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BUILDING CONSUMER TRUST DURING THE PRODUCTIZATION PHASE OF A NEW, SMART HEALTH TECH CONSUMER PRODUCT

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ABSTRACT

Building Consumer Trust During the Productization Phase of a New, Smart Health Tech Consumer Product

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The thesis aims to investigate the role of trust during the New Product Development (NPD) phase of smart health tech products, focusing on the consumer testing phase. The central research question examines the factors related to trust that arise during the productization/NPD process, and how these factors can be incorporated and enhanced during the development of a new smart health tech product. The study seeks to understand the factors influencing trust in smart health tech products, validate these factors in a real-life business setting, and provide recommendations for future research and productization processes.

The research employs a two-step methodology, starting with a literature review to identify general and specific trust-building factors and establish a theoretical framework. Following this, empirical research is conducted with WellO2, a Finnish health tech company planning to launch a new smart mouthpiece designed to measure lung and breathing functions. This phase involves real-life testing of the product to validate the identified trust-building factors and uncover any previously unrecognized factors.

The most crucial findings of the study are expected to highlight the key trust-building factors that emerge during the consumer testing phase of the NPD process and offer practical recommendations for incorporating these factors into future product development processes for SMEs.

The results of this study are intended to be used by companies involved in the development of smart health tech products to enhance trust during the NPD process, leading to successful product adoption and commercialization. While the research is conducted in the context of a specific company and product, the findings and

recommendations may have broader applicability and generalizability to other companies and products in the smart health tech sector.

Keywords: NPD, Product development, smart products, health tech, trust, productization, consumer markets, SME

TIIVISTELMÄ

Asiakasluottamuksen rakentaminen uusien ja älykkäiden terveysteknologiatuotteiden tuotteistamisvaiheessa

Simo Kekäläinen

Oulun yliopisto, Tuotantotalouden maisteriohjelma

Diplomityö 2023, 80 pp. + 9 liitettä

Työn ohjaaja yliopistolla: Professori Harri Haapasalo

Tämä diplomityö pyrkii tutkimaan luottamuksen roolia älykkäiden terveysteknologiatuotteiden uuden tuotekehityksen (NPD) vaiheessa, keskittyen kuluttajatestausvaiheeseen. Keskeinen tutkimuskysymys tarkastelee tuotteistamis-/NPD-prosessin aikana esiin tulevia luottamukseen liittyviä tekijöitä ja sitä, kuinka näitä tekijöitä voidaan sisällyttää ja vahvistaa uuden älyterveysteknologiatuotteen kehityksessä. Tutkimus pyrkii ymmärtämään tekijöitä, jotka vaikuttavat luottamuksen kehittymiseen älyterveysteknologiatuotteissa, arvioimaan näitä tekijöitä todellisessa liiketoimintaympäristössä ja antamaan suosituksia tulevalle tutkimukselle ja tuotteistamisprosesseille.

Tutkimus alkaa kirjallisuuskatsauksella, joka pyrkii tunnistamaan luottamuksen rakentamiseen liittyviä tekijöitä ja luomaan täten teoreettisen viitekehyksen aiemman kirjallisuuden pohjalta. Tämän jälkeen teoreettista viitekehystä ja tunnistettuja luottamusta rakentavia tekijöitä tutkitaan todellisessa liiketoimintaympäristössä. Case-yrityksenä on suomalainen terveysteknologiayritys WellO2, joka suunnittelee uuden tuotteen (älysuukappaleen) lanseerausta, jonka tarkoituksena on pystyä mittaamaan keuhkojen hengitystoimintoja. Tutkimuksen aikana tuotetta testattiin todellisessa kuluttajatestausympäristössä ja sillä pyrittiin validoimaan tunnistetut luottamuksen rakentamisen tekijät ja löytämään uusia, vielä tuntemattomia tekijöitä.

Tutkimuksen tärkeimmät tulokset korostavat avaintekijöitä uuden tuotteen luottamuksen rakentamiseen, mitkä nousevat esiin NPD-prosessin kuluttajatestausvaiheessa ja tarjoavat käytännön suosituksia näiden tekijöiden sisällyttämiseksi tuleviin tuotekehitysprosesseihin PK-yrityksille.

Tämän tutkimuksen tulosten on tarkoitus palvella yrityksiä, jotka ovat mukana älyterveysteknologiatuotteiden kehittämisessä ja joiden tarkoituksena on parantaa kuluttajien luottamusta tuotteeseen NPD-prosessin aikana, mikä helpottaisi tuotteen menestyksekästä käyttäjähyväksyntää ja kaupallistamista. Vaikka tutkimus on tehty yhden yrityksen ja tuotteen kontekstissa, tuloksilla ja suosituksilla voi olla laajempaa käyttöä ja yleistettävyyttä myös muille yrityksille ja tuotteille älyterveysteknologia-alalla.

Avainsanat: NPD, tuotekehitys, älylaitteet, terveysteknologia, luottamus, tuotteistaminen, kuluttajamarkkinat, PK-yritykset

FOREWORDS

This thesis is the final product of a journey that started in the middle of the COVID-19 pandemic in 2020. It also coincides with changes in my own personal life – a feeling of trying to find out my true purpose in professional life. It is also the second time in my life when I find myself writing a master’s thesis albeit this time it happened while I was working full time.

I hope that my master’s thesis provides insights and answers to small and medium sized enterprises that are in the process of creating new products to the market. The truth is that SMEs are the ones keeping the wheels of innovation and economy rolling even though the praise and limelight are often directed to large multinational corporations.

I would like to thank the Faculty of Technology and its department of Industrial Engineering for all the help, support and encouragement they have given over the years. The professionalism and empathy which they showed towards this ”second timer” really did make things a bit easier and also, more fun! I would like to especially thank professor Harri Haapasalo for supervising my thesis and all the life advice he gave me. I also owe a big debt of gratitude to Petteri Annunen and Osmo Kauppila, my fellow TV quizz show competitors, who helped me sort out the mess that was my completed and (un)completed courses so that I could finally graduate!

Thank you to the staff of WellO2 – founder Aulis Kärkkäinen for believing in me and Katri Lindberg & Jesse Väänänen for letting me tag along with you during the user testing phase.

Finally I would like to thank my family – mum, dad, my sister and her husband and all our furry friends at home, for always supporting and helping me. You are simply the best.

Oulu 31.08.2023

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ABBREVIATIONS AND TERMS

USD	United States Dollar
NPD	New Product Development
ECG	Electro Cardiogram
R&D	Research & development
TAM	Technology Acceptance Model
PU	Perceived Usefulness
PEOU	Perceived Ease of Use
UTAUT	Unified Technology Acceptance and Use of Technology
PEF	Peak Expiratory Flow
PIF	Peak Inspiratory Flow
MEP	Maximum Expiratory Pressure
MIP	Maximum Inspiratory Pressure
SD	Standard Deviation

1. INTRODUCTION

1.1 Background

During the last two decades of the 21st century, technological advances have brought humans and machines ever closer to each other. The speed of technological advancements has put an even greater emphasis on companies' ability to productize new technologies. The biggest reason for companies to engage in productization activities is to achieve successful commercialization and entry to markets with new or improved products. Hänninen et al. (2012) synthesized that productization allows companies to be more responsive to whatever customer demands are present in the market and thus, with this understanding, provide new solutions and products to the market quickly and effectively. All this should eventually lead to better products, profits and possibly growth in the market.

When earlier for example, heart rate would be something that was measured in hospitals in health checkups or emergencies, it is nowadays tracked in real-time by millions of smart watches and wearables every single second. Whether it is heart rate, sleep, activity or recovery, there is a wearable, application or a component in the market that can measure it. The current wearable/ smart consumer product technology market size is estimated to exceed over 40 billion USD and expected to increase by 13,8 % every year from 2021 to 2028 (Grand View Research, 2021).

How is a smart consumer product or wearable defined? Literary analysis shows that there is not one generally accepted definition of what a smart product is. However, several researchers and studies have tried to identify attributes to describe what smart products are. Some, like Rijsdijk (2009), provided a general description about how "smart products are able to collect, process and produce information, and can be described to think for themselves" while others, such as Gutiérrez et al. (2013), went on to detail several features that characterize smart products. These included e.g., gathering and learning independently from information (i.e., user preferences), continuous adaption throughout the product life-cycle and proactive interaction with other components (Gutiérrez et al. 2013).

However, there seems to be one common aspect which is often seen as the basis of smart products: information and data. The value added in smart products usually comes from the handling of data and the consequent actions and information based on it. *And when it comes to information and handling user data, trust is at the very core.* This has been demonstrated in many studies and fields (such as autonomous vehicles) where drivers of consumer resistance to smart have been researched (Abraham et al. 2016; Wilson et al. 2017; Souka et al. 2020). Michler et al. (2020) went on to stress that trust in how users' data is handled and how the product works, is the key element in whether a smart product will be adopted or rejected by consumers and the society. However, many of these studies are researching trust only when the product has already been launched to the market and not during the productization phase. *This creates an empty void in the research where the role of trust during the productization and product development phase is not acknowledged.*

1.2 Objective of the study

Therefore, this work will concentrate on how trust and the factors enhancing it can already be built and incorporated during the New Product Development (NPD) phase when bringing a new smart product to market. This will be done via researching the NPD process of a Finnish health tech company, WellO2, which is planning to launch a new, smart health tech product in 2022 designed to measure lung and breathing functions daily. The research will be conducted during a phase where WellO2's new product enters consumer testing.

The research questions to be answered below are specified towards the specific objective of this study state above:

1) Firstly, the literature review seeks to find out w*hat questions and factors related to trust consumers come up with during the productization / New Product Development (NPD) process of a new product.* Or rather, do these factors exist at all? In this part, a research literature framework will be established from several different perspectives and the factors that are recognized here are either general trust building factors common to all products or if possible, also specifically

linked to smart health tech products. This is the first research question (see Figure below)

2) Empirical research → Based on the literature framework, in this phase, this thesis tries to validate whether the factors recognized in the literature synthesis *do come up* during the productization / New Product Development (NPD) process of *a* ***smart health tech product in a real-life business setting.*** In addition, this part also seeks to find out whether there are other factors which existing research has not yet recognized – either general or specifically related to smart health tech products. This is the second research question.
3) Practical implications & improvements for future → Based on the findings from empirical research results, practical future implications & improvements for companies and future research will be given. The third research question is, how trust should be incorporated and taken into account in future productization research and processes.

The scope of this research centers specifically around new, smart health tech products that are entering the customer testing phase of new product development process. In this context, the trust factors are limited and examined during the test phase. During the live product test phase customers get the first look and feel of the product– then based on feedback from customers, the company continues developing the product before releasing it to market. In this study, the empirical research will be done within a Finnish health tech growth company called WellO2. WellO2 is a small-size company according to the European Commission Recommendation of Company classification (2003) and the product at the center of this study is a new smart mouthpiece which is a new additional product to the company's main product – a breathing trainer called WellO2. Both of these products are sold to consumers globally.

1.3 Structure of the thesis and research process

The rest of the thesis is organized as follows: firstly, it covers the theoretical framework around productization, new product development, smart products, health tech industry and lastly, why trust is a key element in customer product adoption when designing new smart products. The literary review acts as a basis for this study – the research questions and themes will be composed from there. Then, the study moves on to the empirical part providing the research setting in a real-life test phase of WellO2's new product and data that answers to proposed research questions. Finally, results will be analyzed and discussed to provide further knowledge and future recommendations into how companies could adapt trust building elements as part of their NPD process.

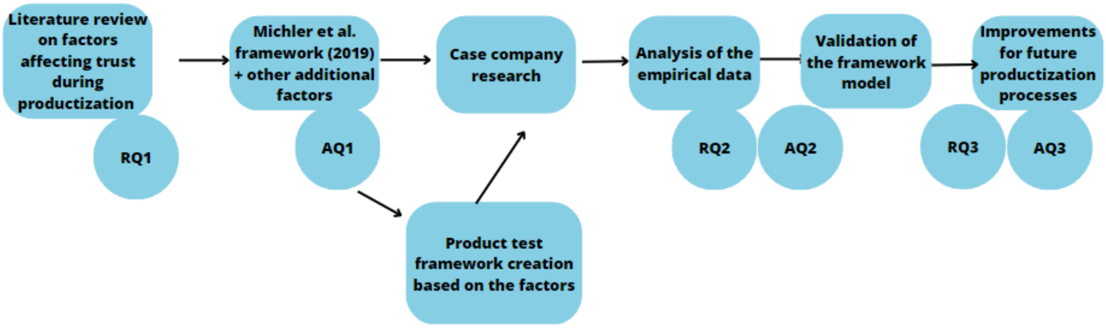

Figure 1: Content structure and research questions of this master's thesis

2. LITERATURE REVIEW

2.1 Smart Products and Health Tech

Cambridge Business English Dictionary (2011) defines ”product” as ” something that is made to be sold or as usually something that is produced by an industrial process”. As discussed in earlier chapters, a product can either be a tangible, physical object (mobile phone, car etc.) or intangible and abstract such as services or experiences. It can also be said that a product answers to real-life need of a customer and this need is fulfilled and solved with the product that is offered (Härkönen et al. 2015). A company or an actor then exchanges its product for a compensation that generates revenue for the company (Majava et al. 2013).

The importance of products for businesses and the economy has been emphasized for several decades. In the 1930s, the famous economist Joseph Schumpeter argued that products and in particular, *new products* act as stimuli to economic development and other growth and development in the society (Schumpeter 1934). The father of Stage-Gate Model, Robert Cooper (2011), highlighted the importance of new products for individual businesses because they improve companies’ financial situation through increased revenues, market shares, net results, and ultimately, share prices.

Then, how is a *new product* defined? The classification of Booz et al. (1982) is one of the most widely used and accepted and it identifies six different categories for new products.

New-to-the-world products are what their category suggests; completely new products which create a new market. Booz et al. (1982) also call these new products *inventions* since they most often are built around a big technological development. An example of a new-to-the-world product is the iPhone. Interestingly, this category represents quite a small proportion of all new products.

New product lines (new to the firm) are products which do not create a new market but are new products in the product-mix of a certain company and allow the company to enter an established yet new market for them (Booz et al. 1982). Again, iPhone can be used as an example as it allowed Apple, a computer company, to enter a new market for them which was the cell phone market.

Additions to existing lines is a sub-category of new product lines which means that the company is introducing a new variation of products in a market where it operates (Booz et al. 1982). This means that the addition is different enough to stand out from the existing product offering but not so different that it is a new product line. An example can be taken from the automotive industry, where car makers provide differently equipped versions of their cars.

Improvements and revisions to existing products are literal replacements of existing products in the product line of a firm (Booz et al. 1982). Again, an example can be taken from the automotive industry where a single car model can be revised and designed again with numerous modification and improvements over the years. Volkswagen Beetle is not the same car today as it was when it was first introduced in the 1930s. According to Booz et al. (1982), this category represents the biggest proportion of all new products.

Cost reductions is a category which matters primarily to the company itself – for the customer, cost reductions will not offer any new benefits other than reduced price (Booz et al. 1982). Cost reductions carry enormous impact in financial terms since it usually comes with the advent of improved manufacturing processes or materials i.e., the development of whole company processes. To be clear – in cost reductions category, there are no actual product improvement, only the cost/price changes.

The last category is called *repositionings.* As its name suggests, these are existing products for which new applications have emerged. Booz et al. (1982) emphasize that in the reposition category, the product improvements stem more from secondary sources such as customer perception and branding rather than actual technical developments. An example can be drawn from the medical industry where an existing drug for a certain purpose is found to have effects that can be used to treat some other condition – like aspirin, a drug originally created to treat headaches, can be used to treat blood clots because of its blood thinning capability.

Trott (2005) calculated that the vast majority of new products (77 %) are cost reductions, line extensions and improvements to products already existing on the market. It is no coincidence that these categories are the least risky ones. The smaller categories which include new product lines and new to the world products for example, always carry a significant risk and demand major resources from the company.

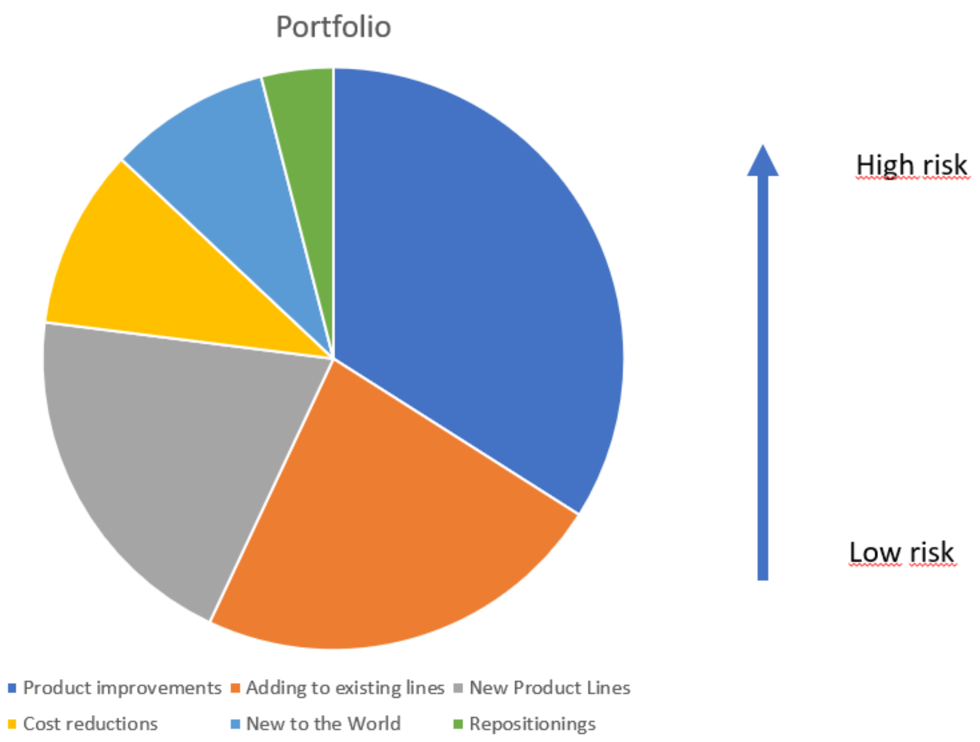

Figure 2: The average new product portfolio modified from Trott (2005)

New products can be created from many sources and needs. Majava et al. (2013) drew a synthesis of six different categories from research literature that drive product development for new products. These categories are *financial goals, strategy and business environment, marketing & customers, technology, internal push & resources, and supply chain stakeholders.* In their research, Majava et al. (2013) found that financial goals (i.e., profitability and revenue targets) are the most important factors that set off new product development processes in companies. They were naturally followed by product mix, brand & image and strategy factors which basically are the components to achieve those financial goals.

Technological advances in the 20th and 21st have been enormous. Humanity has made a move from analogical era to digital era through inventions like electricity, transistors, computers, the Internet, and software. This rapid technological development has also been called the *Third Industrial Revolution* or the *Digital Revolution* and it has changed the economy, societies, and whole industries (Rifkin 2011).

Increased and faster data processing power, wireless communication methods and new sensors have changed the way we can access, analyze, and store data. Secondly these technical developments have given the public a possibility to access and analyze their own data in an unforeseen way. Never have we been able to wear or place comfortable and small devices in our environment that measure numerous things that could be user-related like health data or object-related like the temperature of an apartment (Yang et al. 2015). These developments have been commercialized into so-called *smart products* in many different fields.

Even though there is not one, universally accepted definition for what a smart product is, several researchers and studies have tried to identify attributes that characterize smart products. These attributes usually included e.g., gathering, and learning independently from information (i.e., user preferences), continuous adaption throughout the product life cycle and proactive interaction with other components (Gutiérrez et al. 2013). In general, "*smart products are able to collect, process and produce information, and can be described to think for themselves*" (Rijsdijk 2009).

However, as a synthesis, one common aspect can be recognized as the basis for all smart products, and that is data & information. In addition, the value-added in smart products is created when the collected data and information are processed into knowledge.

One of the industries most affected by the recent developments in technology is the medical industry. Firstly, technological advancements have changed the way people are treated in hospitals but secondly and more importantly, these advancements have opened the way how individuals can access and act on their own health. Especially the so-called *wearable devices* are nowadays widely used to measure health indicators that were normally registered in hospitals. These include heart rate, blood oxygen saturation (SpO2), body temperature, ECG (Heart ElectroCardioGram), and many others. Examples of such wearables are Finnish Polar Electro activity watches and the world-famous Oura ring, Apple Watch, and many others.

The continuous monitoring of one's own health acts both as a preventing and enabling force. When health and in some cases other wellbeing factors such as stress levels or daily activity are monitored, people can adopt a new lifestyle to improve their wellbeing and prevent many of the global lifestyle diseases caused by obesity and inactivity. In addition, sudden events like arrhythmias or even strokes can be detected much earlier and in case hospital treatment is needed, lives can ultimately be saved (Yang et al. 2015).

According to Yang et al. (2015) we are now seeing the *second generation* of wearables which are characterized by continuous monitoring and providing multi-sensor data points – the so-called *agents* which can either autonomously interact with their environment or cooperate with other agents. An example can be drawn from Oura – an intelligent sleep sensing ring, which combines a multitude of data from body temperature to movement into "sleep and activity score" that tells how well the user has slept and recovered. Multimodal sensing provides context and understanding for the data monitored – a clear breakthrough from the *first generation* of wearables which were based on single sensing modality and only provided low-accuracy predictions such as number of steps taken in a day. The future *third generation* of wearables will most likely take a step towards implants and integrate other background data sources such as genetics and health information with real-time sensor data combining them into much more future-oriented predictions that can for example recognize the onset of diseases. In the third generation but also in the second, connectivity (i.e Internet, Bluetooth etc.) plays a big role since they are used as part of the data storing, accessing, and analyzing.

Mani and Chouk (2017) summarized smart health tech products to have *"1) sensors that collect data about the environment; 2) agents that activate an action and are interacting with the environment and 3) connectivity."*

2.2 Productization

All products start from an idea and then undergo a process called productization where they eventually come to life. But what does productization mean exactly? In their paper Härkönen et al. (2015) explored the concept, origins, and benefits of productization via a large literature review. The authors found that while the term ”productization” was used quite a lot, it seemed to be a bit unclear. However, a synthesis from many different definition and researchers was created. This synthesis defined productization as:

” The process of analysing a need, defining, and combining suitable elements, tangible and intangible, into a product-like object, which is standardised, repeatable and comprehendible” (Härkönen et al. 2015, p.70)

Productization can take many forms. The articles Härkönen et al. (2015) reviewed presented four different categories of productization. The productization of 1) products, 2) services, 3) software and 4) technology. Out of these four categories, the productization of products was the most common with over a third of the reviewed articles discussing them.

The definition of a product varies between these different categories. *Productization of products* refers either to physical objects or products that can have both physical and non-physical elements which are referred to as tangible and intangible in the literature (Härkönen et al. 2015). Productisation in this category is either seen as a very concrete activity following R&D, engineering, or product development phase of a company (Belt et al. 2010; Majava et al. 2013) or as a business-related activity that moves beyond product development and brings in understanding from customers and markets to bring about a finished product to the market (Mitola 1999; Hossain 2012; Hänninen et al. 2014).

While the definition of a product in productization of products seemed to be quite varying and ambiguous, *productization of services* is more uniform as it deals with ”objects of exchange that are typically abstract and intangible” as defined by Härkönen et al. (2015). However, the terminology around what productization means in the context of services is not completely clear. Some refer to it as a more commercial-like activity such as making services ”more product-like” (Morrison 2003; Salmi et al. 2008) while others understand it as ”facilitating the development of customer understanding” (Valminen and Toivonen 2012). Yet, the role of productisation in the context of services is to provide order and routine to the abstract as Härkönen et al. (2015) synthesized:

”Productisation has a specific role in clarifying the service offering, creating repeatability and enhancing understanding of the offering” in the context of services.

It could be said that *productisation of software* shares similarities both with the productisation of services and products. Firstly, the object or product itself, i.e. software, is intangible and abstract (i.e. a computer program, data, procedures etc.) but it still is like a product which users can access and use as they want (Kilpi 1997). Härkönen et al. (2015) also noted that just like in productisation of services, standardization is one of the main aspects highlighted in the literature when discussing productisation of software. Also, standardization is seen as the main aim of productisation in this context as it is placed *”at the interface of development and the market enabling repeatability and scalability”* (Härkönen et al. 2015).

Finally, when discussing productisation of technology, many understand this category to be an activity which takes place between ”engineering-oriented and marketing-oriented thinking” (Härkönen et al. 2015). This view is supported by many other studies which seem to define productisation of technology as something that moves forward from engineering knowledge to applications. Whether this activity is taking place during commercialisation (West 2008; Shapira et al. 2012), between development and market launch (Sahlman and Haapasalo 2011; Zhu et al. 2012), or proof of concept/application creation (Myers et al. 2002) depends on the subject defining it.

The reason why companies engage in these various productization processes is that they carry a lot of benefits. One of the aspects mentioned earlier was the possibility to bring in repeatability and scalability to where it has not been used before (Härkönen et al. 2015). However, the biggest reason for companies to engage in productization activities is to achieve successful commercialization and entry to markets with new or improved products. Hänninen et al. (2012) synthesized that productization allows companies to be more responsive to whatever customer demands are present in the market and thus, with this understanding, provide new solutions and products to the market quickly and effectively. All this should eventually lead to better products, profits and possibly growth in the market.

As we see, productization as a term is still a bit vague; it depends on the context and varies between industries and persons using it. As a synthesis, Härkönen et al. (2015) produced a table of characteristics which can be recognised within different contexts of productisation.

Table 1: Summary of productisation characteristics – modified from Härkönen et al. (2015)

Recognised characteristics		Productisation	of	
	Product	Service	Software	Technology
A process / development phase	X	X	X	X
Standardisation / systemisation / better definition / reproducibility	X	X	X	
Making tangible	X	X	X	
Making something marketable / saleable / ready commercially	X	X	X	X
Value creation	X	X	X	X
Improving customer understanding / demonstrating value		X	X	
Packaging to a form suitable for customers		X	X	
Defining offering based on needs	X	X	X	X
At the frontiers of technological knowledge				X

For the purposes of this master's thesis research, the following four characteristics from the above table of Härkönen et al. (2015) which are present in all different contexts of productisation and which also characterize the product researched in this master's thesis, will be used as the basis for defining productisation:

1) *A process / development phase*
2) *Making something marketable / saleable / ready commercially*
3) *Value creation*
4) *Defining offering based on need*

2.2.1 Productization in Creating New Products - New Product Development (NPD) Process

In practice, productisation can take many forms. In many cases and in this master's thesis, the term productization is used in the context of creating a new product – in such cases, the term New Product Development (NPD) is used (Trott 2005). Generally, nearly all productization and new product development models share the same main processes which are needed to create and manage a new product from beginning to end.

Trott (2005) summarizes the main processes of the NPD process as follows. The first stages of the NPD process center around bringing an idea from an abstract concept to something that can be tested and evaluated. Thus, all the models start with *idea generation* which aims to produce a big number of ideas without any limitations. From this mass of ideas, the best are *screened* and chosen for the next phase where the ideas are developed into full-grown concepts. This is called *concept development / concept testing.* In this phase, concepts can be modified and changed relatively easily, and companies spend a lot of time to refine the concepts before moving onwards and making the concept a reality. The subsequent stages from concept testing onward bring in the different departments of the company to analyze and make decisions from the perspective of product design, financials, manufacturing, engineering etc. These are also the phases where costs start increasing sharply as the companies are committing to investing resources. After all the necessary decisions are made, the NPD process moves into *test marketin*g where feedback from customers and markets may lead to changes in the product before finally putting the product out on the market. After commercializing the product, companies actively engage in *monitoring and evaluation* to see how the finalized product is performing on the market.

Figure 3: Commonly presented linear NPD model modified from Trott (2005)

However, very often this linear way of conducting new process development does not really depict the reality very well. Rather, many of the process phases happen simultaneously and concurrently and interaction is not confined to single departments or functions within the company (Hart 1993; Trott 2005).

Since conceptualizing what new product development means in process terms, a multitude of different approaches have been developed. Saren (1984) classified these different NPD models into 7 distinct categories which are:

1. *Departmental-stage models*
2. *Activity-stage models and concurrent engineering*
3. *Cross-functional models (teams)*
4. *Decision-stage models*

5. *Conversion-process models*
6. *Response models*
7. *Network models*

Departmental-stage models are the ones closest to the linear NPD model and are also the earliest forms of NPD models. As the name suggests, in departmental-stage models, responsibilities around certain tasks are delegated to different departments – for example, engineering department takes care of the engineering side of the new product project and then marketing is responsible for the marketing activities (Saren 1984). *Activity-stage models* are much more action-focused and highlight activities undertaken throughout the NPD process (Saren 1984). In addition, these activities can be simultaneous in nature and happen in collaboration. In *cross-functional models,* collaboration is the concept around which NPD process is formed (Saren 1984). Thus, companies build teams which have representation from all different company departments. (Trott 2005). *Conversion-process models* are operating on an input-output basis meaning that inputs such as customer wishes, ideas or engineering capabilities are mixed to form an output which will ultimately be a new product (Schon 1967; Saren 1984). *Response models* are formed on a behaviorist approach pioneered by Becker and Whistler (1967) where the whole idea of the process is based on the response an organisation or individual has when presented with a new idea. Lastly, *network models* act upon a company's internal activities (such as internal departments) and external linkages (e.g., societal needs, technology breakthrough) and how the collaboration of these networks contribute to the accumulation of knowledge gradually over time, and ultimately turning it into a new product. (Saren 1984; Takeuchi and Nonaka 1986).

However, the most widely used NPD processes are based on *decision-stage models.* These models are built as a series of decisions around different topics which need to be passed in order to continue the project. Next, two models based on this category will be presented.

One of the most famous methods to manage and undergo productisation process is Robert Cooper's (1990) Stage-Gate Model. Cooper's methodology is designed to be used from idea-phase all the way up to full commercialization, production, and market launch. The model incorporates decision-making points called *gates* between different phases of productization. Each gate is a fully reviewed part of the whole productization phase where a set of criteria is evaluated. Usually, the decision in each gate can be of four different outcomes. *Go,* means moving forward to the next stage. *Kill* means that the whole project will be terminated – this may be due to for example insufficient business case, unsuccessful product development or failed user tests. *Hold* means that the project is placed on hold until further information, knowledge or actions are implemented. Finally, *recycle* means that the project will repeat the stage where it is.

Process-wise, starting from the original idea phase, the model moves on to *preliminary assessment* gate where the viability and execution of the initial idea is assessed. From here, the process incorporates business evaluation during the second gate. From third gate onwards, the actual product development begins before it enters the testing and validation phase with real life customer cases and tests. Finally, if all the gates have been passed, the product will be launched to the market.

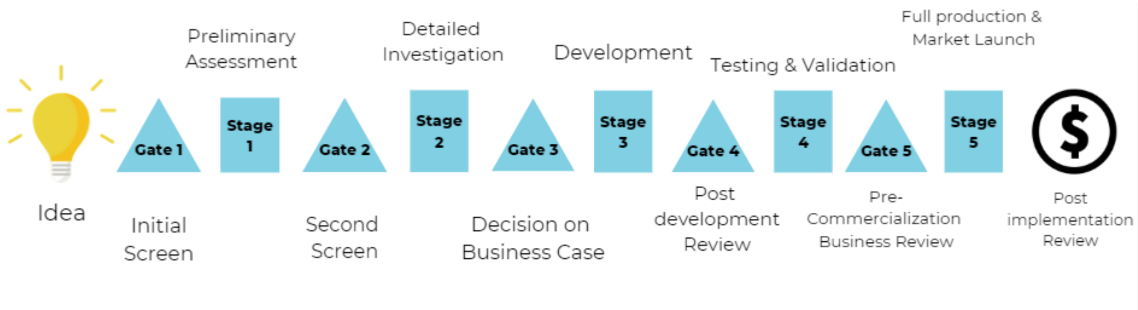

Figure 4: Cooper's Stage-Gate Model illustrated modified from Cooper (1990)

Another example is Ulrich and Eppinger's *Product Development Design* method (2000) which combines a project management framework with the actual productisation process. Ulrich and Eppinger (2000) divide productisation process into levels which address different layers of product development – moving firstly from larger system-level design questions to smaller detail designs before planning the eventual company-wide production of the developed product.

Planning is similar to Cooper's Stage-Gate's initial screen gate. This is the phase, where opportunities are identified, and resources allocated for the upcoming project. During *concept development* actors work with and generate multiple different ideas in conjunction with recognised market and business needs before choosing the most viable concepts for further development. The design phase is divided into two sections; in *system-level design* product architecture with its components and subsystems is decided before moving into the more intricate *detail-level design* where product specifications and materials are laid out. When the process for creating the product is finished, *testing and refinement phase* begins. In this phase, the created product is tested in a real life setting with possible customers to see how it works and how users react to it. Any refinements or improvements will be done based on the test results. Lastly, if the project has been moving successfully up until to this phase, *production ramp-up* will begin. This is where the company plans the manufacturing, trains the workforce, addresses possible issues, and sets everything up for full-scale production and market entry of the product. (Ulrich and Eppinger, 2000).

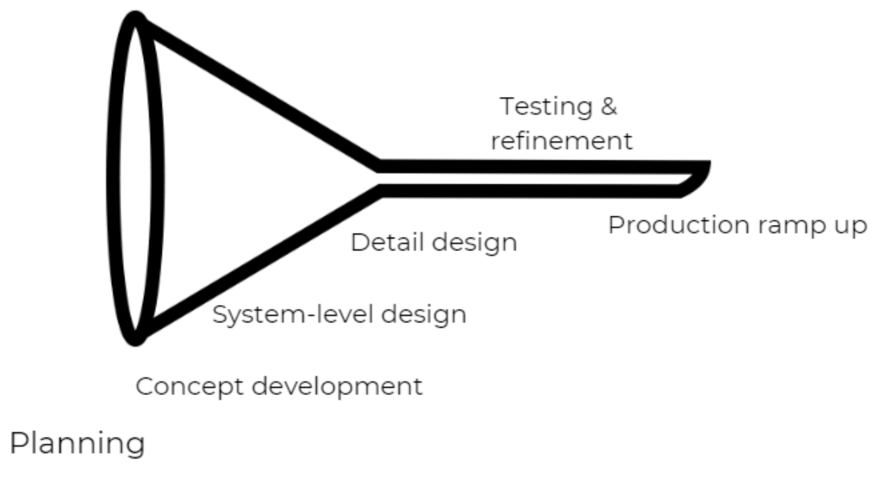

Figure 5: Ulrich & Eppinger's Product Development Design process – modified from Ulrich and Eppinger (2000)

Though these models differ somewhat from each other, they all share the inherent four productization characteristics defined earlier:

1) Process / development phase

2) Making something marketable / saleable / ready commercially

3) Value creation and

4) Defining offering based on need.

2.2.2 Product Testing

Testing is a crucial step in the new product development process because it helps ensuring the quality and reliability of a product. In the early stages of product development, testing is used to identify and fix problems, optimize performance, and validate design choices that continue to be developed in later stages. As the product moves through the development process, more rigorous testing is required to verify that it meets all relevant standards and requirements. This can include functionality testing, compatibility testing, performance testing, and stress testing. Testing at this stage is essential to identify any issues that may arise during use, such as bugs or performance degradation.

Several studies have examined the role of testing in the new product development process. Rothermel (2002) found that testing is a critical aspect of the development process and plays a vital role in ensuring the quality and reliability of a product. They suggest that it is essential to allocate sufficient time and resources for testing to ensure that a product meets the needs and expectations of its users.

Crispin and Gregory (2009) discuss the use of agile methodologies in the product development process. They argue that agile approaches, which prioritize rapid iteration and continuous testing, allow for rapid prototyping and testing of new features, as well as the ability to quickly identify and fix issues. This can help to improve the efficiency and effectiveness of the development process.

Beizer (1990) discusses various testing techniques that can be used in the product development process, including simulation, prototyping, and analysis. He argues that the selection of appropriate testing methods is crucial to ensure the quality and reliability of the final product. Wrong technique might yield results that are not valid, eventually affecting the success and outcome of the new product development process.

Product testing is a crucial part of the product development process that allows companies to ensure that their products are safe, effective, and meet the needs and preferences of their target customers. According to researchers, product testing can be defined as "the process of evaluating a product against a set of criteria to determine its performance, quality, and safety" (Kumar et al. 2016). In recent years, product testing has gained increasing attention from researchers, practitioners, and policymakers, as it is considered an essential component of consumer protection and market regulation.

One of the key benefits of product testing is that it helps companies identify and mitigate potential product failures, defects, or hazards before they reach the market. By testing products under different conditions, scenarios, and user groups, companies can assess their performance, durability, reliability, and safety, and make necessary improvements to ensure that their products meet the relevant quality standards and regulatory requirements. For example, in the food industry, product testing is used to detect pathogens, contaminants, and allergens that may pose health risks to consumers (Ramos-Pereira et al. 2022). In the electronics industry, product testing is used to assess the functionality, usability, and interoperability of devices and software applications (Wen et al. 2019).

Another benefit of product testing is that it can provide valuable feedback to companies on their products' design, features, and usability, which can inform future product development and marketing strategies. Through product testing, companies can collect data on customers' preferences, expectations, and satisfaction levels, which can help them tailor their products to specific market segments and optimize their marketing messages. Moreover, product testing can be used to generate user-generated content, such as reviews, ratings, and testimonials, which can enhance the products' credibility and visibility in the marketplace (Johar et al. 2015).

However, product testing also poses several challenges and limitations that need to be addressed by companies and researchers. One of the main challenges is the cost and time required to conduct rigorous and comprehensive product testing, especially for complex or high-risk products. Product testing may involve a variety of methods and techniques, such as lab testing, field testing, focus groups, surveys, and interviews, which require different skills, resources, and expertise. Moreover, product testing may face ethical and legal issues, such as informed consent, privacy, and confidentiality, which need to be managed appropriately (Kim et al. 2017).

Another limitation of product testing is that it may not always capture the real-world performance and user experience of products, as it may involve controlled or simulated conditions that do not reflect the diversity and complexity of user behaviors, preferences, and contexts. Product testing may also be subject to bias, errors, or limitations in the measurement, analysis, and interpretation of data, which may affect the reliability and validity of the results (Crispin and Gregory 2009.).

To address these challenges and limitations, researchers have proposed several approaches and frameworks for product testing that aim to improve its effectiveness, efficiency, and validity. For example, some researchers have advocated for the integration of user-centered design principles and methods in product testing, which involve user participation and feedback throughout the product development lifecycle (Baskerville et al. 2018). Others have proposed the use of big data analytics, machine learning, and artificial intelligence in product testing, which can enable automated and real-time monitoring, analysis, and optimization of product performance and user experience (Adams et al. 2021).

In conclusion, product testing is a critical aspect of product development and market regulation that can benefit both companies and consumers. However, product testing also poses several challenges and limitations that need to be addressed by companies and researchers through appropriate methods, frameworks,

2.3 Adoption and Use of Commercialized New Technology

2.3.1 How Are New Technologies Adopted?

The current wearable and smart consumer product technology market size is estimated to exceed over 40 billion USD and expected to increase by 13,8 % every year from 2021 to 2028 (Grand View Research 2022). At the same time, the global digital health market is valued at US 175.6 billion and expected to grow nearly 30 % every from 2022 to 2030, which means that future products that combine both markets are growing extremely rapidly. (Grand View Research 2022).

The adoption of new technologies by customers and industries always takes some time. Davis (1989) proposed a model which discusses what happens when users are presented with a new technology. The *technology acceptance model (TAM)* suggests that there are several factors existing that influence users' decision to use and accept technologies. It starts from two psychological factors which are *attitude and behavioural intention.* Attitude is the user's general impression of the technology while behavioural intention is the factor that leads people to use the technology in the first place. Attitude and behavioural intention are social constructs which means that they are very much susceptible to other external variables such social influence, age, and gender.

The next two factors in Davis' model, which are the most important, are more closely related to the technology presented. Firstly, *perceived usefulness (PU)* was defined by Davis as *"the degree to which a person believes that using a particular system would enhance their job performance"* (Davis 1989). Although the 'word' job may seem a bit distracting here, it merely means a task, goal, job etc. anything the user wants to do and how useful the technology is for the task at hand. If the user deems the technology as useful, the next factor is *perceived ease-of-use (PEOU)* defined by Davis (1989) as *"the degree to which a person believes that using a particular system would be free from effort".* In other words, the user evaluates how easy it is for them to use the new technology – if it is, technology is adopted and if not (even if they find it useful) they are less likely to adopt it. Here, themes such as usability, interface, design etc. are considered.

Davis' model thus centers very much around on end-user behaviour. Being one of the most widely known models, however, a lot of criticism has been presented against it. For example, many researchers have pointed out that TAM is too simple and outdated in the era of rapid technology advances in software and that by focusing mostly on the behavioural user aspect it overlooks other factors such as costs and structural changes which are so strong that they force users to adopt a certain technology (Bagozzi 2007; Lunceford 2009).

Since several other models also appeared, which all had a different perspective to technology use and adoption (see for example, Thompson's 1991 Model of PC utilization, Roger's 1962 Innovation Diffusion Theory, Bandura's 1986 Social Cognitive Theory etc.) an effort was made to create a unified theory that could connect different viewpoints. Venkatesh et al. (2003) approached the field by creating a synthesis under the name of *Unified Technology Acceptance and Use of Technology* where technology adoption was the effect of four key constructs: *performance expectancy, effort expectancy, social influence and facilitating conditions.* The effect of these factors depended on four factors which were *age, gender, experience, and voluntariness of use* (Venkatesh et al. 2003).

Performance expectancy was defined *as "the degree to which an individual believes that using the system will help him or her to attain gains in job performance"* (Venkatesh et al. 2003). According to later studies by Venkatesh et al. (2016) it predicted the use intention the most. *Effort expectancy* on the other hand, which was defined as *"the degree of ease associated with the use of the system*" starts to lose its importance after extended use of technology, which means that the longer you use a technology, the more you get accustomed to it even though it would be difficult to use (Venkatesh et al. 2003; Chauhan & Jaiswal 2016). *Social Influence* was defined as "*the degree to which an individual perceives how important it is that others believe he or she should use the new system"* (Venkatesh et al. 2003). As the definition shows, social influence yields significant power if someone expects a user to adopt a technology for example, in an organizational context. However, in personal context the effect of social influence varies (Venkatesh et al. 2003; Chauhan and Jaiswal, 2016). *Facilitating conditions* was defined as *"the degree to which an individual believes that an organisation's and technical* *infrastructure exists to support the use of the system"* and it was noted that they strongly influence the intention to use a certain technology (Venkatesh et al. 2003).

The four factors (age, gender, experience, and voluntariness of use) affect different constructs. *Age* was linked to all four constructs. *Gender* was found to influence effort expectancy, performance expectancy and social influence. *Experience* had a moderate effect on the relationship between effort expectancy, social influence and facilitating conditions. Lastly, *voluntariness of use* only affected the relationship between social influence and behavioural intention (Venkatesh et al. 2003).

UTAUT was significant in the sense that it combined different perspectives from a multitude of studies which would have otherwise been only partial or contradicting. In addition, it was found that the "proposed factors accounted for 70 percent of the variance in use intention" providing much needed prediction power and empirical insight which was not possible with previous models (Venkatesh et al. 2003). It was also lauded to be comprehensive in the sense that it showed the complexity of the technology acceptance process.

However, the original UTAUT framework was developed to explain and predict the acceptance of technology in an *organisational* context (Venkatesh et al. 2003) and although it was later tested in other settings too, there was a need for a model that would cover private users as well. (Venkatesh et al. 2012; Venkatesh et al. 2016).

Venkatesh et al. (2012) then developed an updated framework called UTAUT2 (*Unified Theory of Acceptance and use of technology)* which was created to exist on the outside of organizational setting and explain *consumer technology acceptance.* This was done by adding three new constructs to the original model which were *hedonic motive, cost/perceived value, and habit.* Hedonic motivation was defined *"as the fun or pleasure derived from using technology".* The so-called *perceived enjoyment* has been found to have a significant impact in predicting consumer technology use (Venkatesh et al. 2012). By adding *cost/perceived value* to the model, it was now possible to see how consumers would feel about the trade-off between the benefits a new technology would offer them and how much they would be willing to pay for acquiring those benefits (Venkatesh et al.

2012). The third new construct was habit, defined as *"the extent to which people tend to perform behaviours automatically"* (Venkatesh et al. 2012). Instead of the more traditional, reason-oriented frameworks which were based on the notion that behaviour stems from deliberate evaluations, the automaticity perspective considers technology use as automatic and unconscious (Limayem et al. 2007). UTAUT2 was very successful, and it was found to explain 74 % of the variance in behavioural intention and 52 % of the variance in technology use.

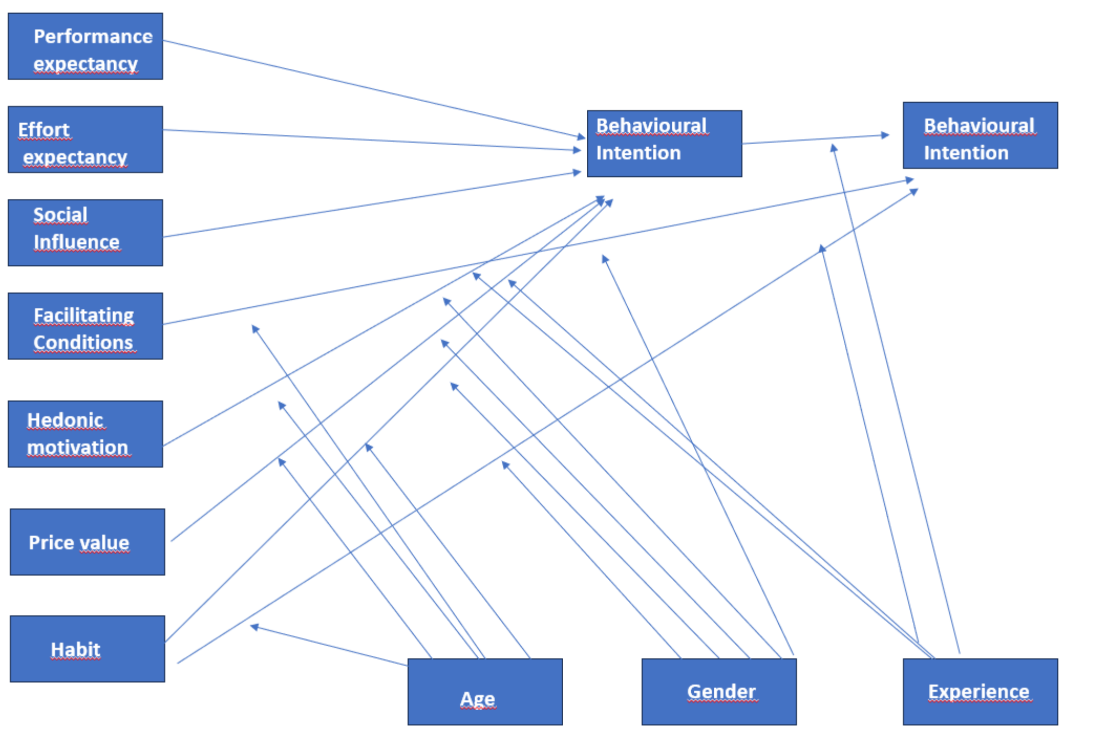

Figure 6: UTAT2 model and the relationships between different constructs – modified from Venkatesh et al. (2003)

2.3.2 Adoption of Consumer Smart Technologies and Products

Smart consumer products first saw their advent in the sports performance field. The very first wireless heart rate monitor was developed by a Finnish company called Polar Electro in the 1970s (Fitzgerald 2005) and from that day onwards, the demand for wearables has been growing exponentially.

As discussed earlier, the adoption of technologies by consumers depends on many different variables – from psychological to technical factors concerning both the user and the technology itself. For example, Peake et al. (2018) noted that consumers choosing new technology should consider the following three aspects:

1. New technology produces desirable (or non-desirable) outcomes → this can be compared with Davis (1989) Technology Acceptance Model's Perceived Usefulness
2. New technology has been developed based on a real world need → somewhat comparable to Perceived Usefulness
3. New technology has been tested and proven effective in applied studies in different settings → comparable to Davis (1989) Perceived Ease of Use

Ram (1987) also categorized reasons for rejecting innovations and products as:

1) Innovation characteristics (relative advantage, compatibility, perceived risk, complexity, reversibility, communicability.
2) Consumer characteristics (personality, attitudes, value orientation, previous experience, innovation perceptions, motivations, beliefs, and demographic variables)
3) Characteristics of propagation mechanisms (credibility, clarity, source similarity and informativeness).

When it comes to smart products, several questions about user data and information have been raised by many researchers (Hsu and Lin 2016). Slettemeås (2009) was also able to identify three problem themes stemming from actual consumers about the use of smart products. These problems were related to ”data protection, lack of human control, and enslavement to devices” (Slettemeås 2009 p.226). In the case of smart health technology products or wearables, many studies have highlighted that to counter these problems, there is a need for more” input from end-users about the effectiveness and value of new technologies” (Peake et al. 2018) and a need to ”enhance people's perception of the reliability and usability of these technologies” (Piwek et al. 2016).

2.4. Trust as a Factor in Adopting New Smart Health Products

One driver for consumer rejection in the case of smart health products is *trust.* The modus operandi and functionality of smart products is based on information which is the combination of data from different sources (e.g., users) and context (e.g., situations or environment). This combination allows the product to make autonomous decisions and actions on user's behalf. However, as it has been seen with many cases over the years, the data collection can raise concerns about the privacy and security of personal data (Dominici et al. 2016; Kumar et al. 2016). Thus, consumers must trust not only the product they use but also the manufacturer before adopting a new smart product which means that trust is not only limited to the customer-product relationship but also extends to buyer-seller relationship (Doney and Cannon 1997).

Trust in this case can be defined as the consumer's willingness to rely on the object of trust (product) which is created by a party that demonstrates trust-related qualities such as integrity, credibility, competence, reliability etc. (Doney and Cannon 1997, Flavian et al. 2006). For the adoption of a product to happen, the consumer must feel that the trust they place in a product (perceived trust) is bigger than the perceived risk they face (Kim and Prabhakar 2000).

Trust is a factor which has been previously studied in online shopping, e-governance of personal documents and mobile payments but its role in physical smart products has not been extensively researched (Bélanger and Carter 2008; Gefen et al. 2003; Srivastava et al. 2010). In many studies factors that influence product level buildup of trust have been only secondary considerations to other factors such as user-friendliness (Chen 2006).

However, Michler et al. (2020) were able to create synthesis of the existing trust building factors for smart products. They found and identified that *trust building factors of smart products* can be divided into seven groups. The more detailed notes of attributes that affect these different categories will be presented during the empirical part of this master's thesis.

The first recognized group of factors was about *control.* Generally, it is widely accepted that some sort of control over a product empowers users and thus, especially with smart products where decision-making is mostly assigned out of user's reach, a sense of disempowerment may appear, and negative consumer attitudes be born (Fasli 2007; Johnson et al. 2008).

Second group that was recognized deals with *transparency.* Wolverton et al. (2008) recognized that especially for smart products that rely on personal user information, high degree of autonomy and are based on new technology not yet completely understood by the user, providing additional information and transparency that create more understanding may be a driving factor for user adoption.

Third group consisted of attributes related to *security and protection.* In the Information Age security threats are a constant problem that products and services need to be prepared for. The emphasis when it comes to smart products is on prevention – meaning that trust is driven by the product's capability for early detection and prevention of potential security threats and protection of user's data (Beldad et al. 2010; Dahlberg et al. 2008)

Fourth group which is *product performance* is very much influenced by factors laid out in models that highlight the performance expectancy of a product. It has been researched that products which are performing well, and meeting user's expectations are rated more trustworthy than those which are not (Johnson et al. 2008). In this case, users evaluate both the actual *technical performance of* a product (perceived usefulness and value) but also the *performance promise* which stems from the company's marketing, sales, and communications. (Roselius 1971; Fasli 2007; Brush et al. 2011).

Product handling was identified as the fifth group and generally it is comprised of factors like *ease-of-use* and *usability* that have also been recognized by many technology diffusion and acceptance models.

Related to product performance but a completely independent sixth category is the *brand.* Although often seen as a component of marketing and sales, brand which can be defined as Batra et al. (2012) defined it "the totality of perceptions and feelings that consumers have about any item identified by a brand name, including its identity (e.g., its packaging and logos), quality and performance, familiarity, trust, perceptions about the emotions and values the brand symbolizes, and user imagery." also plays a significant role in creating trust for a product as it can influence both perceived product quality and even the performance of a product (Rio et. al 2001). It has been shown that consumers put a high emphasis on the product's brand – preferring branded rather than unbranded smart products (Truong et al. 2017; Zheng et al. 2018).

As the last and seventh category, Michler et al. (2020) recognized *onboarding and information* as a factor of building trust in smart products. Onboarding & information influence and build basis for other groups such as product performance and handling. Its effect can be seen as a proactive reducer of uncertainty and perceived risk that users might feel (Rogers 2003; Naor et al. 2015).

2.4.1 Trust as a Factor during the Product Development Phase of a New Product

As discussed earlier, ***testing*** is a crucial step in the new product development process, as it helps to ensure the quality and reliability of a product. In the early stages of development, testing is used to identify and fix problems, optimize performance, and validate design choices. As the product moves through the development process, more rigorous testing is required to verify that it meets all relevant standards and requirements. This can include functionality testing, compatibility testing, performance testing, and stress testing. Testing during product development and before releasing the product to the market is essential to identify any issues that may arise during use, such as bugs or performance degradation.

Consumer trust is an important factor to consider during the testing phase of a new product development process. Trust is defined as a "belief in the reliability, truth, ability, or strength of someone or something" (Fournier et al. 1998, p. 78). When it comes to products, trust can be developed through transparency and honesty about the product's features and benefits, as well as a brand's reputation and past performance (Fournier et al. 1998).

Consumers can be involved in the testing process through many ways. This can be done through focus groups, where a small group of consumers is asked to test and provide feedback on the product (Gwinner et al. 1998). Involving consumers in the testing process can help build trust, as it shows that the company values their input and is willing to listen to their feedback (Gwinner et al. 1998).

Another technique is to use unbiased third-party testers (Gwinner et al. 1998). This can include hiring a testing agency or using volunteer testers who are not affiliated with the company (Gwinner et al. 1998). Using unbiased testers can help build trust, as it provides an independent assessment of the product and reduces the potential for bias (Gwinner et al. 1998).

According to Peng and Finn (2008) the most important objective of testing is to develop the original idea even further. They incorporated an idea of *concept* testing that should take place within the very early phases of product development. In addition to idea development, other objectives in concept testing include estimating the concept's market potential, eliminating poor concepts, identifying the value of features and help identify the highest potential customer segment. With concept testing, consumer can be presented with a proposed product, and it can be used to measure their attitudes and intentions (Trott 2005).

Concept test is the first true consumer filter to be applied. Its benefits include cost-effectiveness and speed with which it can be used. It can be called the "quick and dirty" way of measuring consumer enthusiasm towards a product, and it should be deployed in the very early phases before investing more time and resources to further product development (Trott 2005). It can be likened to conventional market research where consumers are approached to see how they react to the product and whether they are interested in buying it. All that is needed is, for example, a description of the product, sketch, or picture (Trott 2005). Concept testing is especially useful when designing radical new innovations and products rather than incremental new products (Peng & Finn 2008)

The testing phase of the NPD process involves evaluating the product's functionality, reliability, usability, and performance. Testing can be done through laboratory experiments, surveys, focus groups, or field trials. During the testing phase, the product is evaluated against the company's specifications and the customer's needs and preferences.

Consumers' perception of testing is an essential factor in building trust in a new product. When consumers are aware that a company has conducted extensive testing on their product, they are more likely to trust the product's claims. In a study conducted by Czellar and Grohmann (2011), it was found that consumers' perceived quality of a product was positively influenced by the extent of testing conducted on the product.

Transparency in testing is crucial in building consumer trust. Consumers want to know how the product was tested, who conducted the testing, and what the results were. Companies that are transparent in their testing process are more likely to build trust with their consumers. In a study by Wang et al. (2019), it was found that transparency in testing positively influenced consumer trust in a product. Gwinner et al. (1998) also found that consumers are more likely to trust a company that is open and honest about its products and processes (Gwinner et al. 1998). This can include sharing information about the testing process, the results of the tests, and any potential risks or limitations of the product. Gwinner et al. (1998) also mentions several other factors affecting trust building which are:

- Honesty, as false claims, or oversell can damage trust and credibility (Gwinner et al. 1998)
- Communication as keeping consumers informed about the testing process and any updates or changes can help build trust. (Gwinner et al. 1998)
- Being responsive to consumer feedback and addressing any concerns or issues can also build trust, as it shows that the company values the opinions and experiences of its customers. (Gwinner et al. 1998)
- The reputation of the company can also impact consumer trust, with companies that have a history of producing high-quality products and being transparent and responsive more likely to build trust with consumers. This factor was also

mentioned by several other researchers (e.g., Grewal et al. 1998; McKnight et al. 2002)

Involving consumers in the testing phase can also help build trust in a new product. When consumers are involved in the testing process, they feel valued, and their opinions are considered. In a study by Kim et al. (2017), it was found that involving consumers in the product testing phase positively influenced consumer trust in the product.

In conclusion, consumer trust in a certain product is affected and developed during the testing phase of the NPD process. Consumers' perception of testing, transparency in testing, and involvement of consumers in testing are all crucial factors in building consumer trust. Companies that invest in testing and involve consumers in the testing process are more likely to build trust in their products. Building trust in a new product is essential for its success and can lead to long-term customer loyalty.

Therefore, it is important for companies to prioritize building trust with consumers during the testing phase to ensure the product's success upon launch.

2.5 Synthesis of the Literature Review

Based on the literature presented throughout this thesis, it is evident that the element of *trust* has not been extensively researched in the context of consumers adopting new smart health tech products. In addition, the literature shows that users should already be engaged much more in the developing phases of a new product to mitigate the risk of consumers not adopting or accepting the product. Thus, in this master’s thesis, the idea is to research how, and which elements of trust can already be built during the productization phase of a new product.

The question defined in the beginning of this master’s thesis was: *What are the questions and factors related to trust that consumers come up with during test phases of a new product?*

Customers' involvement and their input appear to be most important at the idea generation, design and testing phases (Alam and Perry 2002). Consumer trust is a crucial factor in the success of a new product development process (NPD). During the testing phase of a new product development process, consumer trust can play a crucial role in the success of the product. For example, if consumers do not trust a product, they may be less likely to purchase it or recommend it to others (Fournier et al. 1998).

Consumers are often hesitant to purchase new products because they are unsure of the product's quality, reliability, and effectiveness. Therefore, companies must invest in testing and validating their products before launching them to build consumer trust. This master's thesis will discuss how consumer trust in a certain product is affected and developed during the testing phase of the NPD process.

The literature shows several themes that contain trust building elements from the consumer view. These can be divided to two categories: trust building factors of the product which are then supported or undermined by trust building factors of the test process itself.

According to a study by Grewal et al. (1998), trust in a brand is positively related to consumers' intention to purchase a new product. In other words, the more trust consumers have in a brand, the more likely they are to purchase a new product from that brand. Consumers who trusted the brand and the technology were more likely to use the product and continue using it in the long term. Furthermore, trust can affect the way that consumers interpret and recall information about the product. A study by Lewicki and Bunker (1996) found that when consumers trusted the source of information, they were more likely to rely on that information and remember it accurately.

Brand trust is closely linked to *transparency* – as highlighted by Wolverton et al. (2008). Transparency can either be achieved generally via company communication, or during new product development process in two ways: providing additional information and transparency about the product itself and how it works or providing information about the actual test phase and new product development.

In their *Unified Technology Acceptance and Use of Technology* model, Venkatesh et al. (2003) recognized product-related factors that improve the acceptance of user adoption; these factors included *performance expectancy, effort expectancy, social influence and facilitating conditions.* The first two were internal factors. *Performance expectancy* dealt with how much the users expected the new product help them in their task. *Effort expectancy* was all about the *ease of use* while *social influence* and *facilitating conditions* brought in the supporting external factors like peers and infrastructure. The effect of these factors depended on four factors which were *age, gender, experience, and voluntariness of use* (Venkatesh et al. 2003).

Thus, we can conclude that there are several different factors that build trust which are either related to the product itself, the product development process or the company. These factors are then either boosted or decreased by several user-related factors such as age, gender etc.

Michler et al. (2020) created the synthesis of the existing trust building factors for smart products. These *trust building factors of smart products* were divided into seven groups of which the trust in a brand was a factor already recognized.

The first recognized group was about *control,* and it is linked to product features (performance/effort expectancy of UTAUT model). It included features such as permission management and user control over the product. (Michler et al. 2020)

Second group was *transparency.* In product related features, this group deals with **how openly the company shows** how user's data is being handled (Michler et al. 2020). In general terms, transparency and involving consumers in the testing process can also help build trust, as it shows that the company values their input and is willing to listen to their feedback (Gwinner et al., 1998).

Third group consisted of attributes related to *security and protection* (Michler et al. 2020). In this group the emphasis is on how **securely and responsibly** user's data is being handled– meaning that trust is driven by the product's capability for early detection and prevention of potential security threats and protection of user's data (Beldad et al. 2010; Dahlberg et al. 2008)

Groups four and five *(product performance and product handling)* are directly linked to Venkatesh et al's (2003) UTAUT model (Michler et al. 2020). Here, users evaluate both the actual *technical performance of* a product (perceived usefulness and value, ease-of-use, usability) but also the *performance promise* which stems from the company's marketing, sales, and communications. (Roselius 1971; Fasli 2007; Brush et al. 2011).

It could be said that the seventh and final category, which Michler et al (2020) recognized, *onboarding and information* is an extension to all product related categories. Onboarding & information influence are built on and build for other groups such as product performance and handling and how users perceive them. Its effect can be seen as a proactive reducer of uncertainty and perceived risk that users might feel at the very beginning of using a new product (Rogers 2003; Naor et al. 2015).

*Figure 7: Trust building factors in smart products – modified from Michler et al. (2020). *-sign means that the factor has been investigated at least for one of the smart product categories of smart homes, mobility, or entertainment and communication.*

This framework visualized above by Michler et al. (2020) will act as the basis and research framework for the empirical research in this study. In addition, background information about the participants will be collected (factors like age, gender, experience, and voluntariness of use recognized by Venkatesh et al. 2003) to give a fuller picture of the factors that are affecting the answers in the study.

3. RESEARCH PROCESS

The idea of this master's thesis is to research how, and which elements of trust can already be built during the test phase of a new product. This section discusses how the empirical research process is built. Firstly, the research design will be presented, secondly the case context and company introduction will be given (section 3.2), and lastly methodologies used in collecting and analyzing the data for the study (sections 3.3 and 3.4) will be described in more detail.

3.1 Research Design

Single-case study was chosen as the method to conduct this empirical research. The benefits of a single-case study approach can especially be emphasized in studies that have a qualitative focus – e.g., answering "how" and "why" questions – in a real-world context or are linked to a contemporary phenomenon (Yin 2014). Since the aim of this master's thesis research is to find out how a theoretical framework works in a real-life setting and build understanding about its further applications, a single-case study about a company, which is in the exact state of the framework, is the best the choice.

3.2 Research Method

In August 2022, the actual physical product and application were at a point where they could be subjected to a consumer test. The consumer test was organized in two parts: firstly, a full-scale usability test was planned to go through the features and usability of both the application and the new mouthpiece. This test was conducted by the software development company that WellO2 worked with. Secondly, all participants were provided a questionnaire that would specifically collect data about how trustworthy the new product was. This questionnaire was conducted by the writer of this master's thesis.

The usability test was divided into five sections which were:

1. Getting to know the smart mouthpiece: how to attach it, how different it felt compared to a normal mouthpiece etc.
2. Getting to know the application: a general overview of the contents, is it understandable, how to pair the mouthpiece with Bluetooth etc.
3. Completing the breathing test: whether the instructions are clear, are the scores understandable etc.
4. Completing a breathing exercise
5. General feelings about the product and the applications, feedback, and possible recommendations

After completing the usability tests, participants were provided with the questionnaire that was designed as part of this master's thesis. The questionnaire had eleven sections in total, starting first with collecting background info about the participants and then continuing with questions that were arranged under themes presented in Michler et al. (2020) synthesis. The section themes were (in their order of appearance):

1. Control (How permissions & rights work and are granted while using the product?)
2. Transparency (How data collection and access to personal data is managed?)
3. Security and Protection (How the product protects user data?)
4. Product performance (Does the product perform as expected?)
5. Product handling (Usability of the product)
6. Brand (Is the product aligned with the company's brand?)
7. Onboarding & information (How easy is it to start using the product?)

The last few questions after this seven-point list were framed to find out the respondents' buying intentions. This was used as an alternative measure of trust in the product. The questions were statements where the participants had to evaluate how much they agreed or disagreed with them. In the end, two open ended questions were provided for comments. The results were measured on a Likert scale from 1 (completely disagree) to 5 (completely agree). In addition, two additional open-ended questions were provided to capture comments and thoughts from the respondents. The full questionnaire with a list of questions can be found in the appendices. The combination of a quantitative Likert method and qualitative open-ended questions makes it possible to draw both statistical conclusions but also understand what the users think.

Comparing WellO2's situation with the NPD models of Cooper (1990), Ulrich and Eppinger (2000) and Trott (2005), it could be said that WellO2 is placed mostly in the testing/refinement phase (Ulrich and Eppinger, 2000) and testing and validation gate (Cooper 1990) but is still overall in larger the product development/commercialization phase (Trott 2005). This means that the product specifications are mostly in place and product will be commercialized but before launching the product to the markets, changes can still be done to ensure customer satisfaction.

In total, there were 7 users from various backgrounds who participated in the testing phase of this new product.

3.2.1 Analyzing the data

Statistical analysis was conducted using IBM SPSS Statistics 27. The program was used to calculate averages, medians, and standard deviations for the questions and topics collected during the research phase. To test the correlation between topics and individual questions, Spearman's Rho correlation test was employed. Since ordinal variables do not meet the criteria of normal distribution and continuity, and sometimes contain a large number of abnormal observations, the assumption of normal distribution may not hold. In such cases, a non-parametric Spearman's correlation coefficient is designed for ordinal variables.

Spearman's correlation coefficient is based on ordinal numbers, and a positive correlation coefficient indicates that the variables' values are ranked in the same direction, while a negative coefficient indicates that the variables' values are ranked in opposite directions. A correlation coefficient of 1 describes full parallelism of the ordinal numbers, while a correlation coefficient of -1 indicates full dissimilarity. If there is no connection between the ordinal numbers, the Spearman's correlation coefficient is zero. (Kestilä-Kekkonen, 2023).

The outcome of each statistical test is determined by the p-value, which represents the probability of an incorrect conclusion. When the p-value is less than 0.05, the result is typically considered "almost significant." If the p-value is less than 0.01, the result is deemed "significant," and if it is less than 0.001, it is considered "highly significant." In tables, an "almost significant" result is often denoted with one star (*), a "significant" result with two (**), and a "highly significant" result with three stars (***). (Kestilä-Kekkonen, 2023).

The correlation coefficient can range from -1 to 1, with larger absolute values indicating a stronger dependence between the variables, and values closer to zero indicating weaker dependence. The negativity or positivity of the coefficient indicates the direction of the dependence. To aid interpretation of the result, reference values for the absolute value of the correlation coefficient have been established. For instance, the following classification can be used to evaluate the strength of the correlation (Duodecim, 2023):

- Less than 0.40 indicates a weak correlation
- Between 0.40 and 0.60 indicates a moderate correlation
- Between 0.60 and 0.80 indicates a strong correlation
- Greater than 0.80 indicates a very strong correlation.

3.3. Research Context

The empirical part in this master's thesis will study the product development process of a Finnish health technology company, WellO2. WellO2 entered consumer markets in 2017 and is currently generating over 3 million euros in sales per year and employs 11 people. Therefore, it could be classified as a small company which according to the EU Commission Recommendation (2003) is defined as a company which employs up to 49 people, is generating less than 10 million euros in revenue or has a balance sheet total less than 10 million euros.

The company manufactures a wellbeing product, a breathing trainer, also called WellO2, which is sold to consumers globally. WellO2 is an invention-based product which combines steam breathing and resistance training to strengthen the user's lungs. The product has gone through clinical studies where its effect on treatment of asthma, voice disorders, oxygen intake, COPD and sleep apnea has been researched. The results of the clinical asthma study published in September 2022 showed that by using WellO2 for 15 minutes a day strengthened patients' respiratory muscles by 12-20 percent in just four weeks (WellO2 and European Respiratory Society 2022).

The company started to develop a new smart product for consumer markets at the end of 2021. WellO2 MyBreath is a new extension to the original product. It is a smart mouthpiece which is fitted with sensors that can measure and analyze user's breathing and lung functions with hospital-level accuracy. Lung functions that can be measured include e.g., spirometry, PEF and PIF (Peak Expiratory and Inspiratory Flow), MEP and MIP (Maximum Expiratory and Inspiratory Pressure) and they are used to analyze the state of patient's lungs and breathing. The mouthpiece is connected to a mobile application which stores and analyzes the user data, connects it with other health applications (like GoogleFit and Apple Health) and turns it into recommendations which are exercise programs that fit user's needs and fitness level.

3.4 Data

In the survey, the questions were categorized into nine distinct areas, labeled as A1 to A9 (Table 1). For a more comprehensive list of the questions pertaining to each subject area, please refer to Appendix 1.

Table 2. Theme areas of trust building factors in the real-life research setting

Subject area	Entry
Application permission requests	A1
Application data collection	A2
Application security and protection	A3

Functionality of the application	A4
Function of the mouthpiece	A5
Usability of the application	A6
Functionality of the mouthpiece	A7
Introduction	A8
Brand	A9

3.4.1 Background of Respondents

The survey was completed by seven individuals, consisting of four men and three women, all between the ages of 30 to 64. All respondents expressed interest in utilizing a new smart product that could measure and track body functions daily. Additionally, each respondent reported currently using a smart product, with two using an activity bracelet and five using a smartwatch. The respondents reported using smart products for up to 15 years on a daily basis. While all respondents were generally physically active, one individual stated that they were currently not very active. The level of physical activity was further described as follows:

"I participate in marathons occasionally, but that's about it."

"I aim to run for at least three days every week, usually for an hour, and one two-hour run per week." "I am highly active and move with a sense of purpose."

"I consider myself to be more active than others my age." "I would say I'm about average in terms of physical activity."

"I exercise between one to three times per week, and I do a lot of useful activities in the summer."

"At present, I am not very active and mostly go for walks zero to three times per week."

3.4.2 Average, Median, and Standard Deviation (SD) of Questions and Topics

Appendices 2 and 3 provide tables displaying the individual averages, medians, and standard deviations of each question, as well as the subject areas. The tables demonstrate that, based on the averages, respondents completely agreed with questions about the company's brand, such as *"I think the mouthpiece and application represent WellO2's values well (reliable, caring, inspiring)"* (k32), *"I think the mouthpiece and application are in line with the WellO2 brand"* (k33), and *"I feel that WellO2's brand appeals to me"* (k34)**.** In contrast, respondents partially agreed with 16 questions (k1, k2, k9, k13, k14, k18, k20, k21, k22, k25, k26, k27, k28, k29, k31, k35)**.** Notably, the answers to questions such as *"I think the mouthpiece is easy to use"* and *"I feel I understand what the mouthpiece and application do and why they exist"* varied widely (SD 1.574 and 1.528). For 18 questions, respondents neither agreed nor disagreed (k3, k4, k5, k6, k7, k8, k10, k11, k12, k15, k16, k17, k19, k23, k24, k30, k36, k37). The answers to questions such as *"I think the application offers enough different features", "I feel that I can use the application as it is intended to be used",* and *"I feel that I would be ready to BUY the mouthpiece and the application at the suggested retail price"* were also widely varied (SD 1.813, 1.512, and 1.574).

The questions were categorized into different subject areas and their corresponding averages, medians, and standard deviations were calculated (see Appendix 3). The respondents fully agreed with all statements in topic area nine (with a total average score of 4.571), which pertained to the brand. Notably, the standard deviation for this topic was very low (SD 0.535), indicating a high level of agreement among the respondents. For topics 4-8, respondents partially agreed with the statements**, with topic eight (onboarding) showing the highest level of disagreement (SD 1.345).** In topics 1-3, the respondents neither agreed nor disagreed with the statements. However, the standard deviations for these topics were also low (SD 0.756, 0.900, and 0.951, respectively), indicating a relatively high level of agreement among the respondents regarding usage permission requests, data collection and security, and protection.

3.4.3 Correlation

To investigate the correlation between topics and willingness to buy, Spearman's Rho correlation test was conducted. *The analysis revealed that topic five (functionality of the mouthpiece) showed a positive correlation and was statistically almost significant (0.805; $p<0.05$) (see Appendix 4). Topic 4 (functionality of the application) also had a positive correlation with almost statistical significance (0.715; $p<0.071$) (see Appendix 4).* **However, no correlation was observed between the willingness to buy and other** topics.

Moreover, the correlation between individual questions was examined to identify any correlations that could influence satisfaction and expectations and be utilized in future device development. A highly significant positive correlation between questions k19 *"The application met my expectations and using it would bring me added value/benefit"* and k25 *"I think the application is well designed"* (0.953; $p<0.001$) (see Appendix 4) was found. This shows that well-designed and working product features and usability are positively correlating with how satisfied customers are with the product. Vice versa, satisfied customers usually feel that the product works and is well-designed.

An almost significant positive correlation was also observed between questions k35 *"I feel that I would be interested in using the application and mouthpiece daily in my own life"* and k37 *"I feel that I would be ready to BUY the mouthpiece and application at the suggested retail price"* (0.761; $p<0.047$) (see Appendix 4). This signifies that interest in the product and its features are linked with the intention of buying and vice versa. Also, an almost significant positive correlation was found with questions k8 *"I think the application clearly tells what kind of data it collects about me"* and k19 *"The application met my expectations and using it would bring me added value/benefit"* with a correlation of (0.791, $p<0.034$) (see Appendix 4). This is an interesting finding since it shows that privacy and data collection is viewed as a significant factor that creates satisfaction by customers or that satisfied customers feel that the product handles their data well.

3.4.4 Open Questions

In response to the open-ended questions, five respondents described the price of the mouthpiece and application as expensive, while one respondent found it reasonable. The majority of the respondents expressed a desire for versatility and operational reliability in the product. They stated that they would be disappointed if they purchased the product at the current price of 149 €. One respondent did not find the price to be high. The respondents' feedback on the price of the product is summarized as follows:

"Taking care of your health is like making a long-term investment. You won't feel the impact of the money you put in right away, but it will pay off in the long run!"

"The device seems reasonably priced, but it's important to communicate the added value it brings to consumers."

"I don't want to comment on the mouthpiece itself, but I do think the application is not worth the current price. I would feel like I was ripped off if I purchased it."

"The current features of the application don't justify the high price tag. We need a device that is versatile and reliable."

"I feel like the price is a bit steep."

"I haven't come across any similar devices, so the lack of competition makes the price seem reasonable. It might be worth offering a discounted bundle for customers who purchase the WellO2 device, smart mouthpiece, and App together."

All the respondents expressed their interest in using the mouthpiece and application on a daily basis. More precisely, the idea of daily use & training was described as a good idea and a motivator for health. The comments provided by the respondents have been presented along with the corresponding Likert scale rating in parentheses.

"It adds value to my life, and I believe it can help me stay healthy." (Likert scale value: 5)

"I'm already a daily user of the original product and have got lots of benefits from using it. However, I haven't used the new mouthpiece enough to see the benefits, but I'm open to the idea." (Likert scale value: 4)

"I think it's a good concept and the data it provides is helpful." (Likert scale value: 4)

"It's exciting to be able to track my own progress and see how I improve." (Likert scale value: 5)

"As someone with asthma, I'm always looking for drug-free options to improve my health. I'm interested in seeing how this works for me." (Likert scale value: 5)

"I did the onboarding test recently and using the WellO2 has become more interesting with the smart mouthpiece. The app gives me more detailed information and instructions, which motivates me to exercise more." (Likert scale value: 5)

The respondents were asked to rate the price of the mouthpiece and application using a Likert scale for a second time and were given the opportunity to provide a verbal justification for their answer. In their verbal responses, they expressed a desire for more detailed explanations of how the exercises benefit health and reiterated that even the price of the original WellO2 (229€ in retail) is still perceived as expensive. The verbal answers were similar to those given in response to the previous question. The numerical Likert scale value given by each respondent is indicated in parentheses, followed by a brief description of their response.

"I believe that investing in quality is always worth it." (5)

"I would love to see more information on how the exercises in the app can benefit my everyday well-being and how to properly do them before considering purchasing the mouthpiece." (3)

"The current (trial?) version of the app doesn't justify the high price for me." (1)

"I'd be disappointed if I paid the current price for the product without getting more value from it." (3)

"I think the price is steep, and my friends share the same opinion about WellO2's pricing." (4)

"If the mouthpiece lasts at least three years, then the yearly cost would be reasonable at €50. That's how I see it." (5)

The final open-ended question inquired about the respondents' readiness to purchase the mouthpiece and application at the suggested retail price based on their experience. Responses were mixed, with some indicating their readiness to purchase the product while others required further persuasion. Several respondents expressed that the product needed further development, particularly in terms of versatility, and noted that the appearance of the product looked cheap. (Likert scale values and additional details were provided for each response)

"I don't have any additional comments at this time." (5)

"I would like to see more information about how the product can benefit me before making a decision." (3)

"I think the mouthpiece looks too simple and doesn't seem like a high-tech device. Also, the app looks confusing and cheap." (1)

"The app needs more features and flexibility. It would be great if it could show my breathing data during exercises on a smart device screen. That would definitely make it a 5/5." (2)

"My decision to buy would depend on my current financial situation." (4)

"If there was a bundle offer for both the WellO2 device and smart mouthpiece, I would definitely consider it before making a purchase." (4)

The oldest respondent was 64 years old, so age can indeed play a role in the results.

3.5 Deciphering data

3.5.1 Respondents' Background

If we start to dissect the results of the survey section by section, the first notable factor could be drawn from the background of the respondents. Just as Venkatesh et al. (2003) noted the four background factors (age, gender, experience, and voluntariness of use) affect different constructs of the technology acceptance model, which tries to explain whether users accept or reject new products and technology. *Age* was linked to all four constructs. *Gender* was found to influence effort expectancy, performance expectancy and social influence. *Experience* had a moderate effect on the relationship between effort expectancy, social influence and facilitating conditions. Lastly, *voluntariness of use* only affected the relationship between social influence and behavioral intention (Venkatesh et al., 2003).

From the background information we can determine that the respondents were between the ages of 30 to 64 and the gender distribution was almost 50-50 with 4 men and 3 women. We can argue that the age distribution was almost somewhere in the middle but lacked the perspective of the younger Generation Z (18–30-year-olds) which has grown with smart products. Age can thus play a role in the respondents' answers.

3.5.2 Readiness to Use New Technology

All respondents expressed interest in utilizing a new smart product that could measure and track body functions on a daily basis and they all reported currently using a smart product, with two using an activity bracelet and five using a smartwatch. This means that the respondents demonstrated a very high level of experience and voluntariness of use – both of which facilitate technology acceptance – no matter the background or age. It can also be theorized that the high activity levels respondents showed are linked to Venkatesh et al (2003) *performance expectancy* (i.e., how helpful the product is in helping users achieve their task).

3.5.3 Company Brand

It should also be noted that respondents nearly unanimously agreed with the company's brand description and how it was linked to the new product. Based on the averages, respondents completely agreed with questions about the company's brand, such as *"I think the mouthpiece and application represent WellO2's values well (reliable, caring, inspiring)" (k32),* and *"I think the mouthpiece and application are in line with the WellO2 brand" (k33), and "I feel that WellO2's brand appeals to me" (k34).*

Furthermore, trust can affect the way that consumers interpret and recall information about the product. As Rio et al (2001) noted, a positive brand image can influence both perceived product quality and even the performance of a product (Rio et. al 2001). All the previously mentioned factors had at least given some positive starting points for WellO2's new product – affecting both the perceived product quality and product performance.

3.5.4 Product Performance and Features

When it comes to the factors which are tightly linked to the new product and its features, variation starts to appear. Respondents partially agreed with the statements in topics 4-8 (all of which were related to the usability and functionality of the product itself) with topic eight (onboarding) having the highest level of disagreement (SD 1.345). This shows right away that onboarding was neither fully satisfactory nor did it provide enough information for the users. It could be said however, that even moderate agreement in the usability and functionality themes provides a good basis for the product as these topics are also present in vast majority of technology acceptance models. However, standard deviation was highest in topics 4 and 6 (1,215 and 1,134 respectively) which were related to the application while in topics 5 and 7 SD was lower (0,976 and 0,787) meaning that respondents rated the mouthpiece's functionality and usability higher than the mobile application. This means that the application needs more development work.

Topics 1-3 (permission requests, data collection, security, and control) however, showed neither agreement nor disagreement and the standard deviations for these topics were also low (SD 0.756, 0.900, and 0.951, respectively), indicating a relatively high level of agreement among the respondents regarding usage permission requests, data collection and security, and protection. The reason for this might be because the application and mouthpiece were in early development and testing, data and security questions were not yet completely ready. This was also noted by one respondent (*"I couldn't accurately answer to data collection and security related questions because they weren't so clear)*. It would be interesting to replicate this question in the latter stages of development since earlier an almost significant positive correlation was found with questions k8 *"I think the application clearly tells what kind of data it collects about me"* and k19 *"The application met my expectations and using it would bring me added value/benefit"* with a correlation of (0.791, $p<0.034$) (see Appendix 4) which clearly tells that data factors are influencing the way consumers feel about the product.

However, when looking at individual questions answers varied widely. Questions such as *"I think the mouthpiece is easy to use (k26)"* and *"I feel I understand what the mouthpiece and application do and why they exist (k31)"* varied widely (SD 1.574 and 1.528) and so did answers to questions such as *"I think the application offers enough different features (k23)" "I feel that I can use the application as it is intended to be used (k24)"* and "*I feel that I would be ready to BUY the mouthpiece and the application at the suggested retail price (k37)"* (SD 1.813, 1.512, and 1.574). Notably, even though the means for all the questions related to application and mouthpiece usability and functionality scored well over 3 out of 5, the mean for buying intention dropped below average at 2,857. For 18 questions, respondents neither agreed nor disagreed (k3, k4, k5, k6, k7, k8, k10, k11, k12, k15, k16, k17, k19, k23, k24, k30, k36, k37). These questions were from all topics.

3.5.5 Correlation with the Intent of Buying

Correlation test provided interesting results. The analysis revealed that topic five (functionality of the mouthpiece) showed a positive correlation and was statistically almost significant (0.805; $p<0.05$) (see Appendix 4). Topic 4 (functionality of the application) also had a positive correlation with almost statistical significance (0.715; $p<0.071$) (see Appendix 4). This makes sense and is very much in line with what all the major technology acceptance models propose – that is the factors of *performance expectancy ("the degree to which an individual believes that using the system will help him or her to attain gains in job performance)"* (Venkatesh et al., 2003) and *effort expectancy ("the degree of ease associated with the use of the system*") proposed by Venkatesh et al. (2016). It seems that good usability and functionality extend from just technology adoption to creating willingness to buy the product.

However, no correlation was observed between willingness to buy and other topics. It means that other factors like brand, which was proposed by Grewal et al. (1998) to be positively related to consumers' intention to purchase a new product, did not play a role in this research. At the same time, in the framework of Michler et al. (2020) security, data control and data permission related questions seem to play much smaller role compared to the traditional usability and functionality related ones when it comes to predicting users' buying intentions. This, however, might be due to the incomplete data protocols of the product in question.

Technology acceptance models are also supported by the findings of correlation between individual questions. This was shown when a highly significant positive correlation between questions (k19) "*The application met my expectations and using it would bring me added value/benefit*" and (k25) "*I think the application is well designed"* (0.953; $p<0.001$) (see Appendix 4) was found. Again, the most fundamental factors of technology acceptance models (usability, functionality, and user value) seem to be correlating with each other. It should also be noted that when users felt that they would be "*interested in using the application and mouthpiece daily"* (k35) it correlated with the willingness to buy the product (*k37) "I feel that I would be ready to BUY the mouthpiece and application at the suggested retail price*" (0.761; $p<0.047$) (see Appendix 4). Even though data protection related questions did not show up earlier there was a correlation between data collection and meeting expectations (k8) *"I think the application clearly tells what kind of data it collects about me"* and (k19) *"The application met my expectations and using it would bring me added value/benefit"* with a correlation of (0.791, $p<0.034$) (see Appendix 4). It could be theorized that positive experience from functionality and usability also correlate with performance expectancy.

3.6. Synthesis from Study

In the beginning of this thesis, the second research question set out to seek whether the research literature framework is supported by real-life evidence and what factors affect the trust-building process of a new smart health tech product. The literature firstly concluded that several different factors could build trust in a new product. In total, trust could emerge in three different categories – they are factors associated to the 1) company behind the product, 2) product development/test process or 3) product itself. The impact of the factors can then either be boosted or decreased by several user-related factors such as age, gender, readiness to use new technologies etc.

The research framework by Michler et al. (2020) contained seven different themes which were *control, transparency, security & protection, product performance, product handling, brand,* and *onboarding & information*. The objective of the real-life setting study was to comprehensively examine the tester group's feedback on the new product and its application and validate the findings of the literary framework. There were nine topics and 37 questions in total, but only seven respondents in the test group.

Firstly, the main trust building factor from category 1 (trust building factors related to the company) was the company's brand. The results indicated that the brand was a topic on which the respondents strongly agreed with (see Appendix x). According to the respondents, WellO2's brand was perceived as good, and the development of the application and the mouthpiece seemed to align well with WellO2's values. However, the brand **did not correlate** with *willingness to buy,* suggesting that other factors influenced the respondents' purchase decision. *This goes against* what Grewal et al. (1998) proposed which is that the brand was positively related to consumers' intention to purchase a new product. However, positive brand image might have influenced both perceived product quality and even the performance of the product (Rio et. al 2001) encouraging users' willingness to **use** the product. However, there's a distinct difference between buying and using a product. If the company's image was not so good as it was in this research, it might have influenced the answers negatively.

Secondly, when discussing category 2 (trust building factors related to the product development process), no clear results can be drawn from this thesis since the product development process itself was not reviewed. However, as was shown by Wang et al. (2019) **transparency** in testing and product development is crucial in building consumer trust. Consumers want to know honest information about the product itself, how the product was tested, who conducted the testing, and what the results were. Thus, companies that are transparent in their testing process are more likely to build trust with their consumers. This could be seen with one of the open-ended answers provided by the test user when they said: *"I would love to see more information on how the exercises in the app can benefit my everyday well-being and how to properly do them before considering purchasing the mouthpiece." (3)*

Thirdly, when it comes to category 3 (the product itself) and the themes related to it, it is the basics that matter. For example, a highly significant positive correlation between questions k19 *"The application met my expectations and using it would bring me added value/benefit"* and k25 *"I think the application is well designed"* (0.953; $p<0.001$) (see Appendix 4) was found. This shows that well-designed and well-working product features and usability factors are positively correlating with how satisfied customers are with the product. Vice versa, customers who feel that their expectations were met usually feel that the product works and is well-designed. It should also be noted that not everything needs to be tested right away. Just like in this research, even though data and security question did not seem to matter so much to most of the respondents, they are themes that do matter later when the product enters everyday use. This was shown with an almost significant positive correlation with questions k8 *"I think the application clearly tells what kind of data it collects about me"* and k19 *"The application met my expectations and using it would bring me added value/benefit"* with a correlation of (0.791, $p<0.034$) (see Appendix 4). This shows that privacy and data collection is viewed as a significant factor that creates satisfaction by customers or that satisfied customers feel that the product handles their data well.

Finally, if willingness to buy is used as the ultimate sign of trust in a product which is still in the development/testing phase, then sticking to the basics is the key to success. In this study, the factors that built consumers trust the most were *functionality and usability of the new product.* This is very much in line with many of the technology acceptance models (e.g. Davis 1989; Venkatesh et al. 2003). However, a distinction should be made between *willingness to buy* and *willingness to use* a product. In this research, willingness to use a product scored extremely high scores (mean 4,429, Median 5 and very low SD 0,787) but when the product's proposed price was introduced and the respondents were asked whether they would be willing to buy the product, scores plummeted (Mean 2,857, Median 3, SD 1,574). The analysis in this thesis revealed that topic five *(functionality of the mouthpiece*) showed a positive correlation with willingness to buy and was statistically almost significant (0.805; $p<0.05$) (see Appendix 4). Also, topic 4 *(functionality of the application)* had a positive correlation with almost statistical significance (0.715; $p<0.071$) (see Appendix 4). However, **no correlation** was observed between willingness to buy and any other topics in the research framework. It should also be noted that if users felt that they would be "*interested in using the application and mouthpiece daily"* (k35) it correlated with the willingness to buy the product (*k37) "I feel that I would be ready to BUY the mouthpiece and application at the suggested retail price*" (0.761; $p<0.047$) (see Appendix 4).

4. RESULTS

The goal of this thesis was to firstly find out if the existing research literature recognized factors that build trust in a new product. A literary framework was then formed to test whether these factors would also be supported by real-life evidence. The short answer to whether consumers value trust as an important factor when making decisions to buy or use a product is a resounding “yes”. The literary analysis showed that consumer trust is a crucial factor in determining the success of a NPD process and during product test phase it can play a crucial role in the eventual commercial success of the product. For example, if consumers do not trust a product, they may be less likely to purchase it or recommend it to others (Fournier et al. 1998).

In total, trust could emerge in three different categories – they are factors associated to the 1) company behind the product, 2) product development/test process or 3) product itself. In this thesis, most of the factors recognized were related to the product itself as the final research structure was heavily influenced by the model created by Michler et al. (2020) model which itself was based on several technology acceptance models such as Venkatesh et al. (2003). It could also be said that category 2’s recognized trust building factor, *transparency,* was also heavily involved in the process though the process itself was not the focus of the research.

The objective of the real-life setting study was to comprehensively examine the test group's feedback on the new product and its application and validate the findings of the literary framework. There were nine topics and 37 questions in total, but only seven respondents in the test group. The small sample size has a significant impact on the performance of statistical tests in the set of questions. Hence, caution must be taken while interpreting statistical test results. The significance test's outcome depends on the number of observations and the correlation coefficient obtained. A small p-value does not necessarily imply a strong dependence between variables. Conversely, a weak correlation coefficient can be statistically significant if there are enough observations. (Duodecim, 2023)

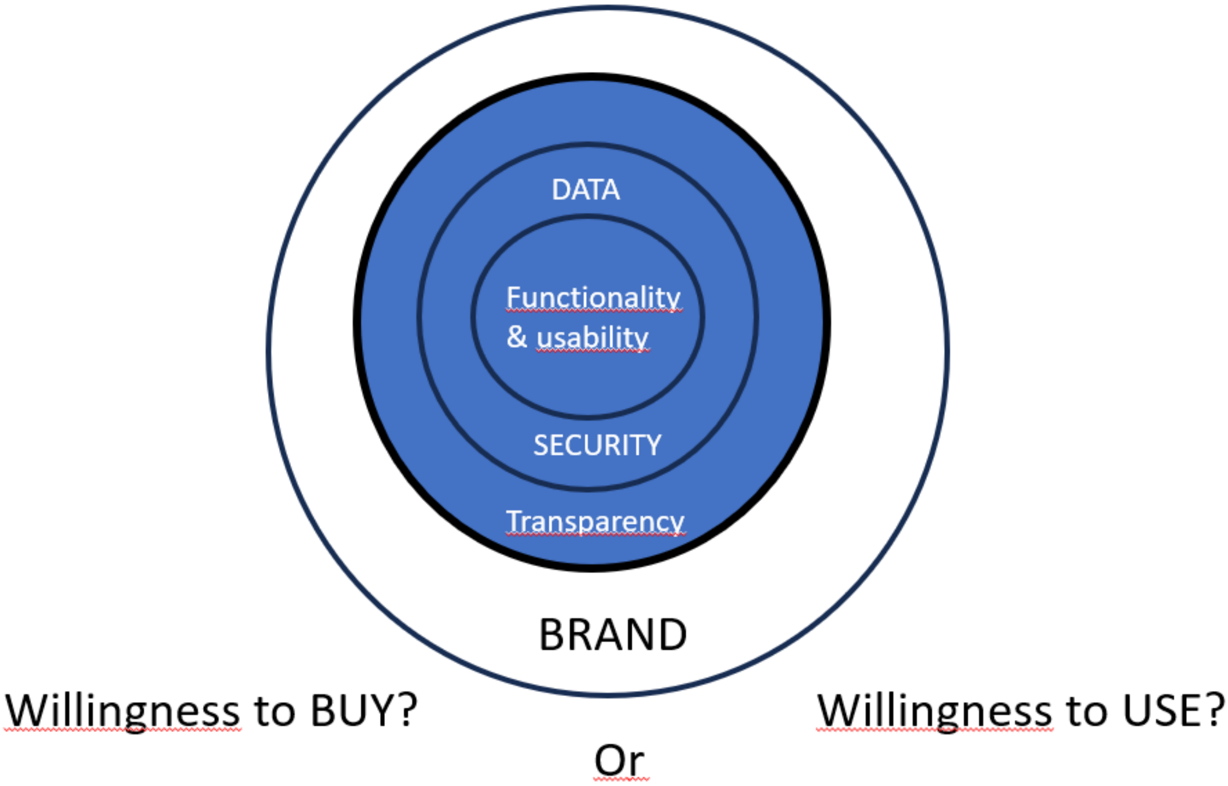

Figure 8: Trust affecting factors in a new smart health tech product

The results and findings are summarized in the picture above and they are:

The underlying question: willingness to *buy* or willingness to *use* a product?

1) Product topics / features in smart products that build trust
2) *Transparency* in the NPD and testing process
3) Brand factor

Firstly, before starting to peel the onion from layer by layer, the underlying question regarding trust in smart products needs to be addressed. In this study, a difference was noted between willingness to buy and willingness to use a product. Even though willingness to use a product naturally also builds the willingness to buy a product, factors like price do seem to change how consumers view the product. Thus, this is the *first improvement* that could be implemented in NPD models and product testing phases in the future for companies developing new smart products. When companies engage in user testing, it might be worthwhile to ask customers two questions: firstly, *Are you interested in using this product?* And secondly, *Are you interested in buying this product?* complemented with the product price info. This could yield extremely important information about the future success of the product on the market when a clear buy-or-no-signal from consumers is received and thus there will not be ambiguous information that does not serve the company. This question should be addressed before the product is launched to the market.

Secondly, it seems that company brand might have some effect on the opinions of consumers and the test phase results. The influence of brand was noted earlier by e.g., Grewal et al. (1998) and McKnight et al. (2002) who found that the reputation of the company can also impact consumer trust, with companies that have a history of producing high-quality products and being transparent and responsive are more likely to build trust with consumers. It can be said that having a good and known brand can have both a mitigating and deceiving effect on the results. Consumers forgive many things if the company's brand is well-positioned in their minds and thus even those products that do not live up to standards can still become successes as opposed those products of the same quality but with inferior brand. However, consumer forgiveness in the product development phase is not something that the company should rely on – the basis of usability and functionality is still the rock where all things are built upon.). Thus, the second improvement would be to add the brand factor in the consumer product test phase. In short, it might be worthwhile to conduct two separate consumer tests; one, where the brand is known and another, where the brand is hidden from respondents on purpose. This would let the product developers focus solely on product features, usability and functionality and only then account in the effect of the brand separately to see how much of the perceived product quality, performance and trust is generated by the company brand. In different NPD processes this brand-added A/B test could be for example set in the testing/refinement phase (Ulrich and Eppinger 2000) or testing and validation gate (Cooper 1990) or the product development/commercialization phase (Trott 2005).

Thirdly, transparency is a clear trust building factor for smart products. Consumers want information and they want to be treated honestly. Thus, the more information the better.

Consumers should be told how the product was tested, who conducted the testing, and what the results were. One way to add transparency in the NPD and test process could be done by following the list Gwinner et al. (1998) compiled. This would add three corner stones mentioned below to all company communications when talking about the new product to consumers testing it (Gwinner et al. 1998):

- *Honesty, no false claims, nor oversell which can damage trust and credibility.*
- *Communication as keeping consumers informed about the testing process and any updates or changes can help build trust.*
- *Being responsive to consumer feedback and addressing any concerns or issues can also build trust, as it shows that the company values the opinions and experiences of its customers.*

Involving consumers in the testing phase is also a transparency factor which can help build trust in a new product. When consumers are involved in an open and honest product development and testing process which they understand and where their opinions are considered, they feel valued and can thus increase the overall value of the product. Thus, including customers even in the early stages of product development builds more trust in the product.

Fourthly, when it comes to product-specific trust factors, two themes rose from the study: security & protection and functionality & usability. This shows two things; firstly, there was an almost significant positive correlation with questions k8 *"I think the application clearly tells what kind of data it collects about me"* and k19 *"The application met my expectations and using it would bring me added value/benefit"* with a correlation of (0.791, $p<0.034$) (see Appendix 4). This shows that security and data protection are viewed as a significant factor that creates satisfaction by customers or vice versa that satisfied customers feel that the product handles their data well. Thus, it seems that security and data protection related themes should be closely reviewed and monitored in detail during the product testing phase of a new smart product. Security and data protection have become more and more important to customers globally and thus, adding this perspective to NPD/testing process could prove beneficial to many companies designing smart products. In different NPD processes could be done by addressing the themes in the theoretical framework built by Michler et al. (2020).

Secondly, the factors that built consumers trust the most, were *functionality and usability of the new product* The analysis in this thesis revealed that only these two factors had positive correlation with the ultimate trust sign in the product - the willingness to buy it. Thus, when thinking about resources, investments, and design of the product development companies should stick to the basics. Investing and using time to create a product that works well should at the core of every company’s product development process. According to this research, functionality and usability should create the foundation for product testing and in the later phases, security and data handling related themes should be heavily emphasized.

5. CONCLUSION & DISCUSSION

5.1. Contribution of the Study

This thesis set out to explore what factors build consumer trust in a new, smart health tech product during the product development process and whether they are also supported by real-life evidence. Firstly, the current research literature identified that there are multiple factors that affect the adoption of new products by consumers when they enter the market – these range from personal factors to product features and company related factors (Davis 1989; Venkatesh et al. 2012). One of these key elements is trust which was defined as a "belief in the reliability, truth, ability, or strength of a product" (Fournier et al., 1998, p. 78).

Trust in turn, can be built from several different elements which were highlighted in the research framework created by Michler et al. (2020). These included for example product related factors such as usability, data protection etc. but also external factors such as company brand. This framework was put to test in a real-life company setting when researching the product development test process of a Finnish health tech company WellO2.

The study conducted in this thesis found evidence for some factors in the literature but contradicting information for others. The most often recognized factors such as usability and functionality of the product were found to be the most essential building blocks of trust. At the same time data & security features were confirmed to be important as well as transparency in the process and product. However, no significant correlation was found with other themes in the research framework. Also, company brand in this study was not found to be such an important factor as the research literature theorized.

With the evidence found in this study, improvements in the product development process were also presented. This included for example, the understanding of whether the product should be evaluated through the lens of willing to *use* it or *buy* it.

5.2 Evaluation of the Study

This research proved an insight into the NDP/testing process of smart products. However, the number of participants (7) and product development process cycles of the company (1) were far too small, which means that some conclusions can be made from the data, but they must be taken with a grain of salt. Statistical tests on a small group of respondents can provide some insight into what the data tells but the results are heavily influenced by the small number of data points. Thus, this study can draw some conclusions to what is crucial for the future development of smart products from the user experience point-of-view, but caution must be taken. In addition, user experience is a subjective perception that is greatly influenced by factors such as the user's familiarity with technology and other technological practices. For instance, a person's age can affect their technological skills, and technology may pose an everyday challenge for the elderly, rather than a benefit (Ympäristöhallinto 2023). In this study, all the participants were proficient in using technological products. Thus, in the future, the same research should be conducted with more participants and taking into account the age, gender and background factors. This is also an important factor to all companies testing and developing new products. Knowing your users and consumers is of paramount importance and it should also be visible already during the early stages of productization process all the way up to testing, launch and continual development of the product in the market.

5.3 Further Research and Development Needs

As the number of smart, data-based health tech products is vastly increasing, more research should be focused on the trust factors that consumers are thinking when adopting new products. The framework of Michler et al. (2020) should be subjected to even more rigorous research to find out how the other product related themes that did not seem to be so important in this study, are affecting trust creation with new smart health tech product. It would also be interesting to research more the ratio of information sharing – what is the sweet spot of how much the customers should know about the product and its development process. Does more information always create more trust or is there a point where information and transparency could create distrust? Also more customer-centric product development processes should be presented where customers are part of the company's product development process from the get-go. How to manage, design and operate these processes – especially in small companies and startups that are generating new innovations to the market more regularly than ever before – is of paramount importance.

Maybe this could be the time to go back in history. When Henry Ford once quipped "*If I had asked what customers wanted, they would have said faster horses",* it could now be a case of *"If we had asked what customers wanted, they would have had more trust in us"*.

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APPENDICES

Attachment 1. Questionnaire questions on a Likert scale. The topic in parentheses after the questions.

k1	In my opinion, the application offered an easy way to manage the user permissions needed by the application. (A1)
k2	In my opinion, the application's permission requests (e.g. permission to connect to a mouthpiece or use another application) were easily manageable and noticeable. (A1)
k3	In my opinion, the application enables the creation of different user profiles. (A1)
k4	In my opinion, the application enables the creation of different user profiles so that different user permissions can be assigned to the profiles. (A1)
k5	I think the application asks the user's permission to manage data often enough. (A1)
k6	I think the application clearly states how it COLLECTS data and information from the user. (A2)
k7	I think the application clearly states how it USES the data and information it collects. (A2)
k8	I think the application clearly states what kind of data it collects about me. (A2)

$k9$	In my opinion, you can clearly see third-party usage permissions in the application (third party rights, i.e. usage permission with your own activity bracelet). (A2)
$k10$	I found the collected data easy to find. (A2)
$k11$	In my opinion, the application's own decision-making/analysis method is easy to understand (i.e. what is the application's operating principle). (A2)
$k12$	I feel that the application protects my data against data breaches and other security threats. (A3)
$k13$	I feel that the application protects and encrypts the data it collects in accordance with the standards. (A3)
$k14$	I feel that the application anonymizes the data it collects in accordance with the standards (i.e. the data cannot be linked to a specific user). (A3)
$k15$	I feel that the application has strong enough authentication to view private data.
$k16$	I feel that the data collection location of the application is clearly stated. (A3)
$k17$	I feel that the application uses well-known and commonly used authentication and security certificates. (A3)
$k18$	I think the application works well technically and I could use it whenever I wanted to. (A4)
$k19$	The application met my expectations and using it would bring me added value/benefit. (A4)

$k20$	I think the mouthpiece works well technically and I could use it whenever I wanted to. (A5)
$k21$	The mouthpiece met my expectations and using it would bring me added value/benefit. (A5)
$k22$	I think the application is easy to use. (A6)
$k23$	I think the application offers enough different features. (A6)
$k24$	I feel that I can use the application as it is intended to be used. (A6)
$k25$	I think the application is well designed. (A6)
$k26$	I think the mouthpiece is easy to use. (A7)
$k27$	I think the mouthpiece offers enough different features. (A7)
$k28$	I think I can use the mouthpiece as it is intended to be used. (A7)
$k29$	I think the mouthpiece is well designed. (A7)
$k30$	In my opinion, the app provided clear instructions on how to turn on and use the mouthpiece. (A8)
$k31$	I think I understand what the mouthpiece and application do and why they exist. (A8)
$k32$	I think the mouthpiece and application represent well the values of WellO2 (reliable, caring, inspiring). (A9)
$k33$	I think the mouthpiece and application are in line with the WellO2 brand. (A9)

k34	I feel that the WellO2 brand appeals to me. (A9)
k35	I feel that I would be interested in using the application and the mouthpiece daily in my own life.
k36	I think the mouthpiece and application are worth the price (suggested retail price €149)
k37	I feel that I would be willing to BUY the mouthpiece and applique at the suggested retail price.

Appendix 2. Means, medians and standard deviations of the answers to the questions (n=7).

	Mean	*Median*	*SD*
k1	4	4	1
k2	3,857	4	1,069
k3	2,571	3	1,134
k4	2,714	3	1,254
k5	2,714	3	1,254
k6	3,429	4	0,787

$k7$	2,857	3	1,345
$k8$	3	3	1,155
$k9$	3,571	3	1,134
$k10$	2,857	3	1,345
$k11$	2,857	3	1,345
$k12$	3,143	3	1,069
$k13$	3,571	3	1,134
$k14$	3,571	3	1,134
$k15$	3,429	3	0,976
$k16$	3	3	1,291
$k17$	3,286	3	0,951
$k18$	4	4	1,155
$k19$	3,286	3	1,496
$k20$	4,143	5	1,215
$k21$	4,286	5	0,951
$k22$	4	5	1,414
$k23$	3,429	4	1,813

$k24$	3,429	4	1,512
$k25$	3,714	4	1,113
$k26$	4,143	5	1,574
$k27$	3,857	3	1,069
$k28$	4,427	5	0,976
$k29$	4,143	5	1,069
$k30$	3,286	4	1,380
$k31$	4	5	1,528
$k32$	4,857	5	0,378
$k33$	5	5	0
$k34$	5	5	0
$k35$	4,429	5	0,787
$k36$	3,429	3	1,397
$k37$	2,857	3	1,574

Appendix 3. Means, medians and standard deviations of the responses of the subjects (n=7).

	Mean	*Median*	*SD*
a1	3,286	3	0,756
a2	3,143	3	0,900
a3	3,286	3	0,951
a4	3,857	4	1,215
a5	4,429	5	0,976
a6	3,571	3	1,134
a7	4,429	5	0,787
a8	3,857	4	1,345
a9	4,571	5	0,535

Appendix 4. Correlations

Correlations

			PURCHASE	a5
Spearman's rho	PURCHASE	Correlation Coefficient	1,000	,805*
		Sig. (2-tailed)	.	,029
		N	7	7
	a5	Correlation Coefficient	,805*	1,000
		Sig. (2-tailed)	,029	.
		N	7	7

*. Correlation is significant at the 0.05 level (2-tailed).

Correlations

			PURCHASE	a4
Spearman's rho	PURCHASE	Correlation Coefficient	1,000	,715
		Sig. (2-tailed)	.	,071
		N	7	7
	a4	Correlation Coefficient	,715	1,000
		Sig. (2-tailed)	,071	.
		N	7	7

Correlations

			k25	k19
Spearman's rho	k25	Correlation Coefficient	1,000	,953***
		Sig. (2-tailed)	.	,001
		N	7	7
	k19	Correlation Coefficient	,953***	1,000
		Sig. (2-tailed)	,001	.
		N	7	7

***. Correlation is significant at the 0.001 level (2-tailed).

Correlations

			k35	k37
Spearman's rho	k35	Correlation Coefficient	1,000	,761*
		Sig. (2-tailed)	.	,047
		N	7	7
	k37	Correlation Coefficient	,761*	1,000
		Sig. (2-tailed)	,047	.
		N	7	7

*. Correlation is significant at the 0.05 level (2-tailed).

Correlations

			k19	k8
Spearman's rho	k19	Correlation Coefficient	1,000	,791*
		Sig. (2-tailed)	.	,034
		N	7	7
	k8	Correlation Coefficient	,791*	1,000
		Sig. (2-tailed)	,034	.
		N	7	7

*. Correlation is significant at the 0.05 level (2-tailed).