4**	1.60
FAC 3	1.38	**TRU4**	1.31
HAB1	3.35	**TRU5**	1.31
HAB2	3.22	**TRU8**	1.21
HAB3	1.36	**PEOU2**	1.46
HAB4	1.30	**PEOU3**	1.66
IOD1	1.83	**PEOU4**	1.78
IOD2	1.80	**PEOU5**	1.79
IOD3	1.57		

Table 26: Variance inflation factor (VIF) analysis of items

It is also important to check the **total effects** in a structure model. Total effects show how the core end variable BI is influenced via the mediator variables of

[475] Cf. Hair et al. (2017), p. 278 f.
[476] Cf. Hair et al. (2017), p. 180 f.
[477] Cf. Hair et al. (2017), p. 180 f.

PU and ATT. Both variables are mediators because they show connections between variables.[478] In Table 27, the end variables (columns) are ATT influenced by FAC, PEOU, PU, REL and TRU; and PU is only affected by PEOU. The core variable BI is influenced by ATT and PU, but also directly by COMP, FAC, IOD, PEOU, REL, SUB and TRU.

Meaningful relationships can be seen if the path coefficient is > 0.2.[479] PU has the strongest effect on BI; PU is strongly affected by PEOU; and PEOU shows a total effect on BI (the second strongest influence). The analysis also shows an influence from habit and compatibility on BI; a low effect by importance of data security, relationship to patient and attitude; and no effect from subjective norm and the trust in the telemedicine centre. Attitude is highly influenced by facilitators and the relationship to the patient, but it is minimally affected by PEOU and PU.

	ATT	BI	PU
ATT		0.02	
BI			
COMP		**0.20**	
FAC	**0.39**	-0.11	
HAB		**0.33**	
IOD		0.19	
PEOU	0.09	**0.35**	**0.73**
PU	0.12	**0.57**	
REL	0.22	0.08	
SUB		-0.05	
TRU	-0.18	-0.14	

Table 27: Total effects (meaningful relationships are presented in bold)

The analysis of these relationships in the structure models shows some low values. Therefore, the bootstrapping procedure was conducted to verify the significance of the relationship.

[478] Cf. Hair et al. (2017), p. 181 f.
[479] Cf. Chin et al. (1998), p. 11.

8.2.4 Significance analysis via the bootstrapping procedure

A bootstrapping procedure was conducted with SmartPLS. This method calculates test statistics with the help of repeated backtracking of samples of a fixed size (500 subsamples) from the empirical dataset. This procedure identifies the distribution of the estimated parameters. This distribution is the basis for the t-test to determine whether the null hypothesis can be rejected; it tests whether the path coefficients are significantly different from zero.[480] The procedure is done with the setting of bias corrected and accelerated (BCa) bootstrap as a two-sided test with a significance level of 0.05. The results of this calculation are presented in Table 28.

	Original sample (O)	Sample average	Standard deviation	T value (O)	P value
ATT → BI	0.02	0.02	0.09	0.17	0.86
COMP → BI	0.20	0.17	0.10	1.95	**0.05**
FAC → ATT	0.39	0.41	0.18	2.16	**0.03**
FAC → BI	-0.12	-0.10	0.17	0.70	0.48
HAB → BI	0.33	0.31	0.15	2.25	**0.02**
IOD → BI	0.19	0.15	0.11	1.74	0.08
PEOU → BI	-0.06	-0.05	0.12	0.50	0.62
PEOU → PU	0.73	0.73	0.06	11.34	**0.00**
PU → ATT	0.12	0.13	0.12	1.01	0.31
PU → BI	0.57	0.55	0.11	5.17	**0.00**
REL → ATT	0.22	0.18	0.17	1.25	0.21
REL → BI	0.07	0.08	0.11	0.65	0.52
SUB → BI	-0.05	-0.04	0.08	0.64	0.52
TRU → ATT	-0.18	-0.18	0.12	1.47	0.14
TRU → BI	-0.14	-0.13	0.10	1.36	0.17

Table 28: Results of the bootstrapping procedure: t statistics and p values

The bootstrapping distribution of the original sample and the corresponding average is used to calculate the t value (Formula 5).[481] The standard deviation

[480] Cf. R. Weiber, (2014), p. 327 f.

[481] Cf. Weiber et al. (2014), p. 327.

is the standard error generated by the boot strapping and adjusted by the average.[482] If the **t-value** is > 1.96, the null-hypothesis can be rejected with an error probability of 5% (see significance level). [483]

$$t_{ij} = \frac{\bar{y}_{ijb}}{s_{ijb}}$$

$\bar{y}$ = average of path coeffieient
s = standard deviation of path coeficient $\bar{y}$ij
i = parameter i
j = paramater j
b = bootstrapping

Formula 5: The t value formula

The **p value** (probability value[484]) describes the probability of erroneously rejecting a true null hypothesis.[485] A p value should be lower than < 0.05, meaning there is a 5% probability that the null hypothesis is true. [486] Only four relationships in this model are significant: FAC → ATT; PEOU → PU; PU → BI; and HAB → BI; COMP → BI is close to significance. In addition, there is a trend for a IOD → BI relationship.

It is important when using SmartPLS to combine the p values with the effects. All significant relationships also show a high effect, and there is also a trend in the effect of compatibility and data security on BI. The analysis of the total effects also shows a relationship between PEOU and BI via PU. Illustration 32 presents the outer loadings, the path coefficients and the p values for each path in the final path model.

[482] Cf. Hair et al. (2017), p. 156 f.
[483] Cf. Weiber et al. (2014), p. 327
[484] Cf. Hair et al. (2017), p. 133 f.
[485] Cf. Hair et al. (2017), p. 168 f
[486] Cf. Hair et al. (2017), p. 156 f.

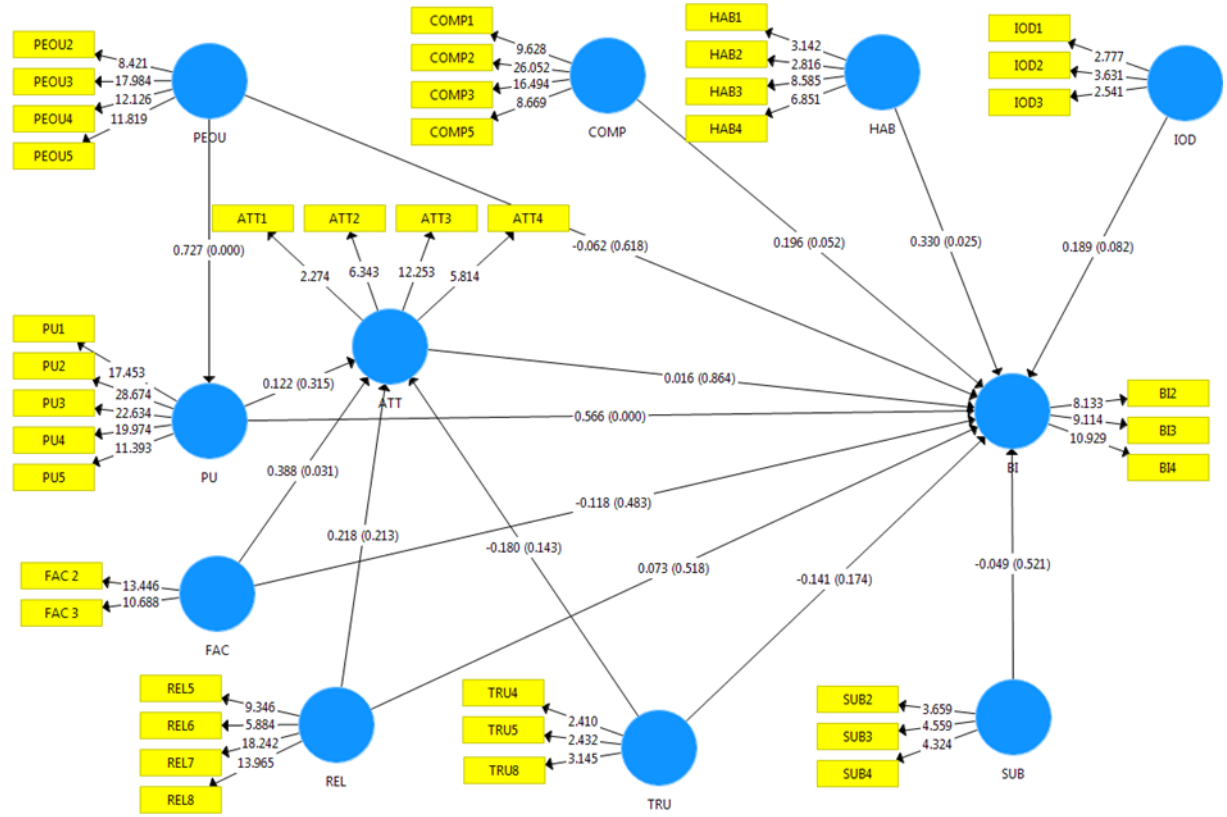

Illustration 33: The final path model, including outer and inner loadings of the construct and p values (presented in round brackets) of construct relationship

Table 29 indicates which hypotheses can be supported or rejected based on these results.

H1	Attitude will have a positive effect on BI.	Rejected
H2a	PU will have a positive effect on BI.	Supported
H2b	PU will have a positive effect on ATT.	Rejected
H3a	PEOU will have a positive effect on PU.	Supported
H3b	PEOU will have a positive effect on BI	Rejected
H4	COMP will have a positive effect on BI.	Rejected
H5	HAB will have a positive effect on BI.	Supported
H6	IOD will have a positive effect on BI.	Rejected
H7a	FAC will have a positive effect on ATT.	Supported
H7b	FAC will have a positive effect on BI.	Rejected
H8a	REL will have a positive effect on ATT.	Rejected
H8b	REL will have a positive effect on BI.	Rejected
H9a	TRU will have a positive effect on ATT.	Rejected
H9b	TRU will have a positive effect on BI.	Rejected
H10	FIN will have a positive effect on BI.	Rejected
H11	SN will have a positive effect on BI.	Rejected

Table 29: Results for support or rejection of the hypotheses

8.2.5 Explanatory power of a model

The target of PLS-SEM results is the maximisation of the explanatory variance for the endogenous variables in the path model: the R^2 value. R^2 is the coefficient of determination and demonstrates the explanatory power to check the predictive power. It is calculated with the squared correlation of the actual and prognosed values of a specific endogenous construct. R^2 can be between 0 and 1, whereby higher values show a better prognostic performance. It is difficult to name limits for acceptable R^2 values because it depends on the complexity of the model and the research area. Only considering R^2 is problematic, because this measure automatically prefers models with many exogenous constructs, which minimally

affect the endogenous constructs. Similar to multiple regression, adjusted R^2 can be measured to avoid this tendency. Adjusted R^2 is modified by the quantity of exogenous constructs as well as the sample size (n).[487]

In the present investigation, BI shows a high predictive power, PU a moderate power and ATT a low prognostic capability (Table 30).

	R^2	*Adjusted* R^2
ATT	0.40	0.36
BI	0.73	0.67
PU	0.53	0.52

Table 30: Explanatory variance of endogenous variables measured by adjusted R^2

Whether an exogenous construct has a substantial influence on an endogenous construct can be measured by the f^2 effect power. The evaluation is measured by the change of R^2 if a exogenous variable is removed. An effect power under 0.02 shows no effect.[488] Table 31 presents the f^2 values for each construct. These results on effect power confirm the t statistics and p values (chapter 8.2.4).

	ATT	**BI**	**PU**
ATT		**0.00**	
BI			
COMP		0.09	
FAC	**0.16**	0.02	
HAB		**0.23**	
IOD		0.11	
PEOU		**0.01**	**1.12**
PU	**0.02**	**0.45**	
REL	0.05	**0.01**	
SUB		**0.01**	
TRU	0.05	0.06	

Table 31: Effect power of construct measured by f^2 (bold values indicate an effect)

[487] Cf. Hair et al. (2017), p. 90 and 170 ff.

[488] Cf. Hair et al. (2017), p. 173 f.

As a summary of the findings, Illustration 34 presents a simplified model. This study confirmed the core construct PEOU influences PU and the further influence of PU on BI; these findings are consistent with studies on other TAMs. There is also a trend of the effect of compatibility and importance of data security on BI. Of note, there is no connection between ATT and BI. However, facilitators influences ATT.

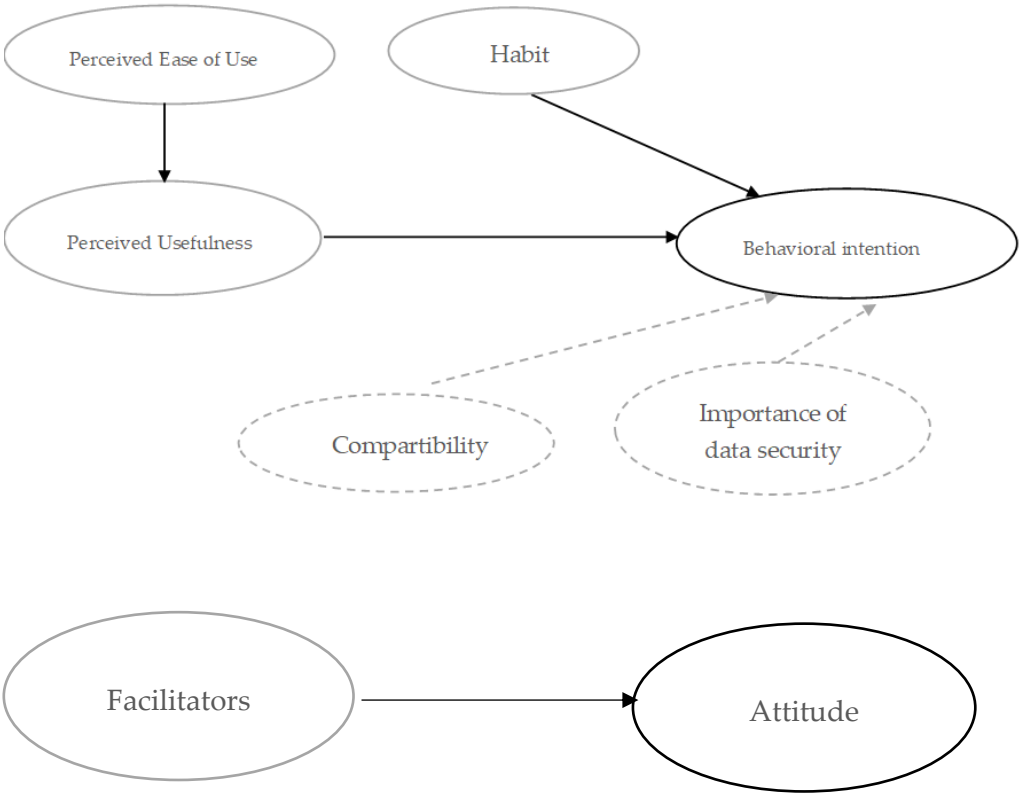

Illustration 34: Significant relationships in a path model based on the field survey results

8.3 MULTIGROUP ANALYSIS (MGA)

Multigroup analysis was not possible because the sample and subsamples are too small. With a sufficient sample size, MGA would have been employed to determine whether there are differences in gender, age, employment status, profession (diabetologists versus diabetes advisors), experiences in practice and regions (postal code). Furthermore, it would have been important to check the contrasts between innovators and late adopters in telemedicine by analysing dimensions in the construct of Habit: 'I have already used telemedicine/I am using telemedicine'.

8.4 FREE-TEXT ANSWERS

Five participants used the free text options for further comments. Three participants named data security as their biggest concern. One comment described that the patient's willingness is crucial. This comment also appeared in the pretest comments (See 6.2.2.3). The last comment was a general positive outlook that having a TSS would be good.

9 INTERPRETATION OF RESULTS

The tendency for a positive attitude and intention to use telemonitoring due to the significant relationship to PU in this study is consistent the DUT study. That 2019 investigation demonstrated that the majority of diabetologists (58% of participants) (See 8) evaluate telemedicine as an important aspect in future diabetes treatment.[489] It must be evaluated in further studies whether this attitude has increased due to the Covid-19 pandemic in 2020 and the consequence of reduced face-to-face contact or meeting with sufficient distance. The important factor of PEOU underlines the requirement of suitable training. The tendency of perceived importance of data security confirms the further finding of the DUT study, which concluded that a safe IT infrastructure as well as the need for training are main preconditions for a high usage rate. Furthermore, the DUT study report stated that medical offices with workers who are highly interested in technology, cloud-based programs, which have been heavily discussed in recent years, are now used daily to improve consultations via telephone, chat or video.[490] This aspect is consistent with the finding of a significant influence of habit on BI. People who feel comfortable using IT, use it in daily life and are interested in technology might have a greater intention to test telemedicine systems. Thus, those people can be seen as innovators (See 2.3.2).

One obstacle named in the DUT report is the aspect of reimbursement: there is great uncertainty about the topic.[491] The European Commission has also mentioned that clarification of financial conditions is a key precondition.[492] However, this uncertainty can also be a reason for the failure of the factor in the present study.

Construct assessment: The construct of financing needs to be assessed again in terms of item dimensions and direction. It may be more precise to alter incentives, reimbursement and cost of implementation, including possible funds,

[489] Cf. von Sengbusch et al. (2020), n. pag.
[490] Cf. von Sengbusch et al. (2020), n. pag.
[491] Cf. von Sengbusch et al. (2020), n. pag.
[492] Cf. European Commission (2018a), p. 126 f.

to check content validity. A study from Leppert et al. showed a lack of information on the financing part when interviewing German physicians,[493] which can be a reason for the dispersed reponses.

Questionnaire and field study: As a consequence of missing data entries from participants, it might be useful to extend the instructions of the questionaire to indicate that all statements should be rated and no questions should omitted. The speed with which the respondants completed the online survey indicates that they prefered to quickly complete the survey and chose a tendency towards a statement, even if the decision was diffcult.[494]

Factor relationships on endogenous variables: The study showed a separation of attitudinal and behavioural acceptance. However, the connection between these levels remains unresolved. Attitude needs to be checked with added dimensions in terms of content validity. As Kollmann explained, the development of acceptance is dynamic and includes several stages from the first contact with the innovation until the usage; these phenomena are considered by the difference between attitude and behaviour.[495] Ths differentiation is a difficulty in this present study, because the participants are faced with the TSS idea for the first time and might not be able to connect it to prior experience to evaluate it propely.

It seems that factors that are intrinsically driven and evaluated mostly influence BI. The attitudinal part is more strongly influenced by rather external influences, like the facilitators via external assistant training. One's perception of working efficiency and ease as well as competency drive the intention to use a programme like TSS. This assumption can also be seen in the effect power of compatibility, which underlines the consistency with the own working style. A lower tendency shows the importance of data security, which is instead influenced via external decisions. Further factors with external influence and interactions with users also show no influence on BI.

[493] Cf. Leppert et al. (2015), ePub
[494] Cf. Kallus (2016), 86 ff.
[495] Cf. Kollmann (1999), p. 114 ff.

10 LIMITATIONS

There are various restrictions to the generalisation of findings. The literature review was limited to ScienceDirect and PubMed. So this research could validate the reliability of constructs only of this filtered and selected variable set. Nevertheless, it provides the first picture of relevant factors. Further data collection, search techniques and exploratory approaches to add determinants and sharpen the reviewed factors are recommended, especially in capturing new aspects within the rapidly developing field of telemedicine. The review also showed high heterogeneity among the studies regarding data analysis approaches as well as clinical and regional foci. The new constructs of relationship with patient as well as trust in telemedicine need to be further proven and scales developed with different dimensions and combinations tested.[496]

The pretest should have been included a paper-based option to check possible weaknesses in responsiveness. The double-page printing needs to be clearly stated to avoid missing answers. A clear introduction on mandatory scoring as well as fast responses needs to be emphasised in future surveys. To simplify indicator analysis in terms of evaluating item loadings and internal consistency, all statements need to be directed in the same positive direction to avoid the conversion of inverse items. Participants may also have interpreted these questions differently, and dissimilar dimensions might be evaluated in a distinct manner. Response bias can possibly occur.[497]

In terms of the field study, the cluster sampling also presented difficulties in terms of representativeness – the so called cluster effect.[498] Only considering one region – Westphalia-Lippe in this study – can also present a biased picture because they are forerunners in several diabetes care programmes and so they might be more open-minded, experienced and evaluate factors differently as early adopters

[496] Cf. Verfürth (2020), n. pag.
[497] Cf. Bortz (2006), p. 236.; Kallus (2016), p. 55 ff.
[498] Cf. Bortz (2006), p. 436 f.; Mossig (2014), p. 4 f

compared with other regions. Nationwide studies focussing on single projects, settings and areas need to be executed to evaluate possible differences and commonalities. Prospective and retrospective analysis need to be conducted.[499]

Furthermore, the tests only included a limited number of HCPs giving treatment, a factor that might have been influenced by their particular health discipline and profession as well as by the Covid-19 pandemic, which made a change in communication with patients necessary. A comparative study after the Covid-19 pandemic is recommended. [500]

The end sample of the main study was too small for MGA. Nevertheless, this study provides an initial direction; further studies in Germany with diabetes HCPs need to be conducted to confirm the findings and proposed adaptions. This survey was limited to primary resident physicians and diabetes advisors.

The test described an example of a prospective TSS that leads to a prognosis issue, which needs subsequent research on dynamic time measurement of the technology acceptance.[501] Prognosis should be seen as critical. Similar implemented systems and interaction types should be evaluated and combined. The participants also needed to evaluate an imagined potential service system, so their answers were based on limited knowledge and comparable experiences.

[499] Cf. Verfürth (2020), n. pag.
[500] Cf. Verfürth (2020), n. pag.
[501] Cf. Verfürth (2020), n. pag.

11 CONCLUSION AND RECOMMENDATIONS

The acceptance literature has shown a variety of approaches to explain the development of the acceptance of an individual. However, only TAM 1 by Davis has become the gold standard. Looking into the transfer of the corresponding ideas into the healthcare technology field – especially telemedicine – there should be a focus on patient acceptance research. There have been few studies on HCPs' acceptance. Concentrating on the diabetes sector, there has been a lack of research and pilot projects in the German healthcare environment, specifically remote interaction between patients and a telemedicine centre. Due to the complex and fragmented market, there are several barriers as well as chances to improve difficult treatment situations and patient compliance.

The development of the model and field survey of the present thesis attempted to close these gaps and to solve the complexity of acceptance behaviour prognosis as well as to picture the diabetes telemonitoring market. New constructs regarding the interaction of different users with the patient in telemedicine in terms of relationship and trust as well as regionalised market related factors as financing were tested for the first time.

Research Question 1: Which consulted determinants strongly influence the acceptance of interactive telemonitoring systems by German resident diabetes physicians and HCPs with regular patient/therapy contact (outside the telemedicine centre)?

For German diabetologist and diabetes advisors, this study showed that the **PU** of the telemonitoring service system is the main influence on behavioural acceptance, expressed by the intention to use this system regularly if accessible and integrate it in daily patient care. PU includes the recognised improvement of speed, productivity of patient care and management as well as the enhancement of effectiveness. This perception on usefulness is highly influenced by the **PEOU** of the service system, which represents how easy it is to learn to use a system and the

clear interaction between the HCP and the patient. Further, the **habit** of a HCP determines the intention to use due to previous experiences of using a telemedicine system and his or her sense of comfort in using ICT. There is also a tendency that **compatibility** with existing needs, values and past experiences influences the willingness to use the system. Finally, the **perceived importance of data security** tends to influence the BI. The importance of data security includes secure technical standards, the transparency of data handling as well as the clarification of data usage for research in consultation with expert associations.

Another finding is that the attitudinal acceptance, described by the positive attitude to the service system itself and to digitalisation as well as telemedicine in general, is influenced by facilitators. Facilitating conditions include the perception on alignment of existing resources from an organisational and technical point of view to the implementation of a telemonitoring system. This also linked to appropriate training and availability of assistance. However, attitude shows only a low prognostic power.

There are no significant effects for the factors of subjective norm determining by the influence of other people like patients, colleagues or important persons to the potential user. The interactive components of change in the relationship to the patients and the trust in the organisation of the telemedicine centre and their medical experts also show no significant effect. Further, financing does not show an effect on attitude or BI.

Research Question 2: Which instruments could a provider use to implement these systems successfully (usage)?

A provider, the institution or company, which make the service and system available, needs to have a comprehensive overview on users' behaviours to successfully implement the TSS. The above aspects can promote and hinder successful implementation.

The strong focus on influencing intrinsically motivated variables demonstrates that HCPs might be better at evaluating their own capabilities. To secure a better evaluation of other externally driven factors, a clear and consequent political communication and strategy is needed. Missing experience and unclear implementation plans can lead to rejection.

On the other hand, it remains to be determined whether trust in telemedicine and subjective norm do not positively influence BI or attitude because only the evaluation is difficult or if the actual usage intention of the diabetes HCPs are strongly driven by their individually evaluated skills. Nevertheless, a view on the whole system – including all involved stakeholders and especially patients with an economic, legal, political, organisational and clinical perspective – is crucial.

Implementation science is the discipline within health service research that deals with the execution options of existing evidence of pilot treatments in routine care. A missing accompanying evaluation of technology can be one barrier for market implementation. A standardised assessment for telemedicine technology needs to be established.[502]

- **Data security**

  Even if this present study cannot fully link data security to BI of diabetes HCPs, the security of health data is mandatory to develop and implement such programmes.

- **The importance of training and knowledge**

  HCPs need to be better informed about the framework in telemonitoring.[503] The European Commission must address the need to implement the training for e-health in academic standards in medical schools in a structured and formal way to ensure quality telemedical treatment. The next generation of HCPs are being trained with digital technology; hence, it might be easier to integrate that topic in healthcare.[504] The topic of digitalisation and diabetes technology is currently not given a sufficient space in the training for diabetes advisors.[505] Telemonitoring providers should collaborate with medical schools to support the adaption of curricula, provide current developments and join research projects to be close to professional users. In addition to training, telemedicine will change workflows in practices in the long term, but it also necessitates a rethinking by medical associations and

[502] Cf. Waschkau et al. (2019), p. 917 ff.
[503] Cf. Leppert et al. (2015), ePub
[504] Cf. European Commission (2018a), p. 97 f.
[505] Cf. https://www.dut-report.de/2020/01/14/telemedizin-update-2020/

insurance companies.[506] Collaborations with medical associations and insurance companies are mandatory for providers to identify the cost savings for that interest groups.

- **User friendliness of technology**

  During system development, HCPs need to participate in the creation of the system. Providers need to invest in training and **assistance programmes** (like technical assistance support lines) to HCPs as PEUO is a strong influence factor. This approach would familiarise physicians and treating therapists with the systems and enable them to use the programme easily.

- **Connection to telemedicine centre**

  It is highly recommended to conduct pilot studies with telemedicine centres (see 4.3) on the acceptance of involved treating HCPs. These data can also help to specify studies for the prognosis of behaviour before the implementation of innovative telemonitoring systems. It can support understanding the factor trust in the telemedicine centre. Here too, the new service and interaction character with a telemedicine centre can hinder a judgement on the cooperation.

- **Assignment of information task**

  A major task of TSS providers is a clear communication strategy and information policy to give users a transparent and understandable view on the framework conditions in such structures.

  - *Information on financing possibilities are needed*[507]

    Providers need to clarify the current financing possibilities so that deciders in medical offices understand the economic risks and opportunities when integrating such programmes.

[506] Cf. https://www.dut-report.de/2020/01/14/telemedizin-update-2020/

[507] Cf. Leppert et al. (2015), ePub

- *Information on assistance*
  It is essential to provide information about available resources for technical and user-communication assistance to enable HCPs to easily handle a possible TSS.
- *Information on data handling*
  HCPs need to understand how data are collected, stored and transferred and who has access to consult with patients when introducing such systems.

- **The importance of the involvement of patient attitude**
  Even though the variable relationship to patient does not sow an influence in this study, the focus on patient acceptance studies and mentioning patient attitudes in the pretest as well as the field test shows that patients' willingness and motivation should be included in this acceptance research. This factor might also strongly influence the HCPs' usage. This aspect leads to a patient-centric orientation, which is described as 'putting the patient first in an open and sustained engagement of the patient to respectfully and compassionately achieve the best experience and outcome for that person and their family'.[508] A patient-centric approach also implies an increased collaboration of HCPs and building networks,[509] which is key in a telemedicine environment. On the other hand, the care- and cost-intensive patients – in particular elderly and multimorbid patients – are only marginally accessible to telemedical care, because existing technologies such as tablet PCs have not yet been sufficiently adapted to the needs and abilities of older people.[510] Hence, technology adaption for elderly people needs to be considered.

- **Sustainable cooperation with involved market partners**
  A conclusive concept of the partnership of patients, their relatives, HCPs, telemedicine providers and payers is needed to guarantee sustainability. Investments and studies need to be made to prepare the implementation.[511] It

[508] Cf. Yeoman et al. (2017), p. 76 ff.
[509] Cf. Uddin (2016), ePub; Kitson et al. (2013), p. 4 ff.
[510] Cf. https://www.dut-report.de/2020/01/14/telemedizin-update-2020/
[511] Cf. WHO (2010), p. 24 f.

is essential for a TSS provider to work with the German diabetes associations to hear the voice of these customers and learn about their needs and concerns. All efforts of providers to develop such telemedicine service system also rely on the IT infrastructure in Germany. The core of the telemonitoring practice is the technical aspects,[512] so Internet connection capacity is essential. Furthermore, the legal framework needs to be set clearly.

[512] Cf. European Commission (2018a), p. 126 f.

12 CLOSING WORDS

The identified gaps in literature on specific telemedicine acceptance research on HCPs in Germany and in the diabetes field, the lack of comprehensive telemonitoring projects as well as the missing financial, legal and technical nationwide framework show the necessity of research in this field. Understanding the complex influences on HCPs' acceptance in the German diabetes telemonitoring market via a model showing the influence factors is a crucial approach. This thesis developed a conceptual framework by the identification and design of multifaceted variables for understanding the acceptance of diabetologists and diabetes advisors. The factors were operationalised in a questionnaire and applied in a field study to generate data, which was specified, estimated and assessed via a corresponding path model to have a tenable basis for future surveys.

This thesis also demonstrated that the core constructs of Davis' TAM 1 (1989) are robust to measure BI. A HCP's high PU with regard to diabetes TSS that includes interaction with a telemedicine centre is a clear promoter for high usage after implementation. Training and technical support as well as the provision of relevant resources can improve the usage because the results showed that the system needs to be easy to use and user needs to feel comfortable in handling.

The present analysis can deliver a robust fundament to expand the research on additional German regions and to the clinical diabetes sector. It is conceivable to transfer the findings to other specific medical disciplines and professions where telemonitoring systems with interactive involvement is considered. Furthermore, the factors of relationship to patient and trust in telemedicine centre are a new basis for capturing the interaction of such TSS infrastructures, but they need to be tested repeatedly. The adapted and new constructs were optimised due to the testing and reached an acceptable reliability for further research. However, the results need to be combined with the attitudinal perspective of patients to collect input from all

relevant players in the system. The findings should be further evaluated in representative studies to get a clear view on the acceptance situation of HCPs.[513]

There is a great need for future research on German HCP acceptance in telemedicine to generate strong evidence that identifies barriers. This endeavour could lead to explicitly defining the requirements of technology, legislation and financing of telemedicine structures in Germany for providers and politicians, especially from the professional society view. This understanding is essential to develop the appropriate conditions for such complex programmes and closing existing gaps. Due to the rapidly growing telemedicine market, it is necessary to continuously conduct dynamic research in this field.[514] The Covid-19 pandemic and the first reaction on easing[515] telehealth financing in Germany has shown the priority and importance of this topic.[516]

Last but not least, this research should motivate additional studies because comprehensive healthcare is essential: Health is a requirement for our daily life.[517] HEALTH IS OUR HIGHEST GOOD.

[513] Cf. Verfürth (2020), n. pag.
[514] Cf. Verfürth (2020), n. pag.
[515] Cf. Hagge et al. (2020), p. 1 ff.; Kassenärztliche Vereinigung (2020), n. pag.
[516] Cf. Verfürth (2020), n. pag.
[517] Cf. Wernitz et al. (2015), p. 27

13 APPENDIX

APPENDIX 1 – OPERATZIONALISATION IN REVIEWED STUDIES

Construct	Scales in studies	
Perceived use-fulness	• Using telemedicine in my job would enable me to accomplish tasks more quickly. • Using telemedicine would improve my job perfor-mance. • Using telemedicine in my job would increase my productivity. • Using telemedicine would enhance my effective-ness on the job. • Using telemedicine would make it easier to do my job. • I would find telemedicine useful in my job.	Segrelles et al. 2017
	• With offers of the health telematics like ... I see new potential benefits for my practice. • The use of health telematics performances will support me in my daily work. • The use of health telematics performances will make it possible to work more efficiently. • The use of EHS increases the quality of medical treatment in my practice.	Dünnebeil et al. 2012
	• Using mobile devices for wireless healthcare would improve my work performance. • Using mobile devices for wireless healthcare would improve my work productivity. • Using mobile devices for wireless healthcare would enhance my work effectiveness.	Wu et al. 2011

	• I find mobile devices for wireless healthcare to be useful in my job.	
	• Using telemedicine technology cannot improve my patient care and management. • Using telemedicine technology cannot enhance my effectiveness in patient care and management. • Using telemedicine technology can make my patient care and management easier. • I would find telemedicine technology not useful for my patient care and management.	Chau et al. 2002
	• Using RTS will improve my job performance. • RTS will be useful to my life in general. • Using the interactive RTS service will enhance my effectiveness on the job.	Hwang et al. 2014
	• The existence of computerised data allows the evolution of the patient's clinical status to be viewed • I am in favour of creating a single computerised medical history for each patient, which can be accessed by any health care professional regardless of the centre where the patient is attended • 'In most cases, computerisation and ICT use in the field of health care minimise bureaucracy and have a major impact on improved clinical practice.	Saigi-Rubio et al. 2014
	• The use of TMS could help me to monitor my patients more rapidly.	Gagnon et al. 2013
	• The use of mobile teledermoscopy could help me quickly diagnose my patients.	Gagnon et al. 2013
	• If my clients could receive telepsychotherapy, it would allow them to get more complete mental care. • If my clients could receive telepsychotherapy, it would allow me to save a lot of time.	Monthy-Blanc et al. 2013

	• Use of the following diabetes-related technologies (where suitable) may improve management of my patients with type 1 diabetes. • The following diabetes-related technologies can facilitate the care of my patients with type 1 diabetes (where suitable). • In general, the following diabetes-related technologies may be useful/are useful to improve the care of my patients with type 1 diabetes (where suitable) • The following diabetes-related technologies can improve my performance in care of my patients with type 1 diabetes (where suitable.	James et al. 2016
Perceived ease of use	• Learning to operate telemedicine would be easy for me. • I would find it easy to get telemedicine to do what I want it to do. • My interaction with telemedicine would be clear and understandable. • I would find telemedicine to be flexible to interact with. • It would be easy for me to become skilful at using telemedicine. • I would find telemedicine easy to use.	Segrelles et al. 2017
	• The practice of health telematics performances like .... would be easy to use. • The handling of health telematics with IT systems would be easy for me to learn. • E-health systems would be flexible enough to be used in my daily work. • To learn the handling of e-health systems would take too much time.	Dünnebeil et al. 2012
	• My interaction with mobile devices for wireless healthcare is clear and understandable.	Wu et al. 2011

	• My interaction with mobile devices for wireless healthcare does not require a lot of mental effort. • It is easy to get mobile devices for wireless healthcare to do what I want it to do. • It is easy to use mobile devices for wireless healthcare	
	• Learning to operate telemedicine technology would not be easy for me. • I would find it easy to get telemedicine technology to do what I need it to do in my patient care and management. • It is not easy for me to become skilful in using telemedicine technology. • I find telemedicine technology easy to use.	Chau et al. 2002
	• Learning to use RTS will be easy for me. • I will be skilful in using RTS. • RTS will be easy to use for me.	Hwang et al. 2014
	• I think that I could easily learn how to use TMS.	Gagnon et al. 2014
	• I think it would be/is easy to perform the tasks necessary to manage my patients with type 1 diabetes using the following diabetes-related technologies (where suitable). • I believe that the following diabetes-related technologies will be/are clear and easy to understand. • I think I will find it easy/I found it easy to acquire the skills necessary to use the following diabetes-related technologies. • I think that the following diabetes-related technologies will be/are easy to use.	James et al. 2016
	• I know how to use a videoconference system or a webcam to allow my clients to receive telepsychotherapy.	Monthy-Blanc et al. 2013

	• I think discussing with a therapist using a videoconference system would require extra efforts from my clients. • I think using a videoconference system to receive telepsychotherapy would be easy for my clients.	
Subjective norm	• People who are important to me would think that I should use mobile devices for wireless healthcare. • People who influence me would think that I should use mobile devices for wireless healthcare. • People whose opinions are valued to me would prefer that I should use mobile devices for wireless healthcare.	Wu et al. 2011
	• If I were using telemedicine in my practice, my patients would… • My colleagues would recommend that I use telemedicine in my practice. • The consulting specialists would recommend that I use telemedicine in my practice. • The hospital managers would encourage me to use telemedicine in my practice. • I consider that using telemedicine is correct for a physician of … my speciality; (2) my region; and (3) my age. • I would feel guilty if I was not using telemedicine in my practice. • Using telemedicine would be in my principles. • It would be unacceptable to not use telemedicine in my practice.	Gagnon et al. 2014
	• People who influence my clinical behaviour think that I should use telemedicine technology. • People who are important to my health care services think that I should not use telemedicine technology.	Chau et al. 2002

	• People who are important in assessing my patient care and management think that I should not use telemedicine technology.	
	• People who affect me expect me to use interactive RTS. • The patient or patient's legal guardian does not refuse to use RTS.	Hwang et al. 2014
	• Most of my patients will welcome the fact that I use TMS.	Gagnon et al. 2013
	• Most of my patients with type 1 diabetes welcome/would welcome me using the following diabetes-related technologies. • Health Managers would welcome/ welcome me using the following diabetes-related technologies. Other health professionals (nurses, other specialist, etc) would welcome/welcome me using the following diabetes-related technologies.	James et al. 2016
Behavioural intention	• I have the intention to use telemedicine when it is available at my job. • I have the intention to use telemedicine when it is necessary to provide health care for my patients. • I have the intention to use telemedicine regularly with my patients.	Segrelles et al. 2017
	• I'd like to use available offers of e-health. • I plan to use available offers of e-health. • I expect that I have to use the offers of e-health.	Dünnebeil et al. 2012
	• I estimate that my chances of using telemedicine in my practice are... • If I have the opportunity, I will use telemedicine in my practice. • I intend to use telemedicine in my practice.	Gagnon et al. 2013
	• I intend to use telemedicine technology for patient care as often as needed.	Chau et al. 2002

	• Whenever possible, I intend not to use telemedicine technology for patient care. • To the extent possible, I would use telemedicine technology in my patient care frequently.	
	• I have the intention to use RTS. • I will be using more RTS in the future.	Hwang et al. 2014
	• I have the intention to use TMS when it becomes available in my centre.	Gagnon et al. 2003
	• Assuming that the community has access to telepsychotherapy through videoconference, I would consider referring my clients to that kind of service. • Assuming that the community has access to telepsychotherapy through videoconference, I would actually refer my clients to that service. • If my clients could receive telepsychotherapy, it would allow them to receive specialized therapeutic care.	Monthuy-Blanc et al. 2013
	• I intend to use the following diabetes-related technologies in the care of my patients with type 1 diabetes (where suitable) when they are available at my centre. • I intend to use the following diabetes-related technologies when necessary to provide health care to my patients with type 1 diabetes. • I intend to use the following diabetes-related technologies routinely for the care of my patients with type 1 diabetes (where suitable).	James et al. 2016
Data security	• National security standards for the handling of patients' medical data are necessary. • Committing standards for the handling of patients' medical data are necessary for my practice.	Dünnebeil et al. 2012

	• It is important to me to be able to extensively inform my patients about the use of their medical data. • Abandoning central storage of patients' data will inevitably result in delay of treatment processes.	
Perceived importance of standardisation	• I am in favour of standardised documentation for medical practices. • In case of standardised treatment processes, the administrative effort exceeds the medical benefits. • I am in favour of standardised administrative documentation for medical practices. • Daily work in medical practices is too heterogeneous to standardise important processes.	Dünnebeil et al. 2012
Facilitating conditions	• The senior management of this business unit has been helpful in introducing RTS. • My boss is very supportive on usage of RTS for my job. • The organization has supported the introduction of RTS.	Hwang et al. 2014
	• (1) I think that my centre has the necessary infrastructure to support my use of telemonitoring systems, (2) I would use telemonitoring systems if I receive appropriate training, and (3) I would use telemonitoring systems if I receive the necessary technical assistance.	Gagnon et al. 2013
	• I would use the following diabetes-related technologies if I receive appropriate training. • I would use the following diabetes-related technologies in the care of my patients with type 1 diabetes (where suitable) if I receive the necessary technical assistance.	James et al. 2016
Financing	• My structure offers incentives for its continued use, such as frequent RTS.	Hwang et al. 2014

	• I get rewarded for my continued patronage of RTS.	
Attitude	• For me, using telemedicine in my practice would be … stressful— relaxing and satisfying—dissatisfying.	Gagnon et al. 2003
	• Using mobile devices for wireless healthcare would be a good idea. • Using mobile devices for wireless healthcare would be a wise idea. • I like the idea of using mobile devices for wireless healthcare.	Wu et al. 2011
	• Using telemedicine technology in patient care and management is a good idea • Using telemedicine technology in patient care and management is unpleasant • Using telemedicine technology is beneficial to my patient care and management	Chau et al. 2002
	• I think positively about RTS. • I consider it a good RTS.	Hwang et al. 2014
	• I think it is a good idea to use TMS to monitor my patients.	Gagnon et al. 2013
	• Overall, I think my client receiving telepsychotherapy through videoconference is … Bad - good; stupid - reasonable; unfavourable - worthwhile; harmful - beneficial; negative – positive.	Monthuy-Blanc et al. 2013
	• I think it is a good idea to use the following diabetes-related technologies in the care of my patients with type 1 diabetes (where suitable). • Use of the following diabetes-related technologies may be/are beneficial for the care of my patients with type 1 diabetes (where suitable). • In my opinion, use of the following diabetes-related technologies in the care of my patients with	James et al. 2016

	type 1 diabetes (where suitable) will have/ has a positive impact.	
Habit	• I have used telemedicine in the past. • I regularly used telemedicine in the past. Never – 3-5 times – more	Gagnon et al. 2013
	• I feel comfortable with information and communication technologies	
	• I feel comfortable with the following diabetes-related technologies. • I already use the following diabetes-related technologies (where suitable) in the management of patients with type 1 diabetes.	James et al. 2016
Compatibility	• The use of TMS may imply major changes in my clinical practice.	Gagnon et al. 2013
	• Use of the following diabetes-related technologies may promote good clinical practice. • Use of the following diabetes-related technologies in the care of my patients with type 1 diabetes (where suitable) would necessitate major changes in my clinical practice.	James et al. 2016

APPENDIX 2 – GERMAN TRANSLATION OF USED SCALES IN THE QUESTIONNAIRE FOR THE FIELD TEST

Construct	ITEM	Items and their operationalisation in a questionnaire in German
Attitude	ATT1	Ich denke positiv über TSS.
	ATT2	Die Nutzung von TSS bei Patienten-behandlung und -management ist eine gute Idee.
	ATT3	Ich befürwörte den Auf- und Ausbau von Telemedizinsystemen.
	ATT4	Die Digitalisierung ist zukünftig ein wichtiges Thema in der Patientenversorgung.
Behavioural Intention	BI1	Angenommen ich habe Zugang zum TSS, dann beabsichtige ich es zu nutzen.
	BI2	Ich beabsichtige das TSS regelmäßig nutzen.
	BI3	Ich weise meine Patienten auf das TSS hin.
	BI4	Ich nehme TSS aktiv in meine Versorgung auf.
Perceived Usefulness	PU1	Die Nutzung von TSS bei meiner Arbeit ermöglicht, dass ich meine Aufgaben schneller bewerkstellige.
	PU2	Die Nutzung von TSS verbessert mein Patientenversorgung und –management.
	PU3	Die Nutzung von TSS steigert die Effektivität meiner Arbeit.
	PU4	Die Nutzung von TSS erhöht die Produktivität meiner Arbeit.
	PU5	Die Nutzung von TSS macht meine Arbeit einfach.
	PU6	Das TSS ist für meine Arbeit nützlich.

Perceived Ease of Use	PEOU1	Die Bedienung des TSS zu lernen, ist einfach für mich.
	PEOU2	Das TSS ist leicht zu bedienen.
	PEOU3	Das TSS ist leicht von meinen Patienten zu bedienen.
	PEOU4	Ich finde das TSS in der Interaktion flexibel.
	PEOU5	Meine Interaktion mit TSS ist klar und verständlich.
Facilitators	FAC1	Mein Arbeitsplatz hat die notwendige Infrastruktur um die Nutzung von TSS zu unterstützen.
	FAC2	Ich nutze das TSS, wenn ich ein entsprechendes Training bekomme.
	FAC3	Ich nutze TSS, wenn ich notwendige technische Assistenz bekomme
	FAC4	Mit gegebenen Ressourcen, Möglichkeiten und Wissen, welche es für die Nutzung von TSS benötigt, ist es einfach.
Compatibility	COMP1	Die Nutzung von TSS ist mit allen Aspekten meiner Arbeit kompatibel.
	COMP2	Die Nutzung von TSS passt gut zur Art, wie ich arbeiten möchte.
	COMP3	Die Nutzung des Systems passt gut zu meinem Arbeitsstil.
	COMP4	Die Nutzung des TSS ist mit großen Änderungen verbunden.
	COMP5	TSS ergänzt meine Tätigkeit und meinen Auftrag zur Patientenversorgung.
Subjective Norm	SUB1	Personen, die mein Verhalten beeinflussen, denken, dass ich TSS benutzen sollte.
	SUB2	Personen, die mir wichtig sind, denken, dass ich das TSS benutzen sollte.
	SUB3	Patienten finden die meine Nutzung von TSS gut.

	SUB4	Meine Kollegen ermutigen mich das TSS zu nutzen.
Habit	HAB1	Ich habe in der Vergangenheit Telemedizin Technologien genutzt.
	HAB2	Ich nutze bereits Telemedizintechnologien.
	HAB3	Ich fühle mich wohl mit der Nutzung von IT.
	HAB4	Ich fühle mich kompetent bei der Nutzung von und Patientenberatung zu Technologien im Arbeitsalltag.
Importance of data security	IOD1	Technische Sicherheitsstandard im Umgang mit Patientendaten sind beim TSS notwendig.
	IOD2	Verpflichtende Standards im Umgang mit Patientendaten sind notwendig für meine Arbeit.
	IOD3	Es ist wichtig für mich, meine Patienten über die Nutzung der medizinischen Daten zu informieren.
	IOD4	Qualitätsdefinitionen aus der analogen Versorgung der Patienten müssen in die digitale Welt transferiert werden.
	IOD5	Fachgesellschaften müssen sich beim Datenschutz rechtlichen und ethischen Fragen stellen und auch die Nutzung der Daten für die Forschung klären.
Financing	FIN 1	Anreizsysteme für Ärzte müssen für eine kontinuierliche und häufige Nutzung angeboten werden.
	FIN 2	Ich soll für eine Nutzung von TSS zusätzlich vergütet werden.
	FIN 3	Digitale Leistung mittels TSS müssen anders bewertet und vergütet werden als die entsprechende analoge Leistung.
	FIN 4	Die Nutzung von TSS ist hinsichtlich der Vergütung besonders förderungswürdig.
	FIN 5	Es ist wichtig, dass TSS für meine Patienten erstattet wird/ erstattungsfähig ist.

	FIN 6	Ein TSS soll über einen Selektivvertrag geregelt werden. (Keine Regelversorgung)
	FIN 7	Es ist in Ordnung, wenn meine Patienten den Service privat bezahlen.
	FIN 8	Es ist abhängig von der Versorgungsleistung, ob TSS privat bezahlt oder vom Kostenträger übernommen werden soll.
	FIN 9	Für den zusätzlichen Service sind die Kosten für die Erstausstattung des TSS als Investition vom Betrieb zu tragen.
Importance of standardization	STAN1	Ich bin für die standardisierte Dokumentation für die medizinische Praxis.
	STAN2	Im Falle eines standardisierten Behandlungsprozess übersteigt der administrative Aufwand den medizinischen Nutzen.
	STAN3	Die tägliche Arbeit in der medizinischen Praxis ist zu heterogen um Prozesse zu standardisieren.
	STAN4	Das TSS muss Evidenz-basierend Daten auswerten und diese Transparenz zeigen.
Relationship to patient	REL1	Ich fürchte im Zuge des TSS Patienten zu verlieren, da sie mich nicht mehr brauchen.
	REL2	Durch den TSS brauchen meine Patienten weniger meine Hilfe, da vieles mit dem Center geklärt werden kann.
	REL3	Ich fürchte die Kontrolle über den Behandlungspfad zu verlieren, da ich nicht immer zuerst involviert bin.
	REL4	Die Beziehung zu meinen Patienten wird durch die umfängliche Begleitung intensiver.
	REL5	Der Behandlungsmix aus analog und digital wird das Arzt-Patienten Verhältnis stärken.
	REL6	Die Therapietreue meiner Patienten wird sich erhöhen.

	REL7	Durch TSS habe ich zu allen meinen Patienten gleich wie weit entfernt einen besseren Kontakt.
	REL8	Ich habe durch TSS zu Patienten, die mich nur selten besuchen eine stärkere Verbindung.
Trust in tele-medicine cen-tre	TRU1	Im Allgemeinen kann ich anderen trauen.
	TRU2	Ich habe Vertrauen in ein zertifiziertes Servicecenter (mit Standards).
	TRU3	Ich habe ein gutes Gefühl, meine Patienten von anderen Fachärzten/ Therapeuten überwachen/ behandeln zu lassen.
	TRU4	Mir ist es wichtig, einen festen Ansprechpartner (Fachkollegen) im Center zu haben.
	TRU5	Mir ist es wichtig vorher persönlichen Kontakt zu den behandelnden Experten im Center zu haben.
	TRU6	Ich fürchte, dass die Fachkollegen im Center anders behandeln als ich es tue/vorsehe.
	TRU7	Ich fürchte, dass ich nicht zeitgerecht alle Informationen zu meinen Patienten erhalte.
	TRU8	Ich möchte vorher über die Standardprozesse und Algorithmen bei der Auswertung der Daten informiert werden.

APPENDIX 3 – SURVEY CIRCLE ADVERT

APPENDIX 4 – RETURN ENVELOPE

APPENDIX 5 – QUESTIONAIRE

FORSCHUNGSPROJEKT
AKZEPTANZ FÜR DIABETES-TELEMONITORINGSYSTEME

Martina Verfürth · Werthacker 75a · 47058 Duisburg

Persönlich
Arzt/Diabetesberater

11.05.2020

IHRE UNTERSTÜTZUNG IST GEFRAGT
Schriftliche Befragung zum Forschungsprojekt Diabetes-Telemonitoring

Sehr geehrte/r xxx,

das Thema Fernmanagement von Patienten ist noch nie so präsent wie aktuell!
Im Zuge des Forschungsprojektes *„Analysis of healthcare professionals' acceptance of service innovations in the german telemonitoring market for diabetes."* wird von der Doktorandin Frau Verfürth eine **Studie im Bereich Akzeptanz von IT-Dienstleistungen für Diabetes Monitoring** geleitet. Das Projekt wird in Kooperation der FOM Hochschule für Ökonomie und Management und der *UCAM Universidad Catolica San Antonia Murcia* (Spanien) durchgeführt. Die Forschung erfolgt firmenneutral.

Folgende Zugänge stehen Ihnen zur bis zum **28. Mai 2020** zur Verfügung:

1) **Handschriftliches Ausfüllen des beilegten Bogens mit Rückversand im vorfrankierten Umschlag**.

2) Besuchen Sie https://akzeptanz-telemedizin.limequery.net/2 und **füllen den Fragenbogen online vom PC oder Smartphone aus** ODER **scannen Sie den QR-Code**, um zu den Fragen zu kommen.

Leiten Sie die Anfrage auch gerne an Fachkollegen: DiabetologInnen und DiabetesberaterInnen weiter.

Vielen Dank vorab für Ihre Unterstützung!

Mit freundlichen Grüßen,

Martina Verfürth
Dipl.-Kffr.(FH), M.A. Marketing & Sales

Ihre Adresse stammt aus der öffentlich zugänglichen Liste der Kassenärztlichen Vereinigung Westfalen-Lippe aller Teilnehmer der Diabetologischen Schwerpunktpraxen (DSP):
https://www.kvwl.de/arzt/asam/genehmigung/teilnehmerlisten/dsp.pdf

FORSCHUNGSPROJEKT
AKZEPTANZ FÜR DIABETES-TELEMONITORINGSYSTEME

Befragung

Akzeptanz von Diabetes-Telemonitoringservicesystemen

Die Befragung ist anonym. Die Beantwortung des Fragebogens dauert ca. 15 Minuten. Bei der Befragung ist Ihre persönliche Einschätzung der Aussagen wichtig. Es gibt keine richtigen oder falschen Antworten. Bitte wählen Sie die Antwortmöglichkeit, die Ihrer Meinung nach am ehesten zutrifft.

Im Folgenden finden Sie einige Informationen zum Studienvorhaben:

Ziel der Studie ist die Untersuchung der **Akzeptanzfaktoren für zukünftige Telemonitoring-Servicesysteme (TSS)** seitens der niedergelassenen Diabetologen und Diabetesberater. E-Health und Telemedizin als Teilbereich steckt noch in den Kinderschuhen der Umsetzung. Dies hat vielerlei Gründe. Diese Befragung möchte die möglichen Hindernisse und Erfolgsfaktoren seitens der niedergelassenen Diabetologie-Fachschaft wissenschaftlich beleuchten und dazu mögliche Anwender befragen.

Aus Gründen der besseren Lesbarkeit wird im Folgenden auf die gleichzeitige Verwendung weiblicher und männlicher Sprachformen verzichtet und das generische Maskulinum verwendet. Sämtliche Personenbezeichnungen gelten gleichermaßen für beide Geschlechter.

In folgendem Fragebogen geht es um eine **zukünftige IT-Dienstleistung im Bereich Telemonitoring**.

Das **INTERAKTIVE System** beinhaltet das Fernmanagement Ihrer Diabetes-Patienten zu Hause durch Sie als behandelnden Arzt und Berater und ein externes Telemedizin-Center (zertifiziertes, medizinisch geschultes und ärztliches Fachpersonal) als Service, welches rund um die Uhr **24/7** die eingehenden Informationen der Patienten prüft und bei Bedarf reagiert: **Fernuntersuchung, -diagnose und -überwachung** und so die Behandlung und Therapie unterstützt.

Konkret heißt dies: **Grundlage ist ein Online-Portal**, auf das der Patient (mit beschränkter Einsicht in die Dokumentation), das Telemedizinzentrum und Sie als behandelnder Arzt oder Berater Zugriff haben. Der Kontakt zwischen den Beteiligten erfolgt regelmäßig telefonisch, per Videochat oder schriftlich elektronisch.

Seitens des Patienten erfolgen Kontaktaufnahmen und Eingaben mit **Informationen rund um den aktuellen Gesundheits- und Aktivitätsstatus (wie ein Tagebuch)**. Eingebunden werden können auch Daten (z.B. Blutzucker, Blutdruck etc.), die der Patient zu Hause durch medizinische Messgeräte und vorhandenen Hilfsmittel, aber auch Wearables erhebt. All diese Interaktionen werden dokumentiert. **Ihre Patientenakte** und **alle Behandlungspläne und Therapiepläne, sowie auch Laborwerte** sind hinterlegt. **Darauf abgestimmt, reagiert der Experte im Telemedizinzentrum Center wenn notwendig oder gefordert mit einer Aktion**. Das Zentrum kann so bei Notfällen Alarm geben, persönliche Besuche bei Ihnen empfehlen, Erinnerungen (z.B. an Medikamenteneinnahme) und Ratschläge aussprechen oder aufkommende Fragen beantworten.

Durch Ihren Zugriff als behandelnder Arzt oder Berater können Sie, wenn es Ihnen gerade möglich ist, Ihre Fälle kontrollieren, aber sind stets im Zweifel, wenn Sie nicht erreichbar sind, durch das Telemedizinzentrum unterstützt.

FORSCHUNGSPROJEKT
AKZEPTANZ FÜR DIABETES-TELEMONITORINGSYSTEME

Stellen Sie sich als behandelnder Arzt oder Berater vor solch ein System und Service (TSS) angeboten zu bekommen und testen zu dürfen.

Bitte bewerten nun Sie die Aussagen anhand der folgenden Skala mit einem Kreuz:
stark ablehnend – ablehnend – neutral – zustimmend – stark zustimmend

Aussage	stark ablehnend	ablehnend	neutral	zustimmend	stark zustimmend
Ich denke positiv über TSS.	☐	☐	☐	☐	☐
Die Nutzung von TSS bei Patientenbehandlung und -management ist eine gute Idee.	☐	☐	☐	☐	☐
Ich befürwörte den Auf- und Ausbau von Telemedizinsystemen.	☐	☐	☐	☐	☐
Die Digitalisierung ist zukünftig ein wichtiges Thema in der Patientenversorgung.	☐	☐	☐	☐	☐
Angenommen ich habe Zugang zum TSS, dann beabsichtige ich es zu nutzen.	☐	☐	☐	☐	☐
Ich beabsichtige das TSS regelmäßig nutzen.	☐	☐	☐	☐	☐
Ich weise meine Patienten auf das TSS hin.	☐	☐	☐	☐	☐
Ich nehme das TSS aktiv in meine Versorgung auf.	☐	☐	☐	☐	☐
Die Nutzung von TSS bei meiner Arbeit ermöglicht, dass ich meine Aufgaben schneller bewerkstellige.	☐	☐	☐	☐	☐
Die Nutzung von TSS verbessert meine Patientenversorgung und mein Patientenmanagement.	☐	☐	☐	☐	☐
Die Nutzung von TSS steigert die Effektivität meiner Arbeit.	☐	☐	☐	☐	☐
Die Nutzung von TSS erhöht die Produktivität meiner Arbeit.	☐	☐	☐	☐	☐
Die Nutzung von TSS macht meine Arbeit einfach.	☐	☐	☐	☐	☐
Das TSS ist für meine Arbeit nützlich.	☐	☐	☐	☐	☐
Die Bedienung des TSS zu lernen ist für mich einfach.	☐	☐	☐	☐	☐
Das TSS ist leicht zu bedienen.	☐	☐	☐	☐	☐
Das TSS ist leicht von meinen Patienten zu bedienen.	☐	☐	☐	☐	☐
Ich finde das TSS in der Interaktion flexibel.	☐	☐	☐	☐	☐
Meine Interaktion mit TSS ist klar und verständlich.	☐	☐	☐	☐	☐

FORSCHUNGSPROJEKT
AKZEPTANZ FÜR DIABETES-TELEMONITORINGSYSTEME

Aussage	stark ablehnend	ablehnend	neutral	zustimmend	stark zustimmend
Mein Arbeitsplatz hat die notwendige Infrastruktur um die Nutzung von TSS zu unterstützen.	☐	☐	☐	☐	☐
Ich nutze das TSS, wenn ich ein entsprechendes Training bekomme.	☐	☐	☐	☐	☐
Ich nutze TSS, wenn ich notwendige technische Assistenz bekomme.	☐	☐	☐	☐	☐
Mit gegebenen Ressourcen, Möglichkeiten und Wissen, welche es für die Nutzung von TSS benötigt, ist es einfach.	☐	☐	☐	☐	☐
Die Nutzung von TSS ist mit allen Aspekten meiner Arbeit kompatibel.	☐	☐	☐	☐	☐
Die Nutzung von TSS passt gut zur Art, wie ich arbeiten möchte.	☐	☐	☐	☐	☐
Die Nutzung des Systems passt gut zu meinem Arbeitsstil.	☐	☐	☐	☐	☐
Die Nutzung des TSS ist mit großen Änderungen verbunden.	☐	☐	☐	☐	☐
TSS ergänzt meine Tätigkeit und meinen Auftrag zur Patientenversorgung.	☐	☐	☐	☐	☐
Personen, die mein Verhalten beeinflussen, denken, dass ich TSS benutzen sollte.	☐	☐	☐	☐	☐
Personen, die mir wichtig sind, denken, dass ich das TSS benutzen sollte.	☐	☐	☐	☐	☐
Patienten finden die Nutzung von TSS gut.	☐	☐	☐	☐	☐
Meine Kollegen ermutigen mich das TSS zu nutzen.	☐	☐	☐	☐	☐
Ich habe in der Vergangenheit Telemedizin-Technologien genutzt.	☐	☐	☐	☐	☐
Ich nutze bereits Telemedizintechnologien.	☐	☐	☐	☐	☐
Ich fühle mich wohl mit der Nutzung von IT.	☐	☐	☐	☐	☐
Ich fühle mich kompetent bei der Nutzung von und Patientenberatung zu Technologien im Arbeitsalltag.	☐	☐	☐	☐	☐
Wo möglich versuche ich Daten, Prozesse und Kommunikation beruflich auch digital abzubilden.	☐	☐	☐	☐	☐
Privat nutze ich ebenfalls einige digitale Medien zur Kommunikation.	☐	☐	☐	☐	☐
Technische Sicherheitsstandard im Umgang mit Patientendaten sind beim TSS notwendig.	☐	☐	☐	☐	☐
Verpflichtende Standards im Umgang mit Patientendaten sind notwendig für meine Arbeit.	☐	☐	☐	☐	☐

FORSCHUNGSPROJEKT
AKZEPTANZ FÜR DIABETES-TELEMONITORINGSYSTEME

Aussage	stark ablehnend	ablehnend	neutral	zustimmend	stark zustimmend
Es ist wichtig für mich, meine Patienten über die Nutzung der medizinischen Daten zu informieren.	☐	☐	☐	☐	☐
Fachgesellschaften müssen sich beim Datenschutz rechtlichen und ethischen Fragen stellen und auch die Nutzung der Daten für die Forschung klären.	☐	☐	☐	☐	☐
Digitale Leistung mittels TSS müssen anders bewertet und vergütet werden als die entsprechende analoge Leistung.	☐	☐	☐	☐	☐
Ein TSS soll über einen Selektivvertrag geregelt werden. (Keine Regelversorgung)	☐	☐	☐	☐	☐
Es ist in Ordnung, wenn meine Patienten den Service privat bezahlen.	☐	☐	☐	☐	☐
Es ist abhängig von der Versorgungsleistung, ob TSS privat bezahlt oder vom Kostenträger übernommen werden soll.	☐	☐	☐	☐	☐
Für den zusätzlichen Service sind die Kosten für die Erstausstattung des TSS als Investition vom Betrieb zu tragen.	☐	☐	☐	☐	☐
Die Beziehung zu meinen Patienten wird durch die umfängliche Begleitung intensiver.	☐	☐	☐	☐	☐
Der Behandlungsmix aus analog und digital wird das Arzt-Patienten-Verhältnis stärken.	☐	☐	☐	☐	☐
Die Therapietreue meiner Patienten wird sich erhöhen.	☐	☐	☐	☐	☐
Durch TSS habe ich zu allen meinen Patienten gleich wie weit entfernt einen besseren Kontakt.	☐	☐	☐	☐	☐
Ich habe durch TSS zu Patienten, die mich nur selten besuchen, eine stärkere Verbindung.	☐	☐	☐	☐	☐
Mir ist es wichtig, einen festen Ansprechpartner (Fachkollegen) im Center zu haben.	☐	☐	☐	☐	☐
Mir ist es wichtig vorher persönlichen Kontakt zu den behandelnden Experten im Center zu haben.	☐	☐	☐	☐	☐
Ich fürchte, dass die Fachkollegen im Center anders behandeln als ich es tue/vorsehe.	☐	☐	☐	☐	☐
Ich möchte vorher über die Standardprozesse und Algorithmen bei der Auswertung der Daten informiert werden.	☐	☐	☐	☐	☐

Persönliche Angaben:

Alter (freiwillig) _____

Geschlecht ☐ männlich ☐ weiblich ☐ divers

Arbeitsverhältnis* ☐ angestellt ☐ selbstständig

Praxiserfahrung in Jahren* _____

Beruf ☐ Diabetologe/-in ☐ Diabetesberater/-in

1 Ziffer der PLZ (freiwillig) _____

Gibt es Ihrerseits Aspekte, die Ihre Einstellung zu TSS beeinflussen?:

_____

_____

_____

_____

_____

_____

Seite 4 von 4

Vielen Dank für Ihre Zeit und Mühe!

4

APPENDIX 6 Introduction in English

The following questionnaire deals with a possible future IT service in the field of telemonitoring. The INTERACTIVE system includes the remote management of your patients at home by you as the attending physician and consultant and an external telemedicine centre (certified, medically trained and qualified medical personnel) as a service, which checks incoming information of the patient around the clock 24/7 and reacts if necessary: remote examination, diagnosis and monitoring to support your treatment and therapy.

In concrete terms this means: the basis is an online portal to which the patient (with limited access to documentation); and the telemedicine centre and you as the attending physician or therapist have access. The contact between the parties involved takes place regularly by telephone, video chat or in writing electronically. The patient contacts and makes entries with information about the current health and activity status (like a diary). Data (e.g. blood sugar, blood pressure, oxygen saturation, vital parameters, etc.), which the patient collects at home using medical measuring devices and available aids, but also wearables, can also be integrated. All these interactions are documented. Your patient file and all treatment and therapy plans, as well as laboratory values, are stored. Accordingly, the expert in the telemedicine centre reacts with an action if necessary or required. In this way, the centre can send out alarms in emergencies, recommend personal visits to you, remind you (e.g. of taking medication) and offer advice or answer any questions that arise.

Through your access as an attending physician or therapist, you can control your cases when you are able to, but you are always supported by the telemedicine centre in case of doubt when you are not available.

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