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ACCEPTANCE OF FRUGAL INNOVATIONS IN GERMANY – INFLUENCING FACTORS ON THE PURCHASE BEHAVIOR INTENTION FOR FRUGAL HOUSEHOLD APPLIANCES

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LIST OF ABBREVIATION

adj ..... adjusted
AT ..... attitude toward using
AVE ..... average variance extracted
B2B ..... business-to-business
B2C ..... business-to-customer
BC ..... perceived behavior control
BCa ..... bias-corrected and accelerated
BOP ..... bottom-of-the-pyramid
CB-SEM ..... covariance-based structural equation modeling
CR ..... convergent validity
DEG ..... degradation time
EA ..... environmental awareness
FA ..... financial advantage
HTMT ..... heterotrait-monotrait
LM ..... linear model
MV ..... mean value
OLS ..... ordinary least squares
PB ..... purchase behavior intention
PE ..... perceived ease of use
PLS ..... partial least squares
PLS-SEM ..... variance-based structural equation modeling
PU ..... perceived usefulness
PX ..... performance expectation
Q^2 ..... Stone-Geisser criterion
RMSE ..... root mean squared error
RSI ..... relative speed index
SCS ..... Status Consumption Scale

SEM ..... structural equation models
SI ..... sustainable innovativeness
SMART ..... sustaibale, modest, affordable, robust, targeted
SN ..... subjective norm
TAM ..... Technology Acceptance Model
TAM-2 ..... Technology Acceptance Model 2
TAM-3 ..... Technology Acceptance Model 3
TOP ..... top-of-the-pyramid
TPB ..... Theory of Planned Bahavior
TRA ..... Theory of Reasoned Action
UTAUT ..... United Theory of Acceptance and Use of Technology
UTAUT2 ..... United Theory of Acceptance and Use of Technology 2
VIF ..... variance inflation factor

1. INTRODUCTION

For several years, the topic of "frugal innovation" has been gaining prominence in the scientific and social (non-scientific) literature (Bound & Thornton, 2012; Radjou & Prabhu, 2015; Tiwari et al., 2014). For the majority, frugal innovation is associated with applications in bottom-of-the-pyramid (BOP) or emerging markets. These markets are characterized by large numbers of consumers, unmet needs, and limited resources (cf. Brem & Wolfram, 2014; Brueckner et al., 2010; Kuo & Ng, 2016; Schleinkofer et al., 2019; Tiwari et al., 2014; Tiwari & Herstatt, 2015; Tiwari & Prabhu, 2018; Zeschky et al., 2011). However, various research papers also show the increasing relevance of frugal innovation in developed and mature top-of-the-pyramid (TOP) countries. In addition to the sales potential in the growing markets of emerging countries, there is also a need in the markets of the developed countries themselves (Bhatti & Ventresca, 2013; Costa et al., 2021; Kroll et al., 2016; Tiwari & Kalogerakis, 2019; Winkler et al., 2020; Wohlfart et al., 2021). The European Commission has also perceived the presumed relevance for Europe and, consequently, has had various studies carried out. These studies indicate the importance of frugal innovations for companies based in Europe and their future significance (Kroll et al., 2016, 2017).

In terms of the concept of frugal innovation, resource scarcity is seen as an opportunity for demand-driven product development. Throughout the life cycle of a product (from production to use to disposal), as few resources as possible are used. Due to the relevance of the use of limited resources, frugal innovation is being increasingly practiced by scientists, political decision-makers, and European companies. The development of frugal innovations can be found in all sizes and types of companies. These include multinational corporations, social enterprises, start-ups, and individuals from both developed and developing countries (Radjou et al., 2012; Rao, 2013; Zeschky et al.,

2011). On the consumer side in the TOP countries and industrialized nations, various developments in recent years mean that the potential demand for frugal innovations could increase in the future. These developments include the financial and economic crisis (2008-2009), recession, stagnating income, rising inflation, conflicts among countries and high unemployment (European Commission, 2021; Eurostat, 2021, 2022a, 2022b; Rao, 2018; RBSC, 2015). Brueckner et al. (2010) dealt with the people living at the lower end of the income scale in the TOP countries. They refer to this group as "the bottom at the top of pyramid." This group is large, but the income level is significantly higher than that of people in the BOP countries (Angot & Plé, 2015; Brueckner et al., 2010). Therefore, frugal innovation is expected to be different in TOP countries than in BOP countries. They are expected to include more digital technologies and high-tech elements. It is also likely that considerations of the circular economy and sustainability will play a greater role in the TOP countries (Gabriel et al., 2016).

In Germany, complementary changes in value perceptions, income trends, more sustainable or price-sensitive thinking, and demand for complexity-reduced products are driving the trend toward frugal innovation (Cappelli et al., 2010; Gassmann & Winterhalter, 2014; Kalogerakis et al., 2017a; Kroll et al., 2016; Sharma & Iyer, 2012). A student survey by Tiwari (2017) revealed a reduced need for status symbols and the increasing importance of social and environmental motives. Factors and individually-perceived benefits are thought to vary by social context (Tiwari, 2017).

In order to explore the future relevance of frugal innovations in Germany on the consumer side, products of daily life are obvious candidates, considering the large number of potential consumers. Large household appliances such as washing machines and refrigerators can be found in many households in Germany (Statista, 2021). Among other things, they are characterized by a high purchase price, a long lifecycle, and resource consumption for production and

use (Bressanelli et al., 2017). In a previous work by the current author, the characteristics of frugal innovations, washing machines and the sustainable development goals were compared (Schneider, 2020). It was found that there was significant overlap of the three areas (see **Figure 1**). Thus, a washing machine would be a suitable product for a frugal innovation in the TOP countries. A washing machine would cover the three areas of environmental, social, and economic sustainability, and appeal to a large potential consumer group. On this basis, the washing machine is also considered in this work, with reference to Germany.

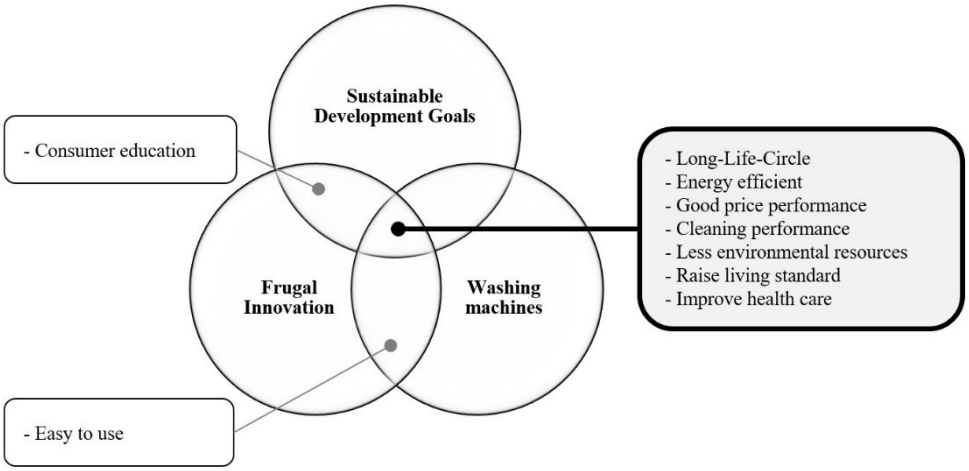

Figure 1 Overlap in frugal innovation, washing machines, and sustainable development goals

Source: Schneider, 2020

Due to the different characteristics of the potential consumer groups in the BOP and TOP countries, the question arises as to which factors influence consumers' purchase behavior intentions for frugal electronic household appliances such as washing machines in an industrialized environment such as

Germany. Based on the results (relevant influencing factors), target group-oriented product development and communication with potential consumers is possible in practice.

2. LITERATURE OVERVIEW

A systematic literature review approach was used to prepare for the study and develop the research model.

This approach includes the following steps: (1) defining the research question, (2) drafting the plan, (3) searching the literature, (4) applying the exclusion and inclusion criteria, (5) quality assessment, and (6) summarizing the literature (Hossain, 2018; Tranfield et al., 2003). Since the goal of this thesis was not to provide a systematic literature review but to conduct quantitative research, steps five and six were not explicitly performed. However, the literature determined to be appropriate and relevant was used for this chapter. First, the research question was defined (1) (see chapter 3). The draft plan (2) was defined, with three core areas being defined for the literature search: 1. frugal innovation; 2. acceptance/purchase intention; and 3. household appliances in developed countries. For the literature search (3), EBSCO and Google Scholar databases were used. For the third core area, the Statista database was consulted. The search terms chosen were “frugal innovation,” “acceptance,” “purchase intention,” and “household appliances.

For the EBSCO database, the following criteria (4) were chosen, “full text,” language: “English” or “German,” and the search terms had to appear in the title or abstract. When searching via Google Scholar, the search criterion “in the title of the article” was chosen. When searching via Statista, no restrictions had to be considered. The literature recorded as relevant to this work according to the quality assessment (5) is presented in chapters 2 and 4.1 and summarized (6).

2.1. Frugal innovation

The term “frugal innovation” is a rather new term in the scientific literature. Its origin is not clearly known. The concept was coined on the basis of the 2006 “frugal engineering” concept of Carlos Ghosn, who was the chairman and CEO of the Renault-Nissan Alliance (Hossain, 2018). The first scientific papers were published in 2011 (e.g. Zeschky et al., 2011). Since then, the number of scientific publications on this topic has been increasing. In the general press, the concept was introduced in 2010 in "The Economist" (The Economist, 2010). So far, there is no clear agreed-upon definition (Tiwari et al., 2017a). However, some definitions can be found repeatedly in the literature.
Bhatti (2012) describes frugal innovation as follows:

> It is not simply about reducing costs, but can also involve increasing the affordability power of the buyer through income generation, saving, or alternative payment schemes. Frugal innovation may also mean that the outcome involves building local entrepreneurship, capacity building, and self-reliance or sustainability.

Zeschky et al. (2014) wrote that:

> Frugal innovations are not re-engineered solutions but products or services developed for very specific applications in resource constrained environments.

Tiwari and Herstatt (2014) define frugal innovations as:

> New or significantly improved products (both goods and services), processes, or marketing and organizational methods that seek to

> minimize the use of material and financial resources in the complete value chain (development, manufacturing, distribution, consumption, and disposal) with the objective of significantly reducing the total cost of ownership and/or usage while fulfilling or even exceeding certain pre-defined criteria of acceptable quality standards.

Agarwal et al. (2017) view frugal innovation as an affordable quality product that is "good enough" for resource-limited users. Zeschky et al. (2014), on the other hand, consider it more than "good enough" because the products contain a technical novelty and a market novelty. According to Radjou and Prabhu (2015), a frugal innovation is "the ability to 'do more with less' – that is, to create significantly more business and social value while minimizing the use of diminishing resources such as energy, capital and time." Their definition has been popularized as "doing better with less" (Radjou & Prabhu, 2015). Hossain et al. (2016) see a frugal innovation as "a resource scarce solution (i.e., product, service, process, or business model) that is designed and implemented despite financial, technological, material, or other resource constraints, whereby the final outcome is significantly cheaper than competitive offerings (if available and is good enough to meet the basic needs of customers who would otherwise remain un(der)served." Pisoni et al. (2018) noted that definitions have changed over time. In 2012-2013, they were mainly product-oriented definitions; in 2014-2015, market-oriented definitions; and in 2016-2017, criterion-oriented definitions followed.

The focus of frugal innovations is on the required service offerings for a specific target group. In particular, it is on the core functions of a service or product and a simultaneous reduction of material and financial resources along the entire value chain, such as energy consumption, maintenance time, ancillary costs, and recycled raw materials (Niroumand et al., 2020; Tiwari et

al., 2017a). Both sustainable and social aspects are taken into account in the development process (Bhatti, 2012; Bound & Thornton, 2012). The products are shown to be extremely robust and easy to use (Hossain, 2020). This is necessary because those in emerging countries often have to work under the most difficult conditions and the end products must be usable by customers with a low level of education (Angot & Plé, 2015). Thus, frugal innovations follow the approach of the "triple bottom line," in which economic, environmental, and social benefits are targeted (Pansera, 2018).

Frugal innovations lead to a reduction in the cost of acquisition and use or ownership, and often exceed the quality standards for existing products (Singh et al., 2012; Tiwari et al., 2017a). The core functions of frugal innovations can be summarized as follows (Agarwal et al., 2017; Angot & Plé, 2015; Basu et al., 2013; Knorringa et al., 2016; Tiwari et al., 2017a; Weyrauch & Herstatt, 2016):

- Focus on core functions and preservation of customer benefits
- Reduction of environmental resources used (high priority given to sustainability)
- Reduction of the required financial resources (from purchase over their entire useful life)
- Creation of a specific consumer group
- Robustness
- Human-centric design: easy to use, intuitive use (no or little prior knowledge required)
-

For simplification, SMART attributes were developed for the classification by Fraunhofer IAO (2021) and Wohlfahrt et al. (2021) (see **Figure 2** below):

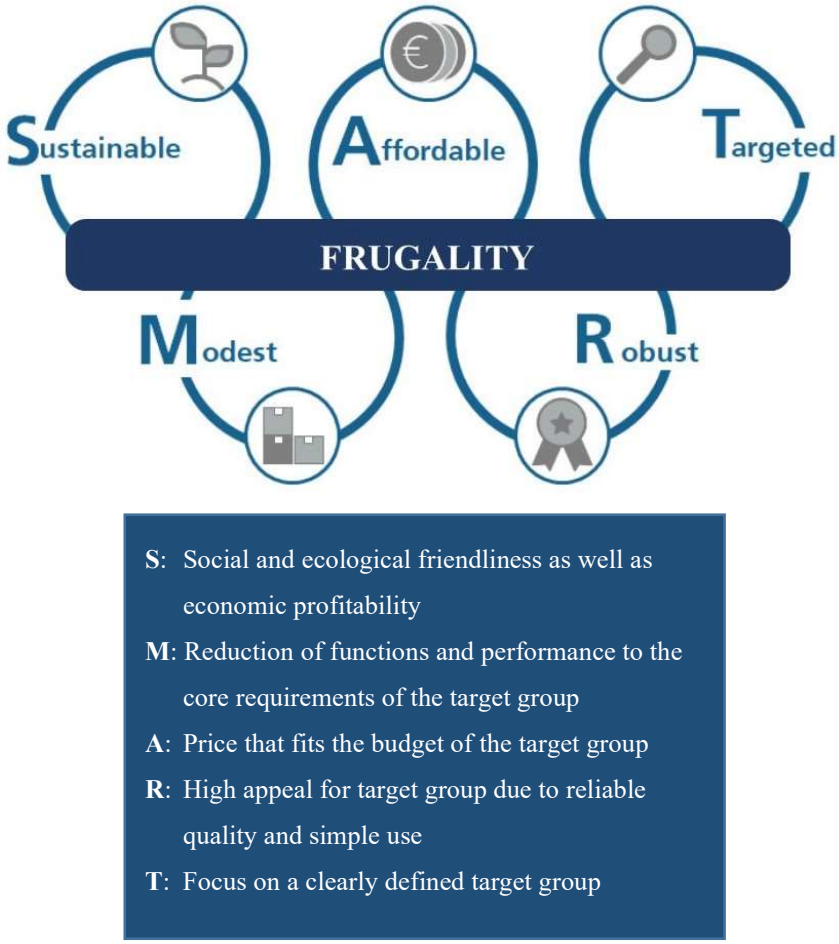

Figure 2 Classification SMART attributes

Source: Fraunhofer IAO, 2021

Rogers' diffusion theory is often used for the dissemination of innovations on the market (Rogers, 1995). Frugal innovations differ from conventional ones at this point. Hossain (2020) picked up on this and shows in his work that frugal innovations flow from a low-income market (in terms of customers and countries) to a high-income one. This is contrary to Roger's theory. George et al. (2012) noted this development and defined frugal innovations, as far back as in 2012, as "innovative, low-cost, and high-quality products and business

models originating in developing countries and exportable to other developing countries or even the developed world."

Frugal innovations can create higher social and business value than traditional innovations (Singh et al., 2012). The social value lies in the improvement of the quality of life and human well-being through the frugal products for the target group (Khan, 2016). The business value is in giving a broad group of consumers access to segments from which they were previously excluded by their poverty and limited resources. In these previously untapped markets, competition is also often lower (Angot & Plé, 2015). For example, Nokia developed a simple and robust cellphone. Here, the social value was enhanced by enabling communication, extended battery life, and an integrated flashlight. The cellphone sold for as little as $15. The profit margins per product were low, but this was offset by high sales volumes due to the large target group, which created business value (Angot & Plé, 2015).

Bound and Thornton (2012) predict the increasing importance of frugal innovations worldwide. Various global challenges can be positively influenced by such innovations. These include (Barclay, 2014; Bound & Thornton, 2012):

- Environmental constraints (e.g. climate, energy, water)
- Weak growth and slow deleveraging in some developed countries
- Aging population
- Rapidly growing population in emerging markets

2.2. Differentiation from other innovation terms

Albert (2016) analyzed the scientific literature for innovation concepts for and from emerging markets. He found that the term “frugal innovation” was often used synonymously with other terms, such as “jugaad innovation,” “value innovation,” “reverse innovation,” and “low-cost innovation.”

In order to have clarity about terminology in this work, brief explanations and distinctions from other commonly-used terms follow.

The focus of jugaad innovations is also on resource reduction, but it is not as scalable or sustainable as frugal innovation. “Jugaad” is a Hindi word. The literal sense would be conveyed in English as “do it yourself” (Agnihotri, 2015). Jugaad innovations are about improvised solutions that can be implemented quickly (Radjou et al., 2012), such as using a coke bottle as a water storage tank. These are not commercially and sustainably viable (Agnihotri, 2015). Jugaad is rather a survival strategy for people with few resources, mainly from emerging countries (Khan, 2016).

With value innovation, the focus is on lower costs and differentiation from the competition to achieve superior customer value to that of competitors (Kim & Mauborgne, 2005). In this context, the focus of innovations tends to be on non-consumers. For example, in the beginning, the IKEA company offered high quality furniture with classic designs to a broad consumer group. Such furniture had previously been available only in niche markets. Customers found the perceived value and quality of the furniture to be higher than that of local furniture manufacturers but lower than high-end furniture designers. The price was also lower than high-end furniture designers but higher than that of local furniture manufacturers. The value innovation was, thus, placed between the “low cost” and “differentiation” strategies (Agnihotri, 2015).

"Reserve innovation" refers to the flow of the development of products and services from developing markets to developed markets (Agarwal & Brem, 2012; Agnihotri, 2015; Bergmann & Tiwari, 2016). Here, innovations developed for developing markets or low cost countries are also purchased and used by developed markets or countries. These low-cost products and services are considered "good enough" by developed countries and are consequently purchased by consumers in developed countries. For example, medical devices developed by General Electric for emerging markets are also found in developed countries such as the United States. Sustainability is not a driver here (Agnihotri, 2015; Immelt et al., 2009).

Low-cost innovation represents an innovative use of an existing technology (Agnihotri, 2015). The goal is to use the existing technology to develop an affordable product for a broad group of consumers. Examples include low-cost products such as the Nano car and the Lulaby baby warmer (Agnihotri, 2015). Here, too, the sustainability aspect was not taken into account.

2.3. Phases of frugality

Frugal innovations are still a rather young topic in the scientific literature. However, "frugality" can be found in several periods of history. Tiwari and Herstatt (2019) describe the changes over time as waves called "frugality 1.0–4.0."

The first wave: “frugality 1.0”

The frugality approach already existed in antiquity, when moderation, modesty, and self-restraint were propagated by philosophers and theologians (Tiwari, Fischer, & Kalogerakis, 2017a).

“The heart is great which shows moderation in the midst of prosperity.”
(Lucius Annaeus Seneca, c. 4 BC–AD 65)

Apart from Western philosophers such as Cicero, Seneca, and Aristotle writing about moderation and frugality, it was also addressed in Eastern philosophy, especially in Buddhism and Neo-Confucianism, according to which frugality and material simplicity were considered valued virtues (Schumacher, 1966; Tiwari, Fischer, & Kalogerakis, 2017a).

Over the centuries, various figures, such as Immanuel Kant (Munzel, 2012), Adam Smith (Smith, 1776), and Max Weber (Weber, 1904), repeatedly referred to frugality and its positive effects (Tiwari et al., 2017a).

However, after World War I and with the onset of the consumer society, the virtue of frugality disappeared (Tiwari et al., 2017a). During the economic crisis of the 1930s, the term “planned obsolescence” was coined (Tiwari & Herstatt, 2019). The term means that products are deliberately made cheaper and their lifecycle is deliberately shortened, so that the customers have to buy the product again and again (Bulow, 1986). The policy of the growth centers of the post-war period led to a strong consumerism and the demise of frugality. The prosperity in the Western world consolidated this attitude. The markets were saturated and people feared that frugality would be a threat to prosperity and growth (Tiwari & Herstatt, 2019).

The second wave: “frugality 2.0”

In the 1970s, frugality became more significant again. Schumacher (1973) called for a more efficient and wise use of global resources. The development of “appropriate solutions” for developing countries then began. However, it failed to take root, for two reasons: First, there was little awareness at the time of the negative effects of heavy consumerism on the environment. Secondly, the products offered did not meet the demands of the target customers in the developing countries (Tiwari & Herstatt, 2019).

The third wave: “frugality 3.0”

The third wave began at the beginning of the 2000s. In the context of globalization, a growing middle class began to demand products and services that were previously unavailable or of substandard quality. Companies in countries such China and India were the first to take notice of this. They developed cost-effective solutions with a level of quality that became known as “good enough” (Prahalad & Mashelkar, 2010; Tiwari & Herstatt, 2019). Consumers demanded products and services that were adapted to local requirements, function-oriented, and affordable. These products and services were intended to replace the inferior local solutions, on the one hand, and the partially outdated and expensive solutions of global companies on the other. Thus, frugal innovation brought a higher standard of living and solutions that met consumers’ needs (Tiwari & Herstatt, 2019). These solutions were also called “affordable excellence” (Haudeville & Wolff, 2016). In the third wave, monetary affordability and the “good enough” quality were the focus of development. Environmental sustainability was not a primary driver at this time, but a rather common accompanying byproduct due to resource efficiency (Weyrauch & Herstatt, 2016).

The fourth wave: “frugality 4.0”

We are currently in the fourth wave. In this wave, in addition to the consumer group that demands affordable and good-quality products, a demand group has emerged that is also looking for more ecologically-sustainable products.
Furthermore, in this wave, an emphasis on frugality has re-entered the more affluent parts of the world, particularly in the industrialized nations (Chancellor & Lyubomirsky, 2011; Hanna, 2012). In these countries, some consumers have changed their lifestyles to more moderate ones, in which the complexity and excessive functions of products are reduced. A rethinking of the growth-centric approach is taking place (Hanna, 2012). Influenced by the development of a circular economy, greater resource efficiency, and the desire for a smaller environmental footprint, consumers and companies in the business-to-business (B2B) and business-to-consumer (B2C) sectors are looking for new opportunities. Compared to the previous waves, in the fourth wave “frugality” can be achieved in more diverse ways. In addition to complexity reduction, robustness, and resource reduction for the entire lifecycle, improving the efficiency of the innovation process (e.g., through crowdsourcing), the production process, the supply chain, and more efficient resource use (e.g., by incorporating the circular economy and rethinking the frequency of resource use) can lead to frugality (Nesta & Fraunhofer ISI, 2020; Niroumand et al., 2020). Building on the affordable excellence of frugality 3.0, affordable green excellence could be the goal of frugality 4.0 (Tiwari & Herstatt, 2019). This combination could make frugality 4.0 a global megatrend (Herstatt & Tiwari, 2020a).

2.4. Situation in developed countries

The first frugal innovations were developed for emerging markets and their specific needs (Tiwari & Prabhu, 2018). However, due to events in the recent past (e.g., the financial and economic crisis, the COVID-19 pandemic, the recession, and high unemployment), potential target groups for frugal products and services can also be found in developed and TOP countries (Herstatt & Tiwari, 2020; Rao, 2018; RBSC, 2015). In addition, many studies suggest that frugal innovations have relevance for long-term business success (Brem et al., 2020; Kalogerakis et al., 2017a; Kroll et al., 2016; Tiwari et al., 2016). Compared to emerging countries, developed and TOP countries have their own BOP populations, for whom the level is higher than in typical BOP or emerging countries (Angot & Plé, 2015).

Economic growth at the expense of the environment is often no longer desired by businesses or consumers (Kuo & Ng, 2016). The growing scarcity of resources is, thus, leading to an increasing demand in developed countries for end products that accommodate this trend. In addition to economically- and ecologically-sound products and services, ethically-sound solutions are also relevant here (Kalogerakis et al., 2017; Knorringa et al., 2016b; Kroll et al., 2016; Nesta, 2020).

In developed countries, there is a trend toward greater interest in frugality and innovations following the frugal approach. This can be observed at different levels (country, consumer, corporate).

At the country level, this is driven by, among other things, income trends in society, and national and international environmental regulations.

At the individual consumer level, there is a changing understanding of values in terms of greater environmental awareness and a conscious choice to live a frugal and more moderate lifestyle (Kalogerakis et al., 2017a; Khan, 2016; Kroll et al., 2016; Kuo & Ng, 2016; Prabhu, 2017). In Germany and Australia, among other countries, these choices are particularly evident among young people (Kalogerakis et al., 2017a; McCrindle, 2014). This generational difference does not exist in all developed countries. For example, Kolnhofer-Derecskei et al. (2017) could not find any generational differences in Hungary with respect to environmental protection. The sample indicated a general positive attitude towards environmental protection. A student survey by Tiwari et al. in Germany showed a reduced need for status symbols and an increase in social motives such as environmental awareness. Factors and individually-perceived benefits are thought to vary by social context (Tiwari, Fischer, Kalogerakis, et al., 2017).

A large percentage of people have become increasingly more accustomed to getting by on a smaller budget. At the same time, however, many people have become more demanding when it comes to the type of company they buy products from or work at (Prabhu, 2017).

Demand for non-high-tech products is also increasing. This is associated with a type of "feature fatigue" (Thompson et al., 2005) among consumers and a desire to reduce "needless complexity layered on to technology-based-products" (Hanna, 2012). However, compared to emerging markets, frugal products for developed countries are expected to include more high-tech elements and digital technologies (Gabriel et al., 2016).

A particularly high increase in demand for simplified products can be seen specifically in the "silver market" sector (Tiwari & Kalogerakis, 2019). This market refers to people who are 50 years old and older (Kohlbacher et al., 2011),. who often look for "easy-to-use" products and services in order to

avoid being overwhelmed by too much complexity and unnecessary functions (Bergmann & Tiwari, 2016; Kohlbacher & Hang, 2010).

At the corporate level, this means that, in addition to taking into account environmental and sustainable aspects, pure technology leadership might no longer be sufficient in the future (Kalogerakis et al., 2017a). Brem et al. (2020), therefore, recommend that companies integrate the demand perspective into their product development strategies. To be able to map the perspective, consumers could be brought from a purely passive consumer status into an active position during targeted product development (Prabhu, 2017).

These factors mean that frugal products and services in industrialized nations are not only targeted at a consumer group with limited resources, but that a broad consumer group is addressed (Kroll et al., 2016; Winkler et al., 2020).

The aforementioned reasons differ from the typical target group for frugal innovations in emerging markets. In terms of content, the focus tends to be on the "frugality 3.0" phase and a consumer target group that is denied access to a product due to limited resources. In the industrialized nations, the idea of sustainability and voluntary frugality are extremely important. The industrialized nations, thus, fall into the "frugality 4.0" phase.

Figure 3 comprises a summary of the future drivers of demand for frugal innovations in Germany.

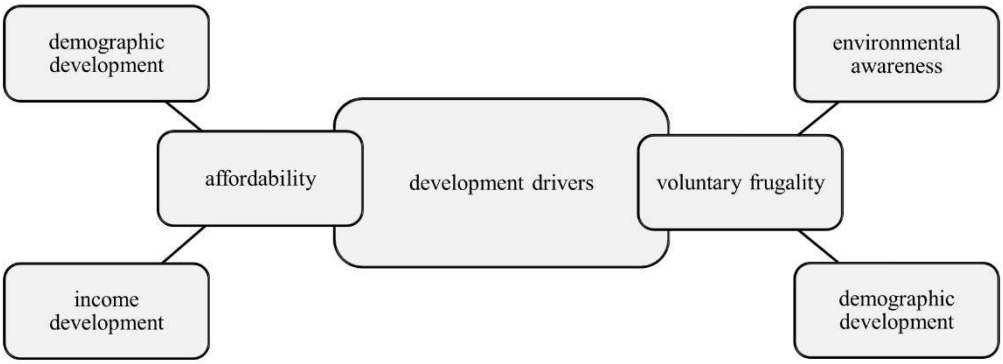

Figure 3 Demand of drivers frugal innovations in Germany

Source: Kalogerakis et al., 2017a; Kohlbacher et al., 2011; Tiwari & Kalogerakis, 2019

In addition to product requirements, other aspects of frugal products and services can be noted in industrialized nations. For example, a high degree of price elasticity can be assumed in these countries. This means that when prices are lowered in conjunction with core functions, a sharp increase in demand occurs above a threshold (Nesta & Fraunhofer ISI, 2020). Empirical evidence has yet to be found in the literature. In the United States, studies have already shown that there is a growing willingness to buy lower-priced private labels; thus, price takes precedence over brand (Kroll et al., 2016). This change in preferences is also evident in supermarkets such as Aldi and Lidl in the European Union. With an intelligent marketing strategy, they could achieve a growing market share in the food sector. (Kroll et al., 2016). A survey has shown that many consumers would not change their behavior even if their incomes increased and would continue to shop there (The Economist, 2014). In addition to these examples from the retail sector, there are other frugal solutions in Germany and in Europe as a whole. The low-priced Renault-Dacia Logan has been on sale in Europe since 2004. It has a special relationship among spaciousness, concentration on the essential equipment and a low price (Renault Dacia, 2021). IKEA can also be counted among the companies that

offer frugal solutions with its range of furniture and furnishings. Overall, however, the development of frugal innovations for industrialized nations is still extremely limited (Wohlfart et al., 2021).

At the outset, the aim of frugal innovations was to deliver economic and social value to BOP consumers. The transferability of frugal innovations from emerging markets to developed nations can be demonstrated by the following example. GE Healthcare has developed a frugal, portable electrocardiogram (ECG, name: MAC 400) for emerging markets (Kroll et al., 2016). This device enables doctors to help many poor people, even outside the cities. This innovation enables GE to make a profit and people can be helped locally. If this product is transferred to the industrialized nations, individual doctors could be equipped with the low-cost MAC 400. This would reduce the volume of patients in hospitals, provide rapid outpatient care, and relieve the financial burden on health insurers (Nesta & Fraunhofer ISI, 2020).

Kalogerakis et al. (2017) conducted interviews with several experts. The majority of them predicted that frugal innovation would be a significant trend in Germany within the next five to 10 years. During development, suppliers of previously high-priced products can, therefore, expect a cannibalization effect from frugal products. To secure business success in the long term, the development of proprietary frugal solutions should begin in good time, otherwise there could be a danger from the competition (Kalogerakis et al., 2017a). So far, however, Germany has tended to adopt a technology-driven approach to innovation (Kalogerakis et al., 2017a; Krohn et al., 2020).

2.5. Household appliances in Germany

In industrialized countries, major household appliances (e.g., washing machines, refrigerators, dishwashers) are an important part of daily life. A total of 96% of households in Germany own a washing machine, 99.9% own a refrigerator, and 73% own a dishwasher (Statista, 2021). The turnover of large household appliances in Germany in 2020 generated 9.96 billion euros. About 2.55 million ovens or electric stoves, 3.65 million refrigerators and 3.3 million washing machines were sold (Statista, 2021). Compared to 2014, this was 21.4% more ovens, 12.3% more refrigerators, and 10% more washing machines (Statista, 2021). Thus, large household appliances belong to a large and important industry of consumer goods (Codini et al., 2012). Large household appliances represent a long-term and relatively costly investment for households. They require occasional maintenance and/or repair, are technologically advanced, and generally have a long lifecycle. The latter is one of the most significant factors in the purchase of a major household appliance (Bressanelli et al., 2017).

In addition, a good price-performance ratio (price, features, quality) is an important factor in purchase decisions in Germany. Consumers also consider the energy efficiency or sustainability of the appliances when making their purchase decisions. They should consume little energy in operation and be produced in a way that conserves resources. Consumers also want user-friendly appliances (Codini et al., 2012; Statista, 2016).

In recent years, growing attention has been paid to sustainable consumer goods in general and sustainable home appliances and home technology in particular. A more pronounced understanding of acceptance factors in this field is therefore of interest to appliance manufacturers, researchers, and policy makers. To this end, several areas of sustainable behavior in households have already been studied (Ahn et al., 2016; Hustvedt et al., 2013; Vermeir & Verbeke, 2006). However, there is a paucity of studies that provide empirical

results on what consumers expect of sustainable household appliances. Findings on what induces consumers to adopt a sustainable household appliance are also scarce.

2.6. Conceptualization of acceptance

The literature contains differing definitions of the term "acceptance" and how to measure it, depending on the research direction (Davis, 1989; Mokhtar, 2006; Schrader, 2001; Wiedmann & Frenzel, 2004). For the field of new technologies, Kollmann (1998) cites acceptance as a key handle for measuring and predicting the success of technological innovations. The introduction of new technologies is not necessarily accompanied by consumers' acceptance. Thus, not everything that is technically possible is also successful in terms of sales (Kollmann, 1998). Furthermore, he sees acceptance as being closely linked to the attitude construct and as a dynamic approach that takes place at several points in time. He distinguishes between the attitude phase (before the purchase), the action phase (during the purchase), and the use phase (after the purchase) (Kollmann, 1998). According to other authors, acceptance includes attitudinal acceptance (acceptance system in a cognitive way) and behavioral acceptance (actual behavior) (Ajzen, 1991; Ajzen & Fishbein, 2000; Müller-Böling & Müller, 1986). Despite no uniform definition, some commonalities can be found in the above descriptions. These are the subjective attitude to a product or a fact, a general readiness for acceptance, a decision character, and a positive attitude to a product or a fact to be evaluated. In the scientific research in the past few decades several models and theories have been developed to explain acceptance. One of the first known models was the "Theory of Reasoned Action" (TRA), which was published in 1975 by Fishbein and Ajzen (1975). In terms of this model, behavioral intention was seen to be influenced by social norms and attitude towards the behavior. In

1985, Ajzen (1985) published an extension called the "Theory of Planned Behavior" (TPB). In this model, in addition to the social norms and attitudes toward the intention, perceived behavioral control was considered to influence intention. Intention ultimately leads to a particular behavior. In addition, perceived behavioral control has a possible direct influence on behavior. In the scientific literature, a large number of scholars have used the TRA and the TPB to explain human behavior. According to both models, attitude to a behavior does not directly affect behavior but does so indirectly through behavioral intention. On this basis, it can be assumed that there will be acceptance at the action and use levels only if there is acceptance at the attitude level (Baker et al., 2007; Barbera & Ajzen, 2020; Chen & Hung, 2016; Cheng et al., 2006; Hukkelberg et al., 2014; Yang et al., 2017).

A further development of the TRA and the TPB is the "Technology Acceptance Model" (TAM) developed in 1985 by Davis (see **Figure 4**). It was developed to determine the factors underlying technology acceptance formation and was initially applied to new technologies in the workplace.

The model shows that the perceived usefulness and perceived ease of use of a technology influence attitude and behavioral intent to use (Davis, 1985; Davis et al., 1989). In this construct, perceived usefulness represents the expected benefit of a technology for a person. The perceived ease of use represents the effort a person has to put into using the technology. The behavioral intention to use relates to the perception of the actual use and, thus, acceptance (Venkatesh & Davis, 2000)

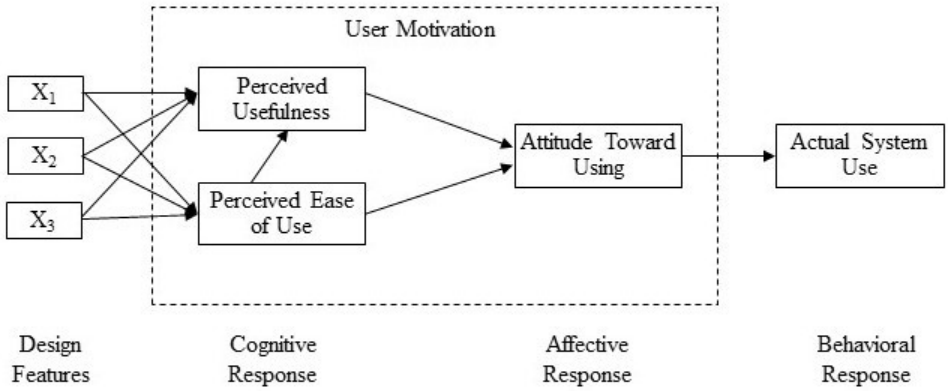

Figure 4

Technology Acceptance Model

Source: Davis, 1985

The TAM has been able to account for a substantial amount of the variance (typically about 40%) in usage attitudes and intentions in a variety of empirical studies (Venkatesh & Davis, 2000). Societal factors (such as subjective norms) influencing behavioral intention to use were not considered in the TAM. This addition emerged in 2000, when Venkatesh and Davis (2000) proposed a more developed TAM-2, which included further theoretical constructs such as social influence processes (subjective norm, voluntariness, image) and cognitive instrumental processes (job relevance, output quality, experience, results demonstrability) as influencing factors (Venkatesh & Davis, 2000). Later, a further modification of the TAM-2 followed. The TAM-3, which takes into account further upstream technological factors influencing perceived ease of use, was published in 2008 by Venkatesh and Bala (2008). With very high similarity, the "united theory of acceptance and use of technology" (UTAUT) model was developed alongside the TAM (see **Figure 5**). In this model, Venkatesh et al. (2003) suggested three factors that acted on behavioral

intention to use. The perceived usefulness from the TAM is represented as "performance expectancy," the perceived ease of use as "effort expectancy," and the subjective norm as "social influence." A fourth factor was the facilitating conditions. These have a direct effect on actual use.

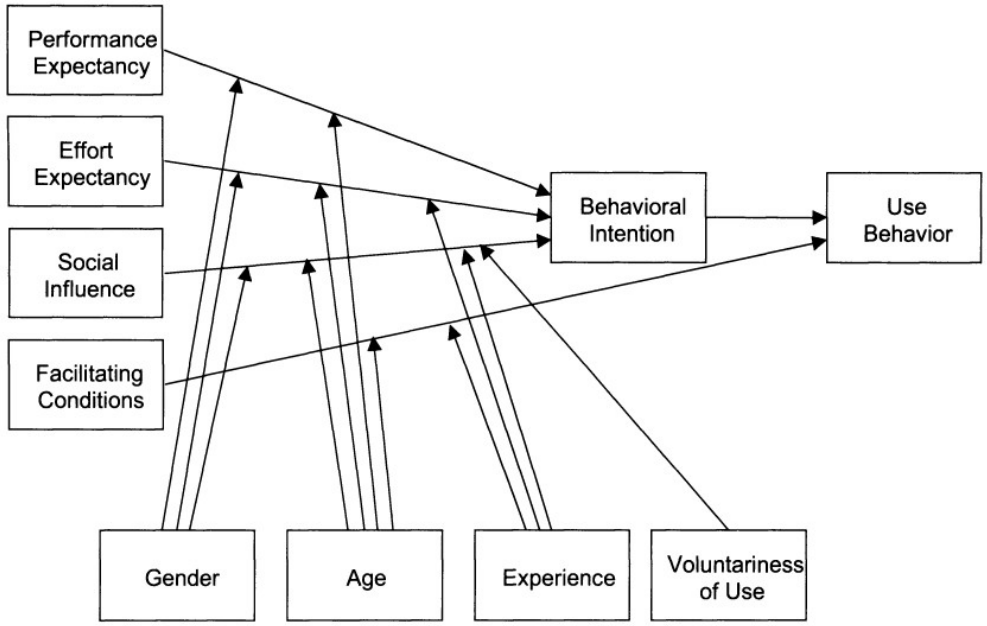

Figure 5

United Theory of Acceptance and Use of Technology

Source: Venkatesh et al., 2003

The UTAUT has been shown to be a promising model in several studies, explaining as much as 70% of the variance in behavioral intention to use and 50% of actual use (Holden & Karsh, 2010). Later, the UTAUT2 constituted an extension with three additional factors (hedonic motivation, price value, habit) (Venkatesh et al., 2012). With each further development, both the TAM and the UTAUT became more complex.

3. OBJECTIVES OF THE DISSERTATION

The aim of this dissertation was to gain knowledge about the acceptance-forming factors of frugal major household appliances in Germany, which can be used for the future development of these products and their marketing.

For this purpose, the following central research question was formulated:

Which factors have an influence on consumers' acceptance of frugal innovations of major electrical household appliances such as a washing machine in Germany?

To answer this question, the social, economic, and environmental factors that might influence consumers' choices had to be considered.

4. MATERIAL AND METHODS

In this chapter, an empirical research model is presented that was developed to answer the research questions. The model includes the hypotheses to be tested regarding the possible factors that influence the acceptance of major household appliances. This is followed by a description of the research design, with the preliminary studies and the main study, as well as the methodology of variance-based structural equation models. In order to make the latent variables measurable, the operationalization of the variables is presented in the following section. Finally, the data collection and the sample are described.

4.1. Theory-based model development

The sparse use of resources is a core element of frugal products and, thus, relevant in the product development process of companies (see e.g., Agarwal et al., 2017; Angot & Plé, 2015; Weyrauch & Herstatt, 2016). In order to assess whether the relevance is also given to the consumer, environmental awareness is included in the model. Environmental awareness in this context means knowledge and concern about the impact of human activities on the climate and the environment (Schuitema et al., 2013). In this context, it is a comprehensive concept that can be broken down (Hopwood et al., 2005) into cognition, concerns, perceptions, and feelings about environmental problems. In addition, it also includes thoughts and attitudes about problem solving, and the ongoing relationship and its improvement between people and the environment. Individual-level environmental awareness is the general understanding of the awareness of environmental problems. It is an important factor that can change an individual's current behavior to one that is more environmentally friendly than before (Schuitema et al., 2013; Wang et al., 2020). Some studies show that consumers who have a higher awareness of the environment are more likely to choose to perform environmentally-friendly

actions (Anjam et al., 2020; Butler & Francis, 1997; Chen & Hung, 2016; Kahn, 2007; Roberts, 1996; Vermeir & Verbeke, 2006), but not all (Hustvedt et al., 2013). For these reasons, it is reasonable to hypothesize that higher levels of environmental awareness predict higher adoption of frugal household appliances, but that the relationship might not be clear-cut. To evaluate the influences of environmental awareness in relation to frugal household appliances, the influences on perceived usefulness and attitude toward using them were tested. Hypotheses H_1 and H_2 were formulated for this purpose:

H_1: The greater the environmental awareness, the greater the perceived usefulness of frugal household appliances.
H_2: The greater the environmental awareness, the more positive the attitude toward using frugal household appliances.

Goldsmith and Newell (1997) describe "price sensitivity" as the consumer's feeling about paying a certain price for a product. In addition, it includes the willingness to buy a product and the measure of satisfaction. Price sensitivity is closely related to perceived value, which refers to the exchange between the purchase of a product or service and the associated sacrifice (Sweeney & Soutar, 2001). In order to keep this sacrifice as low as possible, a "low-cost" phenomenon has been observed for several years. Companies focus on reducing costs along the entire value chain during product development so as to be able to offer the lowest possible price to consumers (Valls et al., 2012). This change is also reflected among consumers in a change in the ratio of the widely used Status Consumption Scale (SCS). The SCS has shown that consumers try to improve their social standing by consuming conspicuous goods. With consumers demanding lower prices, the SCS factors are altered to achieve a certain value proposition (cf. Valls et al., 2012). For frugal innovations, the significantly lower price than that of conventional innovations

is a relevant feature (Hossain et al., 2016; Tiwari et al., 2017b; Winkler et al., 2020). It is not uncommon for the price reductions to reach percentage values of 30% to over 80% (Rao, 2013; Weyrauch & Herstatt, 2017). In order to test this influence on the perceived usefulness of frugal household appliances and the purchase behavior intention regarding them, hypotheses H_3 and H_4 were formulated:

H_3: The greater the financial advantage, the greater the purchase behavior intention regarding frugal household appliances.
H_4: The greater the financial advantage, the greater the perceived usefulness of frugal household appliances.

An individual's innovativeness is a measure used to assess when an individual adopts an innovation relative to others (Ahn et al., 2016). Existing personal innovativeness is an important characteristic of the adoption of innovations (Rogers, 1995). The higher the measure of personal innovativeness, the better the person is able to cope with the uncertainties of an innovation when it is adopted (Rogers, 1995). Agarwal and Prasad (1998) consider personal innovativeness in their model of technology adoption from the worldwide web. Personal innovativeness is described as a personal willingness to take risks more than other people.
The sustainability aspect is gaining importance in the development of new products (Jabbour et al., 2019; Seles et al., 2019). In this context, it includes social, economic, and environmental impacting areas (Hossain, 2020). Therefore, the literature suggests that is the consumer has a combination of sustainability aspirations and personal innovativeness. Personal sustainable innovativeness is, thus, the intention to purchase sustainable new technologies (Ahn et al., 2016; Anjam et al., 2020). To test this, Ahn et al. (2016) considered sustainable innovativeness in their model and found a significant influence on

the intention to purchase sustainable household technology. Since sustainability is part of the foundation of frugal innovation, the influence of sustainable innovativeness on purchase behavior intention and the perceived usefulness of frugal household appliances were tested in this study. For this purpose, the following two hypotheses were formulated:

H_5: The greater the sustainable innovativeness, the greater the purchase behavior intention regarding frugal household appliances.
H_6: The greater the sustainable innovativeness, the greater the perceived usefulness of frugal household appliances.

In this study, social factors were added to the technological, environmental, and economic views. These have been shown to be a significant dimension in product development (Jabbour et al., 2019). The aim was to provide the most complete picture of purchase behavior intention relating to frugal household appliances. The social factors were based on the TAM-2 (Venkatesh & Davis, 2000), the TPB (Ajzen, 1985), and the UTAUT (Venkatesh et al., 2003). They refer to the personal and mostly subconscious aspects of the acceptance of a technology. Consumers want to align their actions with the expectations of, and be approved by, those around them (Eneizan et al., 2019; Pousttchi & Goeke, 2011; Yuen et al., 2020). Ajzen (1985, 1991) maps this tendency with the construct "subjective norm." The assumption is that the expectations of third parties in the consumer's environment have an influence on the consumer's perception of usefulness and behavior. In this study, the subjective norm was used to map what those in the consumer's environment felt about frugal household appliances. Furthermore, the influence of the subjective norm on perceived usefulness and purchase behavior intention was tested. The hypotheses H_7 and H_8 were formulated for this purpose:

H_7: The greater the subjective norm related to frugal household appliances, the greater the purchase behavior intention regarding them.
H_8: The greater the subjective norm related to frugal household appliances, the greater their perceived usefulness.

Physical products are selected for, among other things, their functional and/or symbolic performance (Donoghue et al., 2008; Hawkins et al., 2007). Functional performance refers to the ability of the product to fulfill its useful, functional, or physical purposes. These can vary depending on the product. In the area of major household appliances, durability, ease of use, ease of care, and physical performance (does what it is supposed to do) are often used (Donoghue et al., 2008).
Symbolic performance, on the other hand, refers to the psychological level of performance—what the product symbolizes to the consumer and what it conveys to third parties (Erasmus et al., 2005; Hawkins et al., 2007).
Expectation of the functional and symbolic performance of the purchased product can vary among consumers from low to extremely high (Hawkins et al., 2007). "Personal expectancy" is therefore defined as a belief or prediction about the purchased product (Donoghue et al., 2008). Expectations are based on previous experiences with similar products, positive or negative recommendations, and the marketing efforts of companies (Laufer, 2002; Woodruff et al., 1983).
For major household appliances, perceived product quality (functional performance) has emerged as an important determinant of acceptance (Rakhmawati et al., 2020). Various studies have shown that product quality influences acceptance in the form of willingness to purchase and willingness to use (Walsh et al., 2012; Wang, 2015; Yan et al., 2019). Other studies show perceived quality to be a multidimensional concept, although these differ among studies (Alonso et al., 2002; Kenyon & Sen, 2012). Quality is

manifested in eight dimensions (Garvin, 1987), namely performance, features, conformance, reliability, durability, usability, aesthetics, and perceived quality. In the wake of the increasing relevance of sustainability in product development, Hazen et al. (2017) suggest for remanufactured products the dimensions of durability, features, performance, and fitness for use.
Hypotheses H_9 and H_{10} were formulated to test the relevance of performance expectation for perceived usefulness and the perceived ease of use of frugal household appliances:

H_9: The greater the performance expectation of a frugal household appliance, the greater its perceived usefulness.
H_{10}: The greater the performance expectation of the frugal household appliance, the greater its perceived ease of use.

As another determinant of behavioral intention, Ajzen (1991) introduced perceived behavioral control into the TPB. This is intended to reflect a person's perceived control over the performance of a behavior, or, more specifically, to assess an individual's perception of their control of factors that enable or constrain the accomplishment of specific actions (Verma & Chandra, 2018). Ajzen defined it as "the perceived ease or difficulty of performing the behavior" (Ajzen, 1991). Subsequent studies show that perceived behavioral control has a direct and significant positive impact on an individual's behavioral intention (Baker et al., 2007; Cheng et al., 2006). This finding has been complemented by other studies (Barbera & Ajzen, 2020; Hukkelberg et al., 2014; Kothe & Mullan, 2015), in which a significant positive relationship was found between perceived behavioral control and attitude in predicting intentions. The higher the perceived behavioral control over an individual's behavior, the stronger the influence of attitude on intention. In this context, perceived behavioral control is also referred to as a "non-volitional factor"

(Verma & Chandra, 2018). The influencing factors of perceived behavioral control can be internal or external to the person. Internal factors are, for example, self-confidence, willpower, and the ability to perform a behavior (Kidwell & Jewell, 2003; Sparks et al., 1997). External factors are, for example, opportunity and facilitating conditions (Bagozzi & Kimmel, 1995; Sparks et al., 1997). Facilitating conditions represent all environmental conditions and those affecting the individual that make an action easy or difficult. Previous studies show that an individual is more likely to perform a behavior when it is easy than when it is difficult to perform it (Triandis, 1977). One's assessment of control, however, can also be distorted due to faulty and irrational premises that arise from self-serving motives, fear, or other emotions (Geraerts et al., 2008). Venkatesh and Davis established experimental evidence of a causal relationship between computer self-efficacy and system-specific perceived ease of use (Venkatesh & Davis, 1996). This were attributed to a lack of system experience and, thus, a lack of confidence in one's ability and knowledge of how easy or difficult a new system would be to use. In a later study, Venkatesh additionally found that, among other factors, control served as anchor for perceived ease of use of a new system (Venkatesh, 2000).
To test the influence of perceived behavioral control on attitude and perceived ease of use, hypotheses H_{11} and H_{12} were formulated:

H_{11}: The greater the perceived behavioral control regarding the purchase of a frugal household appliance, the more positive the attitude toward using it.
H_{12}: The greater the perceived behavioral control regarding the purchase of a frugal household appliance, the greater its perceived ease of use.

Hypotheses H_1–H_{12} were formulated based on various research studies. The following hypotheses, H_{13}–H_{17} were derived from the TAM model (Davis, 1989). In this model, perceived usefulness, perceived ease of use, and attitude

toward using are considered to influence intention to use. The latter has been shown in various studies to be a good predictor of actual use (Kim, 2012; Park et al., 2018; Schneider, 2021b; Venkatesh & Davis, 2000; Wang et al., 2006). In this study, intention to use is presented as purchase behavior intention.
Previous studies have shown that when a consumer perceives a technology as useful, this can trigger motivation to actually purchase and use it. (Arnold & Klee, 2016; Hubert et al., 2019; Venkatesh & Davis, 2000). In TAM, this is represented as perceived usefulness. It represents the subjective likelihood of an increase in usefulness from using a technology (Davis, 1989).
Following the TAM, the model of this study was also designed to test the influence of perceived usefulness on attitude toward using and intention to use in the form of purchase behavior intention of frugal household appliances. For this purpose, hypotheses H_{13} and H_{14} were formulated:

H_{13}: The greater the perceived usefulness of a frugal household appliance, the more positive the attitude toward using it.
H_{14}: The greater the perceived usefulness of a frugal household appliance, the greater the purchase behavior intention of buying it.

Previous researchers have used the construct perceived ease of use to represent the ease of using a technology (Lu et al., 2019; Venkatesh et al., 2003). A technology that is intended to be user-friendly must be effortless, clear, simple, and understandable (Holden & Karsh, 2010). In the TAM, the direct influences of perceived ease of use on perceived usefulness and attitude toward using, as well as an indirect influence via perceived usefulness on attitude toward using, were tested (Venkatesh & Davis, 2000). Based on this, hypotheses H_{15} and H_{16} were formulated:

H_{15}: The greater the perceived ease of use of frugal household appliances, the greater their perceived usefulness.
H_{16}: The greater the perceived ease of use of frugal household appliances, the more positive the attitude toward using them.

To represent the general attitude to trading, the construct "attitude toward using" is used (Ajzen & Fishbein, 1977). This construct reflects attitude acceptance. Once consumers engage in an acceptance decision for or against an object, a comparison between attitude to the new object and attitude to using related, familiar, or superior objects usually begins (Mann and Prein, 2008). To implement the actual purchase, the consumer must have a positive use attitude toward frugal household appliances. This is reflected in the construct of purchase behavior intention. To test this, hypothesis H_{17} was formulated:

H_{17}: The more positive the attitude toward using frugal household appliances, the greater the purchase behavior intention of buying them.

Table 1 contains all the hypotheses used to build the research model.

Table 1

Overview about the hypotheses

No.	Hypotheses
H_1	The greater the environmental awareness, the greater the perceived usefulness of frugal household appliances.
H_2	The greater the environmental awareness, the more positive the attitude toward using frugal household appliances.
H_3	The greater the financial advantage, the greater the purchase behavior intention regarding frugal household appliances.
H_4	The greater the financial advantage, the greater the perceived usefulness of frugal household appliances.
H_5	The greater the sustainable innovativeness, the greater the purchase behavior intention regarding frugal household appliances.
H_6	The greater the sustainable innovativeness, the greater the perceived usefulness of frugal household appliances.
H_7	The greater the subjective norm related to frugal household appliances, the greater the purchase behavior intention regarding them.
H_8	The greater the subjective norm related to frugal household appliances, the greater their perceived usefulness.
H_9	The greater the performance expectation of a frugal household appliance, the greater its perceived usefulness.
H_{10}	The greater the performance expectation of the frugal household appliance, the greater its perceived ease of use.
H_{11}	The greater the perceived behavioral control regarding the purchase of a frugal household appliance, the more positive the attitude toward using it.

No.	Hypotheses
H_{12}	The greater the perceived behavioral control regarding the purchase of a frugal household appliance, the greater its perceived ease of use.
H_{13}	The greater the perceived usefulness of a frugal household appliance, the more positive the attitude toward using it.
H_{14}	The greater the perceived usefulness of a frugal household appliance, the greater the purchase behavior intention of buying it.
H_{15}	The greater the perceived ease of use of frugal household appliances, the greater their perceived usefulness.
H_{16}	The greater the perceived ease of use of frugal household appliances, the more positive the attitude toward using them.
H_{17}	The more positive the attitude toward using of frugal household appliances, the greater the purchase behavior intention of buying them.

4.2. Research design

The research area of frugal innovations is a rather young and, thus, an underresearched area. Therefore, the author has structured her research as a mix-method research process (see **Figure 6**). This made it possible to combine an inductive approach, which was suitable for a new research area, with a deductive approach, which was suitable for the final hypothesis evaluation.

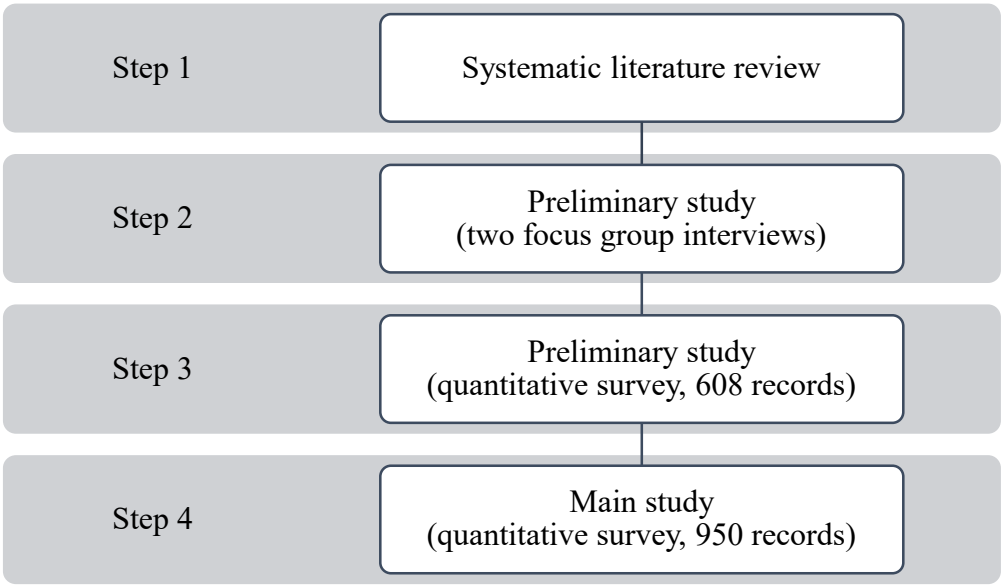

Figure 6

Mix-methods research process

In section 4.2.1, an excerpt from the preliminary studies that were reviewed was indicated to provide an overall understanding of the research process. This was only intended to provide some insight and understanding of the research that preceded the main studies. Due to the scope of this thesis, the preliminary studies have neither been fully represented nor analyzed and evaluated in detail at this point.

4.2.1. Preliminary studies

At the beginning of the author's research, there was little evidence in the literature and no empirically-supported results on possible acceptance-forming factors of frugal innovations in developed countries (see Chapter 2, Step 1). This was due to the novelty of the research area. Due to this, an inductive approach was chosen in the second research step, with a view to developing hypotheses and concepts (Basch, 1987). The focus group interview was

selected as a qualitative data collection instrument. In this moderated discourse method, a small group is stimulated to discuss a specific topic by means of information input (Schulz, 2012). The group dynamic is a special feature here. Focus groups make it possible to obtain a large amount of data in a short time, and the information derived from them is often more profound and richer than that generated by individual interviews (Krueger & Casey, 2014; Rabiee, 2004). The data obtained is often used as a preliminary study before embarking on a quantitative procedure (Rabiee, 2004). This was also the goal in this research process. Exploratory information should be collected as a basis, which can be tested later in the research process with the help of quantitative research. In the current research, two independent focus group interviews were conducted on the acceptance-forming factors of frugal innovations in developed countries. Both groups comprised master's students enrolled in a degree program in economics. The interviews took place on September 16, 2020 in Essen and on September 24, 2020 in Hamburg. The moderation of the focus group interviews was supported in each case by an external moderator in the form of a professor from IFES (Institute for Empirics & Statistics) from Essen and Hamburg.

The evaluation of the results relating to the acceptance factors or moderators of the acceptance-forming factors are indicated in **Table 2** (first and second columns).

The constructs (see right column **Table 2**) were developed and operationalized from the results of the focus group interviews (Step 2) and the literature review (Step 1).

Table 2

Results of the focus group interviews and the allocation to constructs

Results focus group interviews		**Allocation to constructs**
Factor	Subpoint	Construct
Sustainability	Conserving Resources	Environmental Awareness
	Conscious Consumption	Environmental Awareness
	Locality	-
	Culture	-
Price-performance ratio	Price	Financial Advantage
	Margin	-
	Performance	Performance Expectation & Quality Factors
	Durability	Performance Expectation & Quality Factors
Quality	Functionality	Quality Factors
	Standards	Quality Factors
	Risk avoidance	Quality Factors
	Trust	Initial Trust
Functionality/ Usability	Frequency of use	-
	Use behavior	Perceived Usefulness & Attitude Toward Using
	Comfort	Attitude Towards Using
Minimalism	Awareness	Perceived Consumer Effectiveness
	Lifestyle / Trend	Personal Innovativeness
	Simplification / Overview / Stress reduction	Perceived Ease of Use
Status/Image	Design/Optic	Status/Image
	Brand (known brand, core of brand, specific communication)	Initial Trust
	Opinion of others (Family/Friends/Society)	Status/Image & Subjective Norm

Results focus group interviews		**Allocation to constructs**
Factor	Subpoint	Construct
Target Groups	Mid-30to	Demographic data (age)
	Students	-
	Price-linked-Persons	Financial Advantages
	Available Income	Demographic data (income)
Problems	Awareness of Frugal Innovation	Initial Trust
	Mistrust	Initial Trust
	Communication problem	-
	Secondary / Intermediate Solution	-
Availability	Search Costs	-
	Time	-
	Availability at Point of Sale	-
Marketing	Information	-
	Specific Communication	-

Based on the TAM (see **Figure 4**; Davis, 1985) the constructs were transformed into a first research model (**Figure 7**) to be evaluated in the next research step (Step 3), by means of deductive approach of a quantitative survey.

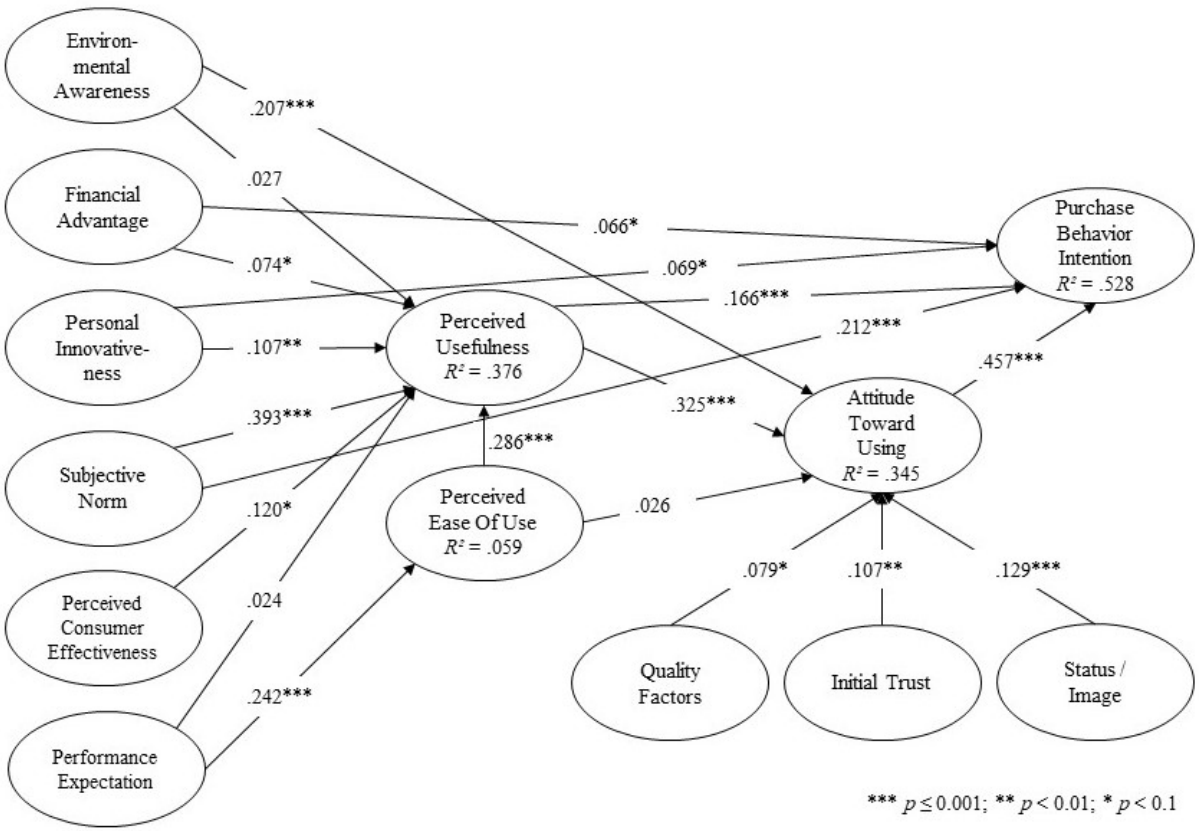

Figure 7

Research model pre-study

The data collection was conducted online from December 11, 2020 to January 13, 2021. A total of 824 records were collected. However, of these, some datasets had to be excluded due to more than 20% missing values (Weiber & Mühlhaus, 2014). Furthermore, those that showed overly rapid response behavior were eliminated (Leiner, 2019). The sample, thus, comprised 608 data records.

The evaluation showed that the TAM was suitable for the object of investigation. The main variables were significant, with high path coefficients. In addition, subjective norm, performance expectation, and environmental awareness were found to be influential factors. A low influence (due to a low path coefficient) was determined for personal innovativeness, perceived consumer effectiveness, quality factors, initial trust, financial advantage, and status/image.

Based on the focus group interviews and the results of the survey (Step 3), a decision was made on the use of each construct (see **Table *3***) in the final research model (Step 4).

Table 3

Decisions after evaluation of the first data collection

Construct	**Result**	**Decision**
Quality Factors	Low significant path-coefficient	Remove
Perceived Consumer Effectiveness		Remove
Status/Image		Remove
Initial Trust		Remove
Personal Innovativeness		Change and query "Sustainable Innovativeness"
Financial Advantage		Leave unchanged in model, check again

Construct	Result	Decision
Environmental Awareness	relevant	One item supplemented by another source
Perceived Usefulness		Change items, other source
Performance Expectation		Leave unchanged in model, check again
Subjective Norm		Leave unchanged in model, check again (formative items)
Perceived Ease of Use		Leave unchanged in model, check again
Attitude Toward Using		Leave unchanged in model, check again
Purchase Behavior Intention		Leave unchanged in model, check again

4.2.2. Main study

To generate a dataset as a basis for testing the research model, primary data collection was conducted by means of an online survey as a quantitatively-oriented method. The platform *soscisurvey.de* was used. The reasons for the online survey were that it enabled a larger range and a lower effort than a personal or telephone survey of several hundred participants, the exclusion of a possible influence on the participant by the interviewer, and the time and location-independent participation possibility (Wright, 2005). In addition, the anonymity of the survey could be credibly guaranteed (Meffert et al., 2019). The knowledge goal of this research could be classified as explorative-explanative. It was explorative because the research area had been barely studied and the results for frugal innovations could be classified as basic research. It was explanative because a theory was applied and extended to the present research context. The derived hypotheses were tested accordingly.

4.3. Quantitative research: partial least squares

Structural equation models (SEM) are often used for explanatory and predictive purposes in the social science. In these models, two methods can be used. One is variance-based structural equation modeling (PLS-SEM) and the other is covariance-based structural equation modeling (CB-SEM or COV-SEM) (Hair et al., 2017). CB-SEM is particularly useful for testing (rejecting or confirming) a theory. It determines how well a model can estimate the covariance matrix for a dataset. PLS-SEM is used mainly in exploratory research applications and theory development. It enables investigations of dependencies between manifest and latent constructs (Boßow-Thies & Panten, 2009). Two models were considered: First, the measurement model for evaluating the manifest indicators to capture the endogenous and exogenous latent constructs and, second, the structural model for evaluation of the constructs (Hair et al., 2017). Thus, the focus of the model is on explaining the variance of the dependent variables (Schneider, 2021a). The PLS-SEM should be used when (Hair et al., 2017; Huber et al., 2011):

- target constructs to be predicted in the model
- formatively measured constructs are present in the model
- the model has a complex structure
- many constructs are present in the model
- the sample is not normally distributed or is small

This work is exploratory and predictive in nature (Boßow-Thies & Panten, 2009; Chin, 1995; Fornell & Bookstein, 1982; Weiber & Mühlhaus, 2014). The established research model was used to predict the target construct "purchase behavior intention." It contained many (10) latent constructs and 17 relationships between the constructs were formulated. Thus, the model can be described as complex. The following **Table 4** shows a formatively measured construct and nine reflectively measured constructs. Moreover, in section 5.1

it will become apparent that not all data were normally distributed. Thus, it conformed to the recommendations of Hair et al. (2017) and Huber et al. (2011) for the use of a variance-based structural equation modeling (PLS-SEM). The analysis in this study was performed using SmartPLS version 3.3.3 software (Sarstedt et al., 2021).

The PLS Model is determined by two systems of equations. The structural model (inner model) reflects the relationships between the constructs, while the measurement models (outer models) show the relationships between the observable manifest variables (synonymous: indicators, items) and the unobservable constructs (latent variables), whereby an indicator is always assigned to exactly one construct (Schneider & Boßow-Thies, 2022).
For the structural model the following applies:
$\eta_j = \sum_i \beta_{ji}\eta_i + \zeta_j$ for all j = 1, ..., J.

with the path coefficients β_{ji} of the structural model, where the index i runs over all the constructs η_j determining the construct and ζ_j stands for the residual variable (Schneider & Boßow-Thies, 2022).
Thus, the constructs are understood as linear functions of their predictor variables (Chin, 1998).

4.3.1. Evaluation measurement model

The measurement model distinguishes between reflective and formative indicators. The direction of effect in reflective measurement (Mode A) runs from the constructs to the indicators. A correlation of the indicators is to be expected. If a construct changes, there is a change in all the indicators assigned to it (Huber et al., 2011). In formative measurements (Mode B), on the other hand, the indicators cause the construct. Thus, a change of the indicators causes

a change of the construct (MacCallum & Browne, 1993). In the case of formative indicators, there should be no correlation among the indicators, so that if one indicator changes, the expressions of the other indicators remain unchanged (Huber et al., 2011).

Thus, for the measurement models, the following continues to apply (Schneider & Boßow-Thies, 2022):

$x_{hj} = \varpi_{hj}\eta_j + \varepsilon_{hj}$, for h=1, ... H. Mode A

$\eta_j = \sum_h \pi_{hj}$, Mode B

While ϖ_{hj} are to be interpreted as changes, π_{hj} represent weights, and ε_{hj} denotes the residual variables of the outer model in reflective constructs (Schneider & Boßow-Thies, 2022).

The PLS algorithm is basically divided into two steps: In the first step, the construct scores are estimated iteratively. Then, in the second step, the path coefficients of the structural model and the weights and loadings of the measurement models are determined using least squares estimations (Boßow-Thies & Panten, 2009; Hair et al., 2021).

The subsequent quality assessment of the PLS model can also be divided into two steps. Thus, the first step is to assess whether the measurement models are considered unidimensional, reliable, and valid. For reflective and formative constructs in the measurement model this assessment is done separately. The reflective constructs are evaluated by means of internal consistency reliability, convergence validity, and discriminant validity. The formative constructs, on the other hand, are evaluated by means of content validity and collinearity testing (Hair et al., 2017). Subsequently, the evaluation of the structural model can begin (Boßow-Thies & Panten, 2009).

Evaluation reflective constructs:

Cronbach's alpha, composite reliability (also called "factor reliability"), and rho_A were used to test internal consistency reliability. The Cronbach's alpha reflects the proportion of the total variance of a scale that is attributable to the common construct. The assumption underpinning the Cronbach's alpha is that the indicators have the same loadings, whereas the composite reliability assumes individual loadings and, thus, returns a more precise result (Cronbach, 1951; Jöreskog, 1971). Both measures of quality have similar thresholds. However, Cronbach's alpha is considered to be the more conservative measure. For both measures, the values should exceed 0.7 (Nunnally & Bernstein, 1994). If the measures have values greater than 0.9 (especially 0.95), this indicates redundant indicators (Hair et al., 2019). In addition, the rho_A is suggested as an exact reliability coefficient. It usually lies between the Cronbach's alpha and the composite reliability. It is, thus, considered an acceptable compromise between the two measures (Dijkstra & Henseler, 2015; Hair et al., 2021)

Convergence validity is used to test the extent to which a measurement is positively correlated with an alternative measurement of the same construct. For this purpose, the amount of loading and the "average variance extracted" (AVE) are used. At least 50% of the variance of an indicator should be explained by the underlying factor, which corresponds to a factor loading of at least 0.707 (Hulland, 1999). In exceptional cases and if the other quality criteria are met, loadings of 0.4 or more can be considered acceptable. Supplementarily, the *p* values of the indicators are assessed from a bootstrap (Hair et al., 2017). Subsequently, the AVE is examined at the construct level. This value is calculated on the mean of the squared loadings of all indicators assigned to the construct. A value of 0.5 indicates that, on average, half of the variance of the indicators can be explained by the construct (Chin, 1998;

Fornell & Larcker, 1981). Discriminant validity is then tested. It gives an indication of the extent to which a construct differs from the others in the model. The cross-loadings of the indicators, the Fornell-Lacker criterion and the heterotrait-monotrait (HTMT) correlation ratio are used to determine this. The cross-charges can be used to check whether the indicator charge on the assigned construct is higher than on the other constructs in the model. In addition, the assigned indicator loadings should be higher on the construct than the other indicators in the model that are assigned to other constructs (Birkinshaw et al., 1995; Chin, 1998). The Fornell-Larcker criterion compares the square root of the AVE with the correlation of the constructs. A construct should share more variance with its associated indicators than with other constructs in the model (Fornell & Larcker, 1981). The HTMT correlation ratio can be used as another criterion (Henseler et al., 2015). This is defined as the mean value of the indicator correlations of different constructs in relation to the (geometric) mean value of the average correlations of the indicators of a construct. If the HTMT value is close to 1, this may indicate a lack of discriminant validity. Depending on the context, thresholds of 0.9 or 0.85 can be used for conceptually similar or dissimilar constructs. An additional test can be performed using the bootstrap. This shows whether the HTMT values are significantly different from 1 or a lower threshold value (Hair et al., 2021).

Evaluation formative construct:

Collinearity and content validity were used to evaluate the formative indicators. Collinearity occurs when multiple indicators in a formative measurement model are highly correlated. Excessive correlation can increase the standard errors of indicator weights, which leads to false negative results (type II errors). If the collinearity is very pronounced, this can lead to a change

in the sign of the indicator weights and, thus, to interpretation distortions (Hair et al., 2021).

The variance inflation factor (VIF) is used as an assessment criterion for this purpose. The VIF value represents the reciprocal of the tolerance, which is the proportion of variance of an indicator that is not explained by the other indicators of the same construct. The threshold value for this is 5. Ideally, the values should be smaller than 3 for the VIF value (Diamantopoulos & Winklhofer, 2001; Hair et al., 2019). Content validity is used to assess whether the indicators sufficiently cover the content of the construct to which they are assigned. The signs and magnitudes of the respective weights, as well as their significances (from the separate bootstrap), are used for the assessment (Bollen & Lennox, 1991). The indicator weights are derived from the regression of each formatively measured construct on its associated indicators. The significances are determined using the bootstrapping procedure (Hair et al., 2021)

If the quality criteria of the reflective and formative constructs in the measurement model are considered to be met, the next step is to begin testing the structural model.

4.3.2. Evaluation structural model

Here, possible collinearities are first assessed. This is done because the later estimation of path coefficients on regressions of the ordinary least squares (OLS) of each endogenous construct is based on their predictive power. If there is a high degree of collinearity among the predictor constructs, the path coefficients may be biased (Hair et al., 2021). If these can be ruled out, the heights and significances of the path coefficients are tested. Furthermore, the explained variances of the endogenous constructs, as well as the effect sizes and predictive relevance, are evaluated (among other Boßow-Thies & Panten,

2009; Hair et al., 2019). For collinearity testing, the VIF is used as before for the formative constructs. The same thresholds apply as for the formative constructs (Hair et al., 2019). Subsequently, the path coefficients of the model are evaluated and the previously theoretically derived hypotheses are tested. These are to be interpreted as standardized regression coefficients that evaluate the direction, significance, and strength of influence of the coefficients in the model. Significance is calculated using a nonparametric bootstrap procedure. Complementary assessment of mediation effects can be done by calculating the indirect and total effects of the exogenous on the endogenous constructs (Matthews et al., 2018). The R^2 of the endogenous constructs is a main criterion in the evaluation of the structural model. It indicates the proportion of the variance of the endogenous constructs that can be explained by all the exogenous constructs associated with it and is, thus, a measure of the explanatory power of the model. According to Chin, values of 0.67 are considered substantial, 0.33 moderate, and 0.19 weak (Chin, 1998). However, the R^2 values should always be assessed in context; for example, in comparison with other studies on the present study context. Since the R^2 is influenced by the number of exogenous constructs, the corrected coefficient of determination R^2_{adj} should also be examined. This should be used, in particular, for the comparison of models (Hair et al., 2017). In addition, the effect sizes (f^2) of the exogenous constructs are calculated. The f^2 value indicate the change in the R^2 value of the endogenous construct when individual constructs acting on it are taken into account and excluded. The values can be divided into different ranges (value above 0.02: small influence; above 0.15: medium influence; above 0.35: large influence; Chin, 1998). For the endogenous reflective constructs, the predictive relevance can additionally be calculated. For this purpose, the Stone-Geisser criterion (Q^2) is used (Geisser, 1974; Stone, 1974). Based on the blindfolding technique, it provides an indication of how well the endogenous constructs can be predicted by the exogenous constructs. Values

greater than 0, 0.25, 0.5 indicate small, medium, and high predictive relevance respectively.

Complementarily, the $PLS_{predict}$ is increasingly used as an additional method for out-of-sample prediction in the context of PLS analyses (Shmueli et al., 2016). Here, *k*-fold cross-validation is performed (*k* = number of subgroups) to assess the predictive quality of the PLS pathway models (Hair et al., 2021). Values of $Q^2_{predict} > 0$ indicate that the present model predicts better values than a naive benchmark (mean of indicators). In addition, the RMSE (root mean squared error) values from the PLS should also be compared to a benchmark. Here, linear regressions (LM for linear model) of all items on one item each of the final endogenous construct can be used (Danks & Ray, 2018). The prediction errors from the PLS should be as small as possible compared to the analysis with LM per item (Hair et al., 2021).

4.3.3. Operationalization of the model constructs

The explanatory model developed for the acceptance of frugal innovations in household appliances was based on relationships among the constructs. In order to be able to evaluate these, the operationalization of the constructs was based on the previously-conducted literature analysis. A prerequisite for the acceptance of an operationalization was high goodness (Cronbach's $\alpha > 0.7$). The operationalizations were adapted to the present context and translated into German for the questionnaire. A seven-point Likert scale, from "1 = strongly disagree" to "7= strongly agree," was used throughout to measure the items. The only exception was the construct "attitude toward using." For this, a seven-point bipolar scale was chosen (see **Table 4**). Except for subjective norm, all the constructs were operationalized reflectively. "Subjective norm" was operationalized formatively. The following **Table 4** shows the operationalization of the 10 constructs of the model.

Table 4

Operationalization of the constructs

Construct (source) **Item**	
Financial Advantage (FA) (Valls et al., 2012)	
FA01_01	I am willing to buy a cheaper household appliance instead of the one I want to buy.
FA01_02	Every time I buy household appliance, I compare prices until I find the lowest one.
FA01_03	I always seek discounts or special offers.
Performance Expectation (PX) (Dodds et al., 1991; Sweeney et al., 1999)	
PX01_01	Frugal household appliances should be reliable.
PX01_02	Frugal household appliances should be dependable.
PX01_03	Frugal household appliances should be durable.
PX01_04	The workmanship of frugal household appliances should be good.
PX01_05	Frugal household appliances should be of good quality.
Environmental Awareness (EA) (Ahn et al., 2016; Wang et al., 2020)	
EA01_01	I consider the potential environmental impact of my actions when making many of my decisions.
EA01_02	I am concerned about wasting the resources of our planet.
EA01_03	I would like to describe myself as environmentally responsible.
EA01_04	I am willing to be inconvenienced in order to take actions that are more environmentally friendly.
EA01_05	It is important to me that the products I use do not harm the environment.
EA01_06	My purchase habits are affected by my concern for our environment.
Subjective Norm (SN) (Pousttchi & Goeke, 2011)	
SN02_01	Friends would recommend the use of frugal household appliances.
SN02_02	Experts would recommend the use of frugal household appliances.
SN02_03	Media would recommend the use of frugal household appliances.
SN02_04	I think other people would use frugal household appliances.
SN02_05	Friends and colleagues would use frugal household appliances.

Construct (source) **Item**	
Sustainable Innovativeness (SI) (Ahn et al., 2016)	
SI01_01	In general, I am among the first in my circle of friends to buy new sustainable products when they appear.
SI01_02	If I heard that a new sustainable product was available in the store, I would be interested enough to buy it.
SI01_03	Compared with my friends, I own a lot of sustainable products.
SI01_04	In general, I am among the first in my circle of friends to know the titles/brands of the latest sustainable products.
SI01_05	I will buy a new sustainable product even if I haven't tried it yet.
SI01_06	I like to buy sustainable products before other people do.
Perceived Behavior Control (BC) (Verma & Chandra, 2018; Yadav & Pathak, 2017)	
BC01_01	Whether or not I buy a frugal household appliance in place of a conventional household appliance is completely up to me.
BC01_02	I have the resources to buy a frugal household appliance.
BC01_03	I am confident that if I want to, I can buy frugal household appliances in place of conventional household appliance.
Perceived Ease of Use (PE) (Davis, 1989; Lu et al., 2019; Venkatesh & Davis, 2000)	
	I think that a frugal household appliance is...
PE01_01	… easy to use.
PE01_02	… clear and understandable in operation.
PE01_03	… easy to learn how to use.
PE01_04	… easy to get to do what I want it to do.
Perceived Usefulness (PU) (Davis, 1989)	
PU02_01	Using a frugal household appliance enhances my effectiveness because fewer resources are needed to achieve the same result.
PU02_02	Using a frugal household appliance would make the activities easier to do.
PU02_03	Overall, I find that frugal household appliances are useful.

Construct (source) **Item**	
Attitude Toward Using (AT) (Ajzen, 1991; Liang et al., 2013)	
	I find the use of a frugal household appliance ...
AT02_01	negative ... positive.
AT02_02	worthless ... valuable.
AT02_03	not desirable ... desirable.
AT02_04	useless ... useful.
AT02_05	disadvantageous ... advantageous.
Purchase Behavior Intention (PB) (Ajzen, 1991; Liang et al., 2013; Moon & Kim, 2001; Venkatesh et al., 2003)	
	Assuming frugal household appliances were readily available on the German market, how likely is it that you would buy a frugal household appliance?
PB01_01	I intend to buy a frugal household appliance.
PB01_02	I plan to buy a frugal household appliance.
PB01_03	I can imagine buying a frugal household appliance.
PB01_04	I will recommend to others that they buy a frugal household appliance.

Figure *8* shows the model to be tested with the constructs and items.

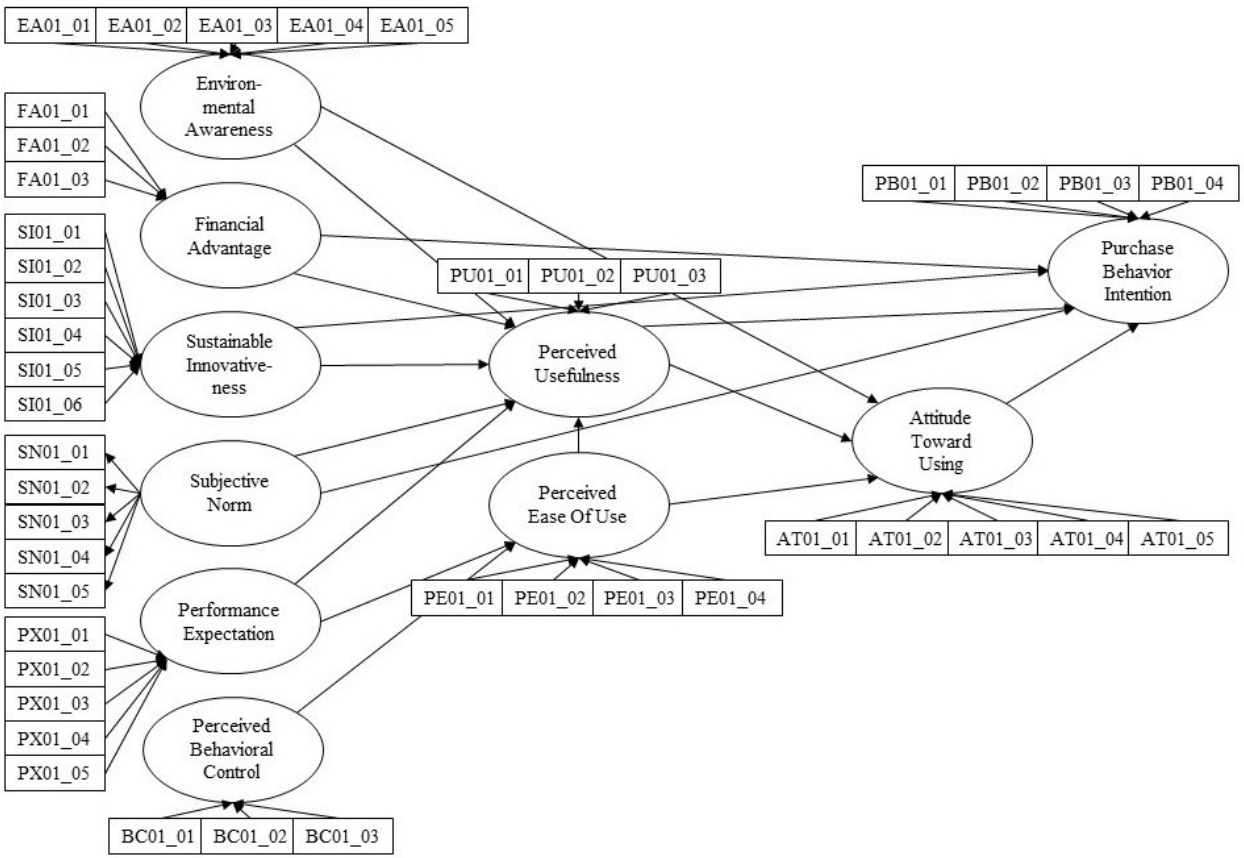

Figure 8 Developed research model

4.4. Data collection and sample description

The data collection was planned as a cross-sectional study and carried out online using the survey platform soscisurvey.de from March 19 to May 13, 2021. The questionnaire had 56 questions that took about 10 minutes to answer (see appendix 1).

Before the main investigation could be carried out, the questionnaire was subjected to a pretest. The focus here was on the applicability, completeness, comprehensibility, and duration of answering all the questions. The modification comments were incorporated into the questionnaire.

The questionnaire opened with an introductory text on the purpose of the survey and a note on the anonymity of the data collection. Furthermore, a short description of frugal innovations was provided on the second page.

The first question was aimed at determining whether the participants had heard of frugal innovations. If this question was answered in the affirmative, the respondents were asked to provide known examples. In the subsequent main section, the 44 questions / items of the operationalized constructs were presented. The questionnaire concluded with questions regarding the socio-demographics of the participants, such as gender, year of birth, school-leaving qualification, household type and size in persons, and household income.

The link to participate was sent electronically via WhatsApp and by email within the university and in private and professional environments. The participants were asked to forward the link as well. Thus, the actual number of linked recipients is unknown. In total, there were 1,259 returns. Of these, those with more than 20% missing values were excluded (Weiber & Mühlhaus, 2014). Furthermore, the ones that showed overly rapid fast response behavior were eliminated. That is, all those with a relative speed index (RSI) > 2 or an RSI ≥ 1.75 with concurrent degradation time (DEG) ≥ 100 were removed

(Leiner, 2019). Thus, the remaining sample was 950 records, with only 0.84% missing values. The latter were replaced by SmartPLS with mean values in order to calculate with a complete dataset (Hair et al., 2017).

When asked about gender in the sample, 510 (53.68%) respondents indicated female, 420 (44.21%) indicated male, 10 indicated diverse (1.05%), and 10 (1.05%) did not answer the question. According to the Federal Statistical Office, the proportion of women in Germany in 2021 was 50.72% and the proportion of men was 49.40% (Federal Statistical Office, 2022). The gender "diverse" is not reported by the Federal Statistical Office. Thus, there is a slight underweighting of men in the sample. The sample comprised participants between the birth years 1937 and 2003. The mean age was 37 years and the median was 31 years. Household size had a mean (MV) of 2.27 and a median of 2. The average household size in Germany in 2019 was 1.99 (Federal Statistical Office, 2020). For the multi-person households in the study, the mean value of the number of children was 0.51 and the median was 0. Moreover, the percentage of single households was 22.11%. According to the Federal Statistical Office, the proportion of single households in Germany is 20% and multi-person households 80% (Federal Statistical Office, 2021).

The proportion of participants with high school diplomas (66.42%) was significantly higher than in the population. In Germany, the proportion of people with a high school diploma in 2019 was 18.4–30.0% (different for the age groups) (Geis-Thöne, 2021).

The aforementioned characteristics were, thus, similar to the population in Germany and the dataset was suitable for the objectives of this study. The following **Table *5*** shows further figures for the sample description.

Table 5

Sample description

Characteristic	Missing values	Mean Value	Median	Number	Percentage
Gender	10				1.05
1 = female				510	53.68
2 = male				420	44.21
3 = diverse				10	1.05
Age (year of birth)	14	1984	1990		
Household type	19				2.00
1 = Single household				210	22.11
2 = Single parent				17	1.79
3 = Couple without child(ren)				351	36.95
4 = Couple with child(ren)				213	22.42
5 = Generation household				55	5.79
6 = Shared apartment				70	7.37
7 = Other households				15	1.58
Lives with parents	20				2.11
1 = yes				60	6.32
2 = no				870	91.58
Household members	29	2.269	2	Min. 1 Max. 10	
thereof children	40	0.511	0	Min. 0 Max. 4	
Household income	18				1.89
1 = less than 1,300 €				28	2.95
2 = 1,300 € to less than 1,700 €				46	4.84
3 = 1,700 € to less than 2,600 €				125	13.16
4 = 2,600 € to under 3,600 €				134	14.11
5 = 3,600 € to under 5,000 €				211	22.21
6 = 5,000 € to under 18,000 €				209	22.00
7 = 18,000 € and more				5	0.53
8 = I have no income of my own.				26	2.74
9 = I do not want to answer this question.				148	15.58

Characteristic	Missing values	Mean value	Median	Number	Percentage
School-leaving qualification	9				0.95
1= No school-leaving qualification				1	0.11
2 = Still in school				2	0.22
3 = Secondary school (German: Hauptschule)				22	2.32
4 = Secondary school (German: Realschule)				114	12.00
5 = Advanced technical college entrance qualification				147	15.47
6 = High school diploma				631	66.42
7 = Other qualification				24	2.53
Academic degree	12				1.26
1 = No academic degree/still in academic training				373	39.26
2 = Bachelor - or equivalent				327	34.42
3 = Master - or equivalent				203	21.37
4 = Doctor / Professor				35	3.68
Professional qualification	109				11.47
1 = No completed vocational training/still in vocational training				235	24.74
2 = Completed vocational training/journeyman's examination or similar				471	49.58
3 = Master craftsman/Fachwirt or similar				135	14.21

The characteristics of Podsakoff et al. (2003) and MacKenzie and Podsakoff (2012) were considered to obtain the lowest possible common method bias. The participants were assured of the anonymity of their responses and were told that there were no right or wrong answers. In addition, the measurement indicators were adapted to the study.

5. RESULTS AND EVALUATION

5.1. Descriptive analyses

The first analysis was done on item level. The descriptive data were searched for abnormalities. The expressions of the items covered the complete scale range of 1–7 (except for the items PX01_02, PX01_03, PX01_05). The items PX01_02, PX01_03 and PX01_05 covered the scale width of 2–7. The standard deviations and mean widths did not show any particular abnormalities (except for the PX items). Due to the standard deviations of up to 1.78, a wider dispersion in the data could be assumed (see **Table 6** below).

Table 6

Descriptive analysis

Item	Mean value	Median	Min	Max	Standard deviation	Camber	Skew
BC01_01	5.58	6	1	7	1.43	0.181	-0.877
BC01_02	5.44	6	1	7	1.38	0.232	-0.764
BC01_03	5.36	5	1	7	1.37	0.071	-0.674
EA01_01	4.52	5	1	7	1.34	-0.361	-0.193
EA01_02	5.73	6	1	7	1.29	0.678	-0.992
EA01_03	4.57	5	1	7	1.25	-0.197	-0.187
EA01_04	4.77	5	1	7	1.29	-0.255	-0.334
EA01_05	4.98	5	1	7	1.28	-0.253	-0.344
EA01_06	4.61	5	1	7	1.49	-0.522	-0.323
PU02_01	5.29	6	1	7	1.51	0.115	-0.784
PU02_02	4.25	4	1	7	1.61	-0.443	-0.158
PU02_03	5.19	5	1	7	1.32	-0.117	-0.402
FA01_01	4.41	5	1	7	1.67	-0.800	-0.256
FA01_02	4.28	4	1	7	1.74	-0.935	-0.151
FA01_03	4.46	5	1	7	1.78	-0.921	-0.246

Item	Mean value	Median	Min	Max	Standard deviation	Camber	Skew
AT02_01	5.79	6	1	7	1.13	0.244	-0.796
AT02_02	5.54	6	1	7	1.35	0.974	-1.004
AT02_03	5.51	6	1	7	1.36	0.824	-0.957
AT02_04	5.42	6	1	7	1.38	0.776	-0.922
AT02_05	5.30	5	1	7	1.39	0.359	-0.736
SI01_01	3.40	3	1	7	1.55	-0.657	0.223
SI01_02	4.28	4	1	7	1.57	-0.591	-0.240
SI01_03	3.77	4	1	7	1.44	-0.415	0.019
SI01_04	3.20	3	1	7	1.50	-0.518	0.368
SI01_05	3.96	4	1	7	1.57	-0.734	-0.058
SI01_06	3.30	3	1	7	1.55	-0.739	0.206
PE01_01	5.35	5	1	7	1.28	-0.167	-0.493
PE01_02	5.54	6	1	7	1.31	0.618	-0.877
PE01_03	5.62	6	1	7	1.20	0.341	-0.727
PE01_04	5.34	5	1	7	1.28	0.042	-0.571
PX01_01	6.42	7	1	7	0.93	4.734	-2.013
PX01_02	6.31	7	2	7	0.97	2.825	-1.621
PX01_03	6.41	7	2	7	0.94	3.934	-1.908
PX01_04	6.33	7	1	7	0.97	3.689	-1.737
PX01_05	6.37	7	2	7	0.93	3.262	-1.732
SN02_01	3.96	4	1	7	1.43	-0.291	-0.090
SN02_02	4.55	5	1	7	1.39	-0.129	-0.352
SN02_03	3.94	4	1	7	1.45	-0.488	-0.064
SN02_04	4.70	5	1	7	1.23	0.176	-0.405
SN02_05	4.46	5	1	7	1.25	0.086	-0.314
PB01_01	4.76	5	1	7	1.41	0.147	-0.528
PB01_02	3.67	4	1	7	1.71	-0.796	0.074
PB01_03	5.26	5	1	7	1.40	0.362	-0.738
PB01_04	4.36	4	1	7	1.58	-0.436	-0.254

The means and medians of the items PX01_01 to PX01_05 show conspicuous values >6.0, a low deviation (<1). This is shown graphically with a left skewed distribution (see **Figure 9**). There is a high degree of uniformity among participants. Since PLS-SEM does not require normally distributed data, these could be left in the dataset.

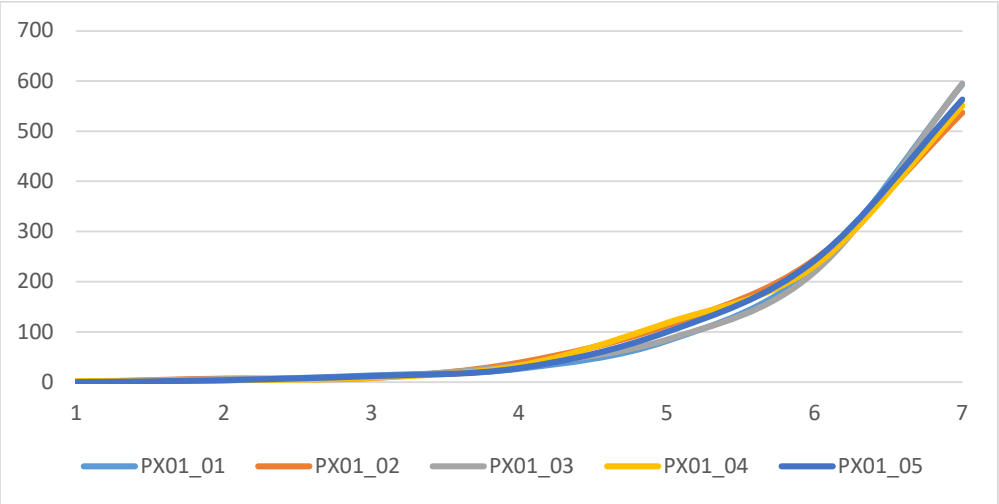

Figure 9 Items Performance Expectation

After the evaluation of the descriptive data, the data evaluation with PLS could begin. As described in the section 4.3, the measurement model was analyzed in the first section and the structural model second.

5.2. Evaluation of the measurement model

The measurement model tested how well the items reflected the hypothetical construct. The reflective and formative constructs were analyzed separately. The model contained nine reflective operationalized constructs and one formative operationalized construct. As described in section 4.3.1, the evaluation of the reflective constructs was based on internal consistency

reliability, convergence validity, and discriminant validity. The formative construct was evaluated as described in section 4.3.1 on the multicollinearity and content validity.

To account for static significances, bootstrapping was applied as a non-parametric procedure in SmartPLS. Random subsamples were drawn from the dataset to ensure the stability of the results. A total of 5,000 subsamples were chosen for the analysis. The bias-corrected and accelerated (BCa) bootstrap was chosen. This corrects for bias and skewness in the bootstrap distribution and results in narrow intervals (Efron, 1987). A two-sided significance test with a significance level of 0.1 was chosen.

5.2.1. Quality assessment of reflective operationalized constructs

In general, the first step in assessing the quality of reflective constructs is to examine content validity. This ensures that the items capture the meaning of the construct. Since the operationalization of the constructs of this study was based on already validated items, a sufficient content validity could be assumed and the researcher could directly proceed to the indicator reliability. This was based, among other things, on the level of the loadings of the individual items and their significances. The loading needed to be greater than 0.7 and smaller than 0.95. **Table 7** below shows that (except for item BC01_01 and FA01_03) all the factor loadings in the original sample were between 0.746 and 0.926 and all p values were ≤0.001, and, thus, highly significant. Item BC01_01 had a loading of 0.699 and was, thus, only minimally below the value of 0.7. Item FA01_03 had a loading of 0.668. Both showed high significance. Both items were tested individually to determine whether the deletion led to an increase in the reliability of the internal consistency and the

convergent validity (Hair et al., 2021). Since this was not the case for either of them, they were left in the model.

Table 7

Content validity of constructs: outer loadings and significances

Item	Loadings	Standard deviation	T-Statistic	*P* value
BC01_01	0.699	0.033	21.099	<0.001
BC01_02	0.846	0.018	45.917	<0.001
BC01_03	0.869	0.013	68.000	<0.001
EA01_01	0.837	0.012	70.302	<0.001
EA01_02	0.769	0.017	46.055	<0.001
EA01_03	0.821	0.015	55.857	<0.001
EA01_04	0.806	0.014	56.357	<0.001
EA01_05	0.856	0.010	83.678	<0.001
EA01_06	0.872	0.008	111.674	<0.001
PU02_01	0.782	0.021	37.877	<0.001
PU02_02	0.746	0.024	30.665	<0.001
PU02_03	0.879	0.008	114.891	<0.001
FA01_01	0.861	0.064	13.437	<0.001
FA01_02	0.787	0.098	7.995	<0.001
FA01_03	0.668	0.125	5.358	<0.001
AT02_01	0.807	0.017	47.208	<0.001
AT02_02	0.864	0.013	66.915	<0.001
AT02_03	0.885	0.009	99.198	<0.001
AT02_04	0.860	0.011	75.199	<0.001
AT02_05	0.861	0.011	81.065	<0.001
SI01_01	0.843	0.013	67.381	<0.001
SI01_02	0.828	0.012	70.343	<0.001
SI01_03	0.856	0.011	80.579	<0.001
SI01_04	0.832	0.013	65.316	<0.001
SI01_05	0.790	0.015	52.149	<0.001
SI01_06	0.804	0.016	49.386	<0.001

Item	Loadings	Standard deviation	T-Statistic	*P* value
PE01_01	0.875	0.012	74.415	<0.001
PE01_02	0.864	0.017	50.975	<0.001
PE01_03	0.920	0.008	108.545	<0.001
PE01_04	0.890	0.010	87.225	<0.001
PX01_01	0.904	0.017	54.448	<0.001
PX01_02	0.889	0.014	62.793	<0.001
PX01_03	0.919	0.010	90.449	<0.001
PX01_04	0.926	0.008	118.593	<0.001
PX01_05	0.916	0.010	93.496	<0.001
SN02_01	0.822	0.034	24.335	<0.001
SN02_02	0.578	0.053	10.951	<0.001
SN02_03	0.360	0.060	5.994	<0.001
SN02_04	0.750	0.039	19.479	<0.001
SN02_05	0.920	0.024	37.566	<0.001
PB01_01	0.857	0.012	73.913	<0.001
PB01_02	0.766	0.017	43.828	<0.001
PB01_03	0.851	0.012	73.489	<0.001
PB01_04	0.884	0.009	95.397	<0.001

Table *8* shows the internal consistency reliability, which, as described in section 4.3.1 was evaluated by Cronbach's α (>0.7), the CR value (>0.6) and rho_A (Hair et al., 2021). All the values were above the minimum values. The internal consistency of the constructs was fulfilled via sufficient values of Cronbach's α (between 0.715 and 0.949), the composite reliability (between 0.818 to 0.961) and the reliability coefficient rho_A, which was in the range of 0.759 to 0.950.

The convergent validity, as described in section 4.3.1, was tested by the AVE (>0.5) (Hair et al., 2021). The AVE, as shown in the**Table 8** below, was also fulfilled with values from 0.830 to 0.602.

Table 8

Internal consistency reliability and convergent validity

Construct	Cronbach's α	CR	rho_A	AVE
Attitude Toward Using (AT)	0.909	0.932	0.913	0.733
Environmental Awareness (EA)	0.908	0.929	0.910	0.685
Financial Advantage (FA)	0.715	0.818	0.847	0.602
Perceived Behavioral Control (BC)	0.732	0.849	0.759	0.653
Perceived Ease Of Use (PE)	0.910	0.937	0.913	0.787
Perceived Usefulness (PU)	0.738	0.845	0.817	0.646
Performance Expectation (PX)	0.949	0.961	0.950	0.830
Purchase Behavior Intention (PB)	0.861	0.906	0.872	0.706
Sustainable Innovativeness (SI)	0.907	0.928	0.909	0.682

Discriminant validity was then tested using the cross loadings, the Fornell-Lacker criterion, and the HTMT correlation ratio. The cross loadings show that the correlation of the items with the assigned constructs was higher than with the remaining latent constructs (see appendix 2).

Table 9 shows that the correlations between the latent variables were smaller than the root of the AVE.

Table 9

Fornell-Larcker criterion

Construct	Construct								
	AT	EA	FA	BC	PE	PU	PX	PB	SI
AT	*0.856*								
EA	0.422	*0.828*							
FA	0.071	-0.014	*0.776*						
BC	0.278	0.255	0.116	*0.808*					
PE	0.276	0.227	0.128	0.381	*0.887*				
PU	0.520	0.397	0.139	0.281	0.321	*0.804*			
PX	0.277	0.238	0.076	0.381	0.365	0.311	*0.911*		
PB	0.600	0.464	0.125	0.348	0.382	0.558	0.244	*0.840*	
SI	0.359	0.690	0.007	0.204	0.170	0.341	0.102	0.462	*0.826*

As can be seen in **Table 10**, the HTMT thresholds did not exceed 0.85 due to the conceptually different constructs. Thus, all the constructs met the requirements of discriminant validity (Hair et al., 2021).

Table 10

Heterotrait-monotrait ratio

Construct	Construct							
	AT	EA	FA	BC	PE	PU	PX	PB
EA	0.458							
FA	0.085	0.076						
BC	0.330	0.309	0.144					
PE	0.298	0.250	0.133	0.461				
PU	0.586	0.457	0.184	0.351	0.366			
PX	0.294	0.256	0.083	0.459	0.391	0.347		
PB	0.663	0.518	0.132	0.420	0.422	0.654	0.262	
SI	0.389	0.757	0.060	0.238	0.185	0.402	0.107	0.517

Thus, all the reflective constructs met the quality criteria and were sufficiently valid and reliable.

5.2.2. Quality assessment of formative operationalized construct

In order to assess the formative construct subjective norm, the researcher began by examining the extent of the linear dependencies of the items, as these can lead to biased significance estimates. The VIF was used as an assessment criterion for this purpose. **Table 11** below shows that all the VIF values were below 3; thus no collinearity problems were indicated.

Table 11

Outer weights and significances

Item	Weight	Standard deviation	T-Statistic	*P* value	VIF
SN02_01	0.399	0.070	5.743	0.000	1.620
SN02_02	0.162	0.066	2.458	0.014	1.576
SN02_03	-0.074	0.062	1.196	0.232	1.377
SN02_04	0.093	0.083	1.115	0.265	2.232
SN02_05	0.581	0.089	6.498	0.000	2.524

To assess content validity, the item weights were examined first. In **Table 11** above, it can be seen that all the weights of the formative construct have the hypothesized signs, except for item SN02_03. The items SN02_01, SN02_02 and SN02_05 show appropriate weights. These range from 0.162 to 0.581 and are significant ($p \leq 0.1$). The items SN02_03 and SN02_04 of the construct subjective norm have non-significant weights (0.232 and 0.265).

In accord with Hair et al. (2021), an additional inspection of the loadings and the significance of the corresponding items was performed. First, it was determined for both items that the weights showed non-significant *p* values.

The loadings were subsequently inspected (cf. **Table 7**). The loading of the item SN02_04 showed a value of >0.5, so the item remained in the model. The loading of the item SN02_03 was <0.5; therefore, the significance of the loading was tested in a next step. The *p* value was significant ($p \leq 0.001$). Thus, the item also remained in the model.

Finally, the measurement model fulfilled all the quality criteria. In the next step, the structural model could be analyzed on this basis.

5.3. Evaluation of the structure model

For the quality assessment, the structural model was first examined for possible collinearity problems. For this purpose, the inner variance inflation factors (VIFs) were calculated (see **Table 12**). No VIF value exceeded the cutoff value of 5, nor the narrower value of 3 (Hair et al., 2019). The highest value in the model was 2.114.

Table 12

Inner variance inflation factors

	Construct			
Construct	AT	PE	PU	PB
AT				1.586
EA	1.226		2.087	2.114
FA			1.073	1.075
BC	1.232	1.170		
PE	1.249		1.254	
PU	1.292			1.510
PX		1.170	1.203	
SN			1.377	1.475
SI			1.991	1.283

Subsequently, the height of the path coefficients and the significance of the path coefficients were evaluated (see **Table 13**). These were determined using the bootstrapping procedure. A two-sided significance test with a significance level of 10% was performed. The path coefficient from FA to PB (H3) was the only one that was not significant. The path coefficients of FA on PU (H4), SI on PU (H6), BC on AT (H11) and PE on AT (H16) were significant, but their influence was very small (<0.1) (Sellin & Keeves, 1994).

Table 13

Path coefficients and significances

Construct	Hypothesis	Path coefficient	Standard deviation	*T*-statistic	*P* values
Perceived Usefulness (PU)					
EA → PU	H1	0.178	0.041	4.390	≤0.001
FA → PU	H4	0.065	0.030	2.154	0.031
SI → PU	H6	0.092	0.041	2.254	0.024
SN → PU	H8	0.216	0.037	5.814	≤0.001
PX → PU	H9	0.171	0.028	6.210	≤0.001
PE → PU	H15	0.127	0.033	3.797	≤0.001
Perceived Ease Of Use (PE					
PX → PE	H10	0.256	0.033	7.829	≤0.001
BC → PE	H12	0.284	0.034	8.356	≤0.001
Attitude Toward Using (AT)					
EA → AT	H2	0.234	0.033	7.111	≤0.001
BC → AT	H11	0.087	0.032	2.688	0.007
PU → AT	H13	0.381	0.035	10.987	≤0.001
PE → AT	H16	0.068	0.036	1.860	0.063
Purchase Behavior Intention (PB)					
FA → PB	H3	0.010	0.025	0.421	0.674
SI → PB	H5	0.168	0.028	6.044	≤0.001
SN → PB	H7	0.271	0.033	8.157	≤0.001
PU → PB	H14	0.237	0.030	7.875	≤0.001
AT → PB	H17	0.293	0.031	9.522	≤0.001

In addition, a multiple mediation analysis of the structural model was performed because exogenous constructs often influence endogenous constructs through more than one mediator variable (Hair et al., 2017). For this purpose, the indirect and total effects of the exogenous constructs on the endogenous constructs were evaluated. As **Table 14** indicates, the path BC→PE→AT→PB was not significant and was, thus, not a mediator in the relationship. The others show significant path coefficients with a small influence. Only the path coefficient of PU→AT→PB was above 0.1. Thus, these stand as mediators in their respective relationships.

Table 13 shows that the path coefficient of hypothesis H3 of FA→PB was not significant. The indirect effects via PU and PU→AT showed significant path coefficients with small influences. Thus, there was a purely indirect mediation (Matthews et al., 2018).

All the other hypothesized direct relationships had significant path coefficients (see **Table 13**) and significant path coefficients of the indirect relationships (see **Table 14**). Thus, for all of them, a partial mediation by the indirect relations was present, which, however, due to the path coefficients <0.1 (with the exception of PU→AT→PB=0.112), can be considered as low.

Table 14

Specific indirect effects

Path	Path coefficient	Standard deviation	*T*-statistic	*P* values
EA → AT → PB	0.068	0.011	6.341	≤0.001
EA → PU → AT	0.068	0.016	4.317	≤0.001
EA → PU → AT → PB	0.020	0.005	3.763	≤0.001
EA → PU → PB	0.042	0.011	3.901	≤0.001
FA → PU → AT	0.025	0.011	2.149	0.032
FA → PU → AT → PB	0.007	0.003	2.063	0.039
FA → PU → PB	0.015	0.007	2.061	0.039
BC → AT → PB	0.025	0.010	2.533	0.011
BC → PE → AT	0.019	0.011	1.771	0.077
BC → PE → AT → PB	0.006	0.003	1.645	0.100
BC → PE → PU	0.036	0.011	3.287	≤0.001
BC → PE → PU → AT	0.014	0.004	3.321	≤0.001
BC → PE → PU → AT → PB	0.004	0.001	3.144	0.002
BC → PE → PU → PB	0.009	0.003	2.912	0.004
PE → AT → PB	0.020	0.011	1.722	0.085
PE → PU → AT	0.048	0.013	3.818	≤0.001
PE → PU → AT → PB	0.014	0.004	3.563	≤0.001
PE → PU → PB	0.030	0.009	3.283	≤0.001
PU → AT → PB	0.112	0.017	6.692	≤0.001
PX → PE → AT	0.017	0.010	1.803	0.072
PX → PE → AT → PB	0.005	0.003	1.675	0.094
PX → PE → PU	0.033	0.009	3.544	≤0.001
PX → PE → PU → AT	0.012	0.004	3.525	≤0.001
PX → PE → PU → AT → PB	0.004	0.001	3.310	≤0.001
PX → PE → PU → PB	0.008	0.002	3.122	0.002
PX → PU → AT	0.065	0.013	5.205	≤0.001
PX → PU → AT → PB	0.019	0.004	4.490	≤0.001
PX → PU → PB	0.041	0.009	4.735	≤0.001
SN → PU → AT	0.082	0.018	4.490	≤0.001
SN → PU → AT → PB	0.024	0.006	3.910	≤0.001
SN → PU → PB	0.051	0.011	4.585	≤0.001
SI → PU → AT	0.035	0.016	2.141	0.032
SI → PU → AT → PB	0.010	0.005	2.044	0.041
SI → PU → PB	0.022	0.010	2.188	0.029

To determine whether a path coefficient was meaningful, the total effects (sum of the direct effect and all the indirect effects) were also interpreted in the next step. This provided a more comprehensive picture of the relationships in the structural model.

The total effects (see **Table 15**) were all significant, except for FA→PB (H3). However, many values were below 0.1 and, therefore, negligible. The total effect of EA→PB showed a significant influence and consisted only of indirect effects (no direct influence was found). For hypotheses H2, H5, H7, H9, H11, H14, and H16, the total effects showed higher values than the path coefficients (see **Table 13**). For these, there was both a direct and indirect effect, which were complementary. The values of the path coefficients and total effects differed by 0.033-0.075. The limit value of 0.1 was exceeded for hypotheses H11 and H16. The largest indirect effect also affected hypothesis H14. For this one, the difference amounted to 0.111 due to the previously established indirect influence PU→AT→PB.

There were no relevant indirect influences for hypotheses H1, H4, H6, H8, H10, H12, H13, H15, or H17.

Table 15

Total effects

Path	Hypothesis	Path coefficient	Standard deviation	*T*-statistic	*P* values
AT → PB	H17	0.293	0.031	9.522	≤0.001
EA → AT	H2	0.302	0.035	8.610	≤0.001
EA → PU	H1	0.178	0.041	4.139	≤0.001
EA → PB	-	0.131	0.018	7.115	≤0.001
FA → AT	-	0.025	0.011	2.149	0.032
FA → PU	H4	0.065	0.030	2.154	0.031
FA → PB	H3	0.033	0.026	1.286	0.198
BC → AT	H11	0.120	0.032	3.783	≤0.001
BC → PE	H12	0.284	0.034	8.356	≤0.001
BC → PU	-	0.036	0.011	3.287	≤0.001
BC → PB	-	0.044	0.011	3.944	≤0.001
PE → AT	H16	0.116	0.037	3.098	0.002
PE → PU	H15	0.127	0.033	3.797	≤0.001
PE → PB	-	0.064	0.016	3.974	≤0.001
PU → AT	H13	0.381	0.035	10.987	≤0.001
PU → PB	H14	0.348	0.027	12.673	≤0.001
PX → AT	-	0.095	0.016	6.049	≤0.001
PX → PE	H10	0.256	0.033	7.829	≤0.001
PX → PU	H9	0.204	0.028	7.311	≤0.001
PX → PB	-	0.076	0.012	6.426	≤0.001
SN →AT	-	0.082	0.018	4.490	≤0.001
SN → PU	H8	0.216	0.037	5.814	≤0.001
SN → PB	H7	0.346	0.032	10.885	≤0.001
SI → AT	-	0.035	0.016	2.141	0.032
SI → PU	H6	0.092	0.041	2.254	0.024
SI → PB	H5	0.201	0.031	6.520	≤0.001

After evaluating the relevance and significance of the structural model relationships, the explanatory power of the model was then examined. For this purpose, the coefficient of determination R^2 of the endogenous constructs was assessed (**Table *16***). The values of PE (0.202) and PU (0.293) were found to be weak. AT (0.339) and PB (0.541) had moderate R^2 values. The R^2_{adj} supported this result.

Table 16

Coefficient of determination (R^2)

Construct	R^2	R^2_{adj}
Attitude Toward Using (AT)	0.339	0.337
Perceived Ease Of Use (PE)	0.202	0.200
Perceived Usefulness (PU)	0.293	0.289
Purchase Behavior Intention (PB)	0.541	0.538

In addition, the effect sizes (f^2) of the exogenous constructs were assessed (see **Table 17**). FA→PE, FA→PB, BC→AT, PE→AT, PE→PU and SI→PU had no relevant effect. The others showed a small effect and PE→AT a moderate effect.

Table 17

Effect size (f^2)

Construct	Exogenous construct			
	AT	PE	PU	PB
AT				0.120
EA	0.067		0.022	
FA			0.005	0.000
BC	0.009	0.087		
PE	0.006		0.018	
PU	0.170			0.082
PX		0.070	0.034	
SN			0.048	0.108
SI			0.006	0.048

Subsequently, the predictive relevance Q^2 was calculated for the endogenous constructs (**Table 18**). The values showed that all the endogenous constructs had a predicted relevance. These were evaluated as small and medium predict relevancies.

Table 18

Prediction relevance (Q^2)

Construct	SSO	SSE	Q^2 (= 1-SSE/SSO)
Attitude Toward Using (AT)	4750	3610.872	0.240
Perceived Ease Of Use (PE)	3800	3206.968	0.156
Perceived Usefulness (PU)	2850	2358.480	0.172
Purchase Behavior Intention (PB)	3800	2372.107	0.376

In the next step, the $PLS_{predict}$ procedure was applied for out-of-sample prediction. For k-fold cross-validation, three subgroups (k) and 10 repeats were applied. All $Q^2_{predict}$ values were > 0, indicating better predictive performance

than a naive benchmark (**Table 19**). The majority of the RMSE values from the PLS-SEM were lower than the RMSE values from the LM. This indicated an intermediate predictive power of the model (Hair et al., 2021).

Table 19

Out-of-sample predictive power

Construct	**PLS-SEM**		**LM**
Item	**$Q^2_{predict}$**	**RMSE**	**RMSE**
Attitude Toward Using (AT)	0.257		
AT02_01	0.988	0.988	0.964
AT02_02	1.208	1.208	1.207
AT02_03	1.226	1.226	1.227
AT02_04	1.284	1.284	1.288
AT02_05	1.264	1.264	1.274
Perceived Ease Of Use (PE)	0.197		
PE01_01	1.200	1.200	1.198
PE01_02	1.197	1.197	1.210
PE01_03	1.094	1.094	1.090
PE01_04	1.159	1.159	1.157
Perceived Usefulness (PU)	0.270		
PU02_01	1.402	1.402	1.431
PU02_02	1.539	1.539	1.532
PU02_03	1.123	1.123	1.132
Purchase Behavior Intention (PB)	0.410		
PB01_01	1.205	1.205	1.231
PB01_02	1.545	1.545	1.568
PB01_03	1.144	1.144	1.137
PB01_04	1.259	1.259	1.279

Figure *10* shows the results of the structural model and refers to the R^2, path coefficients, and significances of the model.

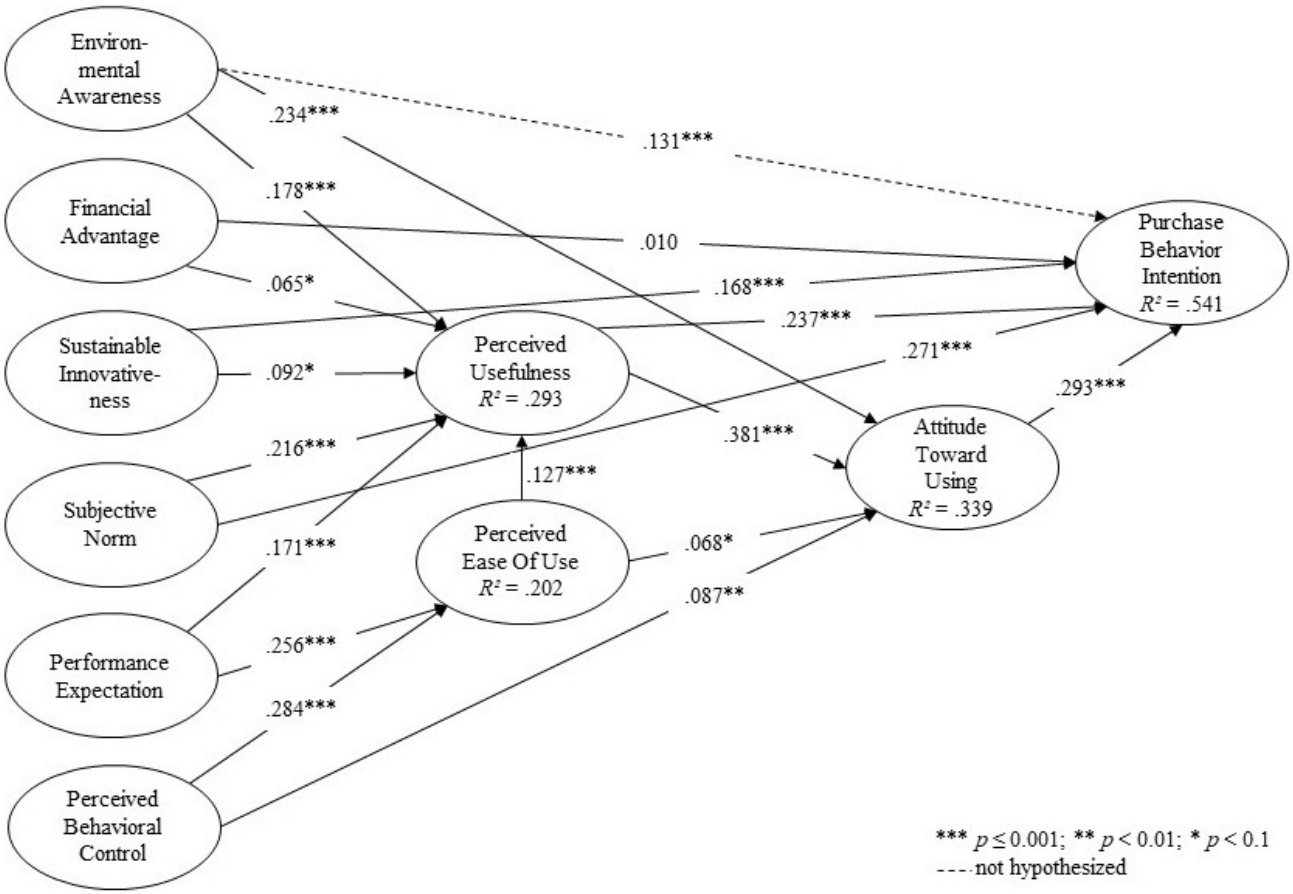

Figure 10 Research model with path coefficients, significance and R^2

It can be seen that environmental awareness has an effect on both perceived usefulness (β = 0.178, $p \leq 0.001$, f^2 = 0.022) and attitude toward using (β = 0.234, $p \leq 0.001$, f^2 = 0.067). Due to the indirect effect of environmental awareness via perceived usefulness on attitude toward using, the total effect is even higher at β = 0.302 and $p \leq 0.001$. Moreover, the total effect shows a non-hypothesized influence of environmental awareness on purchase behavior intention (β = 0.131, $p \leq 0.001$).

Financial advantage showed a small direct effect on perceived usefulness (β = 0.065, $p \leq 0.1$, f^2 = 0.005) and no effect on purchase behavior intention (β = 0.01, p = 0.674). The indirect and total effects indicated no influences on the coefficients and significances to be considered.

Sustainable innovativeness showed an influence on purchase behavior intention (β = 0.168, $p \leq 0.001$, f^2 = 0.048), which was further strengthened by the indirect effects on the total effects (β = 0.201, $p \leq 0.001$). The effect on perceived usefulness showed a small influence (β= 0.092, $p \leq 0.1$, f^2 = 0.006).

The subjective norm was a construct with larger influences on perceived usefulness (β = 0.216, $p \leq 0.001$, f^2 = 0.048) and purchase behavior intention (β = 0.271, $p \leq 0.001$, f^2 = 0.108). The total effect on purchase behavior intention was more pronounced due to the indirect effects (β = 0.346, $p \leq 0.001$).

The performance expectation showed an influence on the perceived ease of use (β = 0.256, $p \leq 0.001$, f^2 = 0.070), as well as on perceived usefulness (β = 0.171, $p \leq 0.001$, f^2 = 0.034). In the latter case, the total effect was amplified by the indirect effects (β = 0.204, $p \leq 0.001$). Moreover, the total effects on attitude toward using (β = 0.095, $p \leq 0.001$) and purchase behavior intention (β =0.076, $p \leq 0.001$) showed a small, significant, and not hypothesized influence.

A small direct influence can be seen in perceived behavioral control on attitude toward using (β = 0.087, $p \leq 0.01$, f^2 = 0.009). This was raised by the indirect

effect to a total effect of $\beta = 0.12$ ($p \leq 0.001$). A stronger effect was found directly on perceived ease of use ($\beta = 0.284$, $p \leq 0.001$, $f^2 = 0.087$).

The main constructs of the TAM showed increased higher path coefficients with a very high significance. Perceived usefulness had a direct effect on purchase behavior intention ($\beta = 0.237$, $p \leq 0.001$, $f^2 = 0.082$) and attitude toward using ($\beta = 0.381$, $p \leq 0.001$, $f^2 = 0.170$). The latter showed the highest effect size (f^2) in the model. Through the indirect effect of perceived usefulness via attitude toward using on purchase behavior intention, a total effect of $\beta = 0.384$ ($p \leq 0.001$) was achieved. Perceived ease of use had a small effect on attitude toward using ($\beta = 0.068$, $p \leq 0.1$, $f^2 = 0.006$). Indirect effect via perceived usefulness showed a higher total effect ($\beta = 0.116$, $p \leq 0.01$). The direct effect on perceived usefulness was larger ($\beta = 0.127$, $p \leq 0.001$, $f^2 = 0.018$). The influence of attitude toward using on purchase behavior intention had one of the highest influences in the model ($\beta = 0.293$, $p \leq 0.001$, $f^2 = 0.120$).

In addition, all the endogenous constructs had Q^2 values greater than zero and indicated a small or medium predictive relevance with values of 0.172, 0.156, 0.24 and 0.376 for the constructs perceived usefulness, perceived ease of use, attitude toward using, and purchase behavior intention respectively.

After evaluating the criteria for assessing the structural model, they can be rated as acceptable in terms of multicollinearity, explained variances, the height and significance of the path coefficients, and predicted relevance. Overall, this indicates a reliable estimation of the structural model. In the following, the results are interpreted.

6. CONCLUSIONS AND RECOMMENDATIONS

The chosen survey form of an online questionnaire proved to be suitable for answering the research question. The dataset had many parallels to the basic (German) population. Based on this, it is possible to provide findings that are highly likely to be representative. The research model set up proved to be solid.

As already suspected in the literature (Kroll et al., 2016; Tiwari & Kalogerakis, 2019), environmental awareness emerged as a relevant factor among the respondents. It influenced perceived usefulness, attitude toward using, and purchase behavior intention. This corresponded to the characteristics of "frugality 4.0," in which more ecologically sustainable products are developed (see section 2.3) (Herstatt & Tiwari, 2020a). The direct influence of environmental awareness on purchase behavior intention should be emphasized. Thus, it does not act as a moderator variable, as in other studies (Ashiq et al., 2019) or only indirectly via the attitude toward using (Yadav & Pathak, 2017) on the purchase behavior intention, but directly as in the case of Anjam et al. (2020) and Chen & Hung, (2016).

Financial advantage showed a small influence on perceived usefulness and none on purchase behavior intention. This could be for serveral reasons. Since frugal innovations are, by definition, less expensive than ordinary products, this factor could be taken as given (Hossain et al., 2016; Tiwari et al., 2017b; Winkler et al., 2020) and therefore prices are compared less or no attention is paid to special offers. A large number of the respondents (44.21%) had a monthly household income of 3,600–18,000€ (see section 4.4). For a more detailed evaluation of the financial advantage, this figure should be related to the household members, since the financial advantage could have a different

impact on households with a low per capita income than on households with a higher per capita income.

Sustainable innovativeness had a highly significant influence on purchase behavior intention. This indicated that consumers in Germany had a combination of sustainable innovativeness and personal innovativeness. Personal sustainable innovativeness, thus, influences intention to purchase frugal innovations. In contrast to the studies by Ahn et al. (2016) and Anjam et al. (2020), the influence on perceived usefulness was also determined. It was small, but increased the total effect on the purchase behavior intention relating to frugal household appliances.

The influence by subjective norm on purchase behavior intention had one of the highest path coefficients in the model. Thus, for frugal household appliances, it is shown that the influence of third parties on the consumer's decision is a given and is a significant dimension (Jabbour et al., 2019). The influence should be taken into account by manufacturers because it can have a positive or negative impact on the consumer's actual behavior. In many studies, only the direct influence of subjective norms on behavioral intention was examined (Ahn et al., 2016; Chen & Hung, 2016; Eneizan et al., 2019; Yadav & Pathak, 2017). According to TAM-2, however, there is also an influence of subjective norms on perceived usefulness (Venkatesh & Davis, 2000). In this study, this influence was shown to have a highly significant path coefficient. Thus, upstream of the influence on purchase behavioral intention, the influence on the individual perceived usefulness of frugal household appliances is determined to be relevant.

The results suggest that performance expectation of the product quality, durability, and reliability of frugal household appliances has an impact on perceived usefulness. This demonstrates that feature reduction should not be at the expense of product quality. This is a relevant factor for consumers (cf. **Figure *9***). In addition to perceived usefulness, the model shows an influence

on perceived ease of use. This was more pronounced, confirming the desire for frugal household appliances to be easy to use (Bergmann & Tiwari, 2016; Hanna, 2012; Kohlbacher & Hang, 2010; Tiwari & Kalogerakis, 2019).

Contrary to many studies and the theory of planned behavior, only a small influence of perceived behavioral control on attitude toward using and purchase behavior intention could be confirmed by this model (Ajzen, 1985; Baker et al., 2007; Cheng et al., 2006). In the dataset, there were participants (about 20%) who had little to no control over the purchase of a frugal household appliance (response items BC01_01, BC01_02, BC01_03). This group should be analyzed further. For example, are there correlations with household type? Another clear influence can be seen on perceived ease of use. This correlation has not been studied frequently before, even in other research areas. In this work, it was demonstrated that confidence in one's own control and own abilities is the basis for the estimation of whether a system will be easy or difficult to use (Venkatesh, 2000).

As in the original TAM, perceived usefulness had an influential position (Davis, 1989). With the highest path coefficient in the entire model, it affected attitude toward using. This demonstrates that the participants perceived frugal household appliances as useful and that this, in turn, positively influenced their attitude to using them. In addition, purchase behavior intention was also influenced by perceived usefulness. The perceived usefulness was a relevant factor for the actual purchase of frugal household appliances. However, the R^2-value of perceived usefulness indicated only a weak value of 0.293 (Chin, 1998). This means that only a small proportion of the variance can be explained by the constructs associated with the construct. Future researchers should identify further factors influencing perceived usefulness. For example, the construct perceived consumer effectiveness from the preliminary study could be evaluated again. A higher proportion of explained variance will have an impact on the actual purchase decision regarding a frugal household appliance.

Perceived ease of use, which is also a component of the original TAM, showed little influence on perceived usefulness and attitude toward using in this model. This could be for several reasons. On the one hand, similarly to perceived usefulness, only a weak R^2 value (0.202) was determined. Thus, for this construct too, research should be conducted to find further influencing factors to increase the explained variance. Another explanation could be the characteristic of a frugal household appliance itself. In the model, the construct perceived ease of use stood for an effortless, clear, simple, and understandable utility (Holden & Karsh, 2010; Venkatesh et al., 2003). Frugal innovations are, by definition, solutions that are intended to be easy to use (Angot & Plé, 2015; Hossain, 2020; Tiwari et al., 2017a). Thus, this property could be taken as a given and, thus, regarded as not influential in the model. This requires further research.

In the model, attitude toward using was shown to be a relevant factor influencing purchase behavior intention. This means that attitude acceptance of frugal household appliances is a significant factor for the actual purchase. The R^2 (0.339) showed a moderate value. This means that other factors also have an influence on this construct and further research should start here. In this context, the constructs initial trust and status or image from the preliminary study could be included again. The final value of purchase behavior intention can also be explained by the model with a moderate R^2 value (0.541).

In the preceding paragraphs, some starting points for future research and for increasing the explained variance of the target construct were mentioned. Other influencing factors could be operationalized from the focus group interviews. As an example, these included the locality of the manufacturer, frequency of use, and availability.

In addition to the other factors influencing acceptance, research should also be conducted into differences in the population. Frugal innovations are developed

in emerging markets for a specific target group (Fraunhofer IAO, 2021). In the evaluation of this work, no individual groups were evaluated or compared. For example, the dataset included responses from many respondents with a high-school diploma or a higher household income. Concerning the second one, frugal innovations are, in principle, aimed at groups of people with low incomes (bottom-of-the-pyramid). It can be assumed that the influencing factors used in the model have differing effects on different groups of people. Accordingly, further investigation of groups with differing per capita household incomes might be useful. Further group differences could be found in the generations. An analysis of a partial data set from the preliminary study found moderate R^2 values for Generation Y (Schneider, 2021b), but individuals in the other generations might yield different results.

7. NEW SCIENTIFIC RESULTS

The new scientific results of the dissertation are summarized in this section.

1. The results demonstrate that frugal innovations are not only of interest to and beneficial for individuals in emerging markets. Frugal household appliances are also relevant and accepted in an industrialized country like Germany.
2. The model reveals that the financial advantage of frugal household appliances in Germany has little effect on consumer decision.
3. Particularly relevant are environmental awareness, sustainable innovativeness, and product performance of frugal household appliances.
4. Perceived control over one’s actions and trust in one's skills can determine whether a frugal household appliance is easy or difficult to operate.
5. Perceived usefulness, attitude toward using, and the purchase decision are substantially influenced by the consumer’s surroundings (through the subjective norm and the pre-study status/image).

8. SUMMARY

The aim of the dissertation was to answer the central research question "Which factors have an influence on consumers' acceptance of frugal innovations of major electrical household appliances such as a washing machine in Germany?" The research field of frugal innovations in developed countries is still young. Therefore, in order to answer the research question, the author first started with a literature review and then with two focus group interviews. After the first possible influencing factors were identified, they were transferred into a research model based on the TAM and evaluated by means of a quantitative preliminary study in the form of an online survey. The results were used to create a final research model. The data was collected using the quantitative method of an online survey. Variance-based structural equation modeling (PLS-SEM) was used for the evaluation.

The assessment indicated that the TAM represented a suitable basis for the research subject. The included constructs perceived usefulness, perceived ease of use, and attitude toward using were found to be relevant influencing factors with respect to the acceptance of frugal household appliances in the form of purchase behavior intention. Beyond the constructs of the TAM, product performance with product quality and perceived behavioral control of frugal major household appliances were shown to be influential factors.

Environmental awareness and attitudes toward sustainable innovation were confirmed as relevant ecological influencing factors.

On the social level, there was an influence of the subjective norm and, in addition, of the status or image in the preliminary study.

The economic influence, represented by the financial advantage, could not be confirmed as a relevant influencing factor.

The R^2 values of the endogenous variables suggest that other factors influence the acceptance of frugal major household appliances in developed countries.

For this young research area, this model can be considered a solid starting point and can be used for further research.

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11. LIST OF AUTHORS' PUBLICATIONS IN THE FIELD OF THE DISSERTATION

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13. CURRICULUM VITAE

Sandra Schneider was born on 19 January 1988 in Pinneberg, Germany. She graduated from secondary school in 2004 and began vocational training as an industrial clerk. After this, she embarked on part-time education to become a Bachelor Professional of Management for Industry (CCI) (completed in 2009) and then a Master of Professional of Business Management (CCI) (completed in 2011). At that time, she worked as a sales assistant in a company in the chemical industry. After a short break from further education, she first completed a part-time Bachelor of Arts in Economics and Management (completed in 2015) and then a Master of Science in Sales Management (completed in 2017). In 2017, she began teaching part-time as a lecturer at various universities in the subjects of scientific work and marketing at the bachelor's and master's level. In parallel, since 2018, she has been pursuing Ph.D. studies at Kaposvár University, now MATE – Hungarian University of Agriculture and Life Sciences.

During this period, her family life and in her profession changed significantly. Today she is married and has two children. Professionally, she changed to the field of thermoplastics in 2012, starting as a salesperson and then developing further in various companies. Since 2020, she has been working as a technical sales manager.

14. APPENDIX

Appendix 1

The translation of the original German questionnaire.

Page 01

Good day,

Thank you very much for your willingness to participate in our survey on the subject of

"Acceptance of frugal innovations".

NOTE: If you open the survey via **smartphone**, please use **landscape format,** otherwise content cannot be displayed correctly.

The investigation takes place within the framework of an empirical project.

Filling out the questionnaire takes about **5 minutes**. All information is collected **anonymously** and treated confidentially.

Data collection and analysis are performed exclusively for scientific research purposes.

Please answer each question according to your personal opinion - there are no right or wrong answers. If you cannot or do not want to answer a question, leave the corresponding fields blank. The questions can be answered predominantly on an answer scale from 1 = "strongly disagree" to 7 = "strongly agree". You can use the values in between to grade your judgment accordingly.

Due to the evaluation method, some questions sound similar. This is intended in order to be able to statistically validate the answers. Please do not let this confuse you.

Thank you for your support!

Page 02

Description: Frugal Innovations

Frugal innovations are products reduced to their core functions. They are robust, resource-efficient, inexpensive, easy to use and of high quality.

Dacia is a successful example of this. With the launch of the Dacia brand, Renault has created a completely new segment in the automotive industry. Here, quality and affordability are combined. Dacia products are also environmentally friendly, as over 90% of components are recyclable.

The principle can also be applied in other areas. For example, in the development of a washing machine of comparable quality to a conventional washing machine, but e.g. reduced to the mainly used washing cycles (e.g. 30°C, 40°C, 60°C and 90°C).

Have you heard of frugal products?

○ yes

○ no

Page 03

What frugal products have you heard of?

1. _____

2. _____

3. _____

4. _____

5. (and others if necessary) _____

Page 04

To what extent do you agree with the following statements?

	strongly disagree 1	2	3	4	5	6	7 strongly agree
I consider the potential environmental impact of my actions when making many of my decisions.							
I am concerned about wasting the resources of our planet.							
I would like to describe myself as environmentally responsible.							
I am willing to be inconvenience in order to take actions that are more environmentally friendly.							
It is important to me that the products I use do not harm the environment.							
My purchase habits are affectd by my concern for our environment.							
	strongly disagree 1	2	3	4	5	6	7 strongly agree
In general, I am among first in my circle of friends to buy new sustainable products when they appear.							
If I heard that a new sustainable product was available in store, I would be interested enough to buy it.							
Compared to my friends, I own a lot of sustainable products.							
In general, I am among the first in my circle of friends to know the titles/brands of the latest sustainable products.							
I will buy a new sustainable product even I haven't tried it yet.							
I like to buy sustainable products before other people do.							

Page 05

To what extent do you agree with the following statements regarding household appliances?

	strongly disagree 1	2	3	4	5	6	7 strongly agree
I am willing to buy a cheaper household appliance instead of the one I want to buy							
Every time I buy household appliance, I compare prices until I find the lowest one.							
I always seek discounts or special offers.							

Page 06

To what extent do you agree with the following statements regarding frugal household appliances?

	strongly disagree 1	2	3	4	5	6	7 strongly agree
Frugal household appliances should be reliable.							
Frugal household appliances should be dependable.							
Frugal household appliances should be durable.							
The workmanship of frugal household appliances should be good.							
Frugal household appliances should be of good quality.							
	strongly disagree 1	2	3	4	5	6	7 strongly agree
Friends would recommend the use of frugal household appliances.							
Experts would recommend the use of frugal household appliances.							
Media would recommend the use of frugal household appliances.							
I think other people would use frugal household appliances.							
Friends and colleagues would use frugal household appliances.							
	strongly disagree 1	2	3	4	5	6	7 strongly agree
People whose opinions I value would recommend the use of frugal household appliances.							
People who influence my behavior would think that I should use frugal household appliances.							
People I care about think I should use frugal household appliances.							
	strongly disagree 1	2	3	4	5	6	7 strongly agree
Whether or not I buy a frugal household appliance in place of a conventional household appliance is completely up to me.							
I have the resources to buy a frugal household appliance.							
I am confident that, if I want to, I can buy a frugal household appliances in place of conventional household appliance.							

Page 07

For the following questions, please imagine a frugal household appliance compared to a conventional one!
I think that a frugal household appliance is....

	strongly disagree 1	2	3	4	5	6	7 strongly agree
... easy to use.							
... clear and understandable in operation.							
... easy to learn how to use.							
... easy to get to do what I want it to do.							
	strongly disagree 1	2	3	4	5	6	7 strongly agree
Using a frugal household appliance enhances my effectiveness because fewer resources are needed to achieve the same result.							
Using a frugal household appliance would make the activities easier to do.							
Overall, I find that frugal household appliances are useful.							

Page 08

For the following question, we ask you to imagine a frugal household appliance compared to a conventional one!
I find the use of a frugal household appliance ...

	-3	-2	-1	0	+1	+2	+3	
... negative.	○	○	○	◉	○	○	○	... positive.
... worthless.	○	○	○	◉	○	○	○	... valuable.
... not desirable.	○	○	○	◉	○	○	○	... desirable.
... useless.	○	○	○	◉	○	○	○	... useful.
... disadvantageous.	○	○	○	◉	○	○	○	... advantageous.

Assuming frugal household appliances were readily available on the German market, how likely is it that you would buy a frugal household appliance?

	strongly disagree 1	2	3	4	5	6	7 strongly agree
I intend to buy a frugal household appliance.	○	○	○	○	○	○	○
I plan to buy a frugal household appliance.	○	○	○	○	○	○	○
I can imagine buying a frugal household appliance.	○	○	○	○	○	○	○
I will recommend to others that they buy a frugal household appliance.	○	○	○	○	○	○	○

Page 09

What gender are you?

[▾]

In which year were you born?

How many people live in your household?

[ ] There are people in my household, including [ ] children.

Are you still living in your parents' household?

○ Yes

○ No

Page 10

What is your marital status?

○ Single

○ with partner (living alone)

○ with partner (living together)

○ married

○ Divorced

○ widowed

Page 11

Approximately what is your monthly net household income? Please include your own income as well as that of other household members.

○ less than 1.300 €

○ 1,300 € to under 1,700 €

○ 1,700 € to under 2,600 €

○ 2,600 € to under 3,600 €

○ 3,600 € to under 5,000 €

○ 5,000 € to under 18,000 €

○ 18,000 € and more

○ I have no income of my own.

○ I don't want to respond to that.

Appendix 2

Cross loadings

	Construct								
Item	AT	EA	FA	BC	PE	PU	PX	PB	SI
BC01_01	0.157	0.158	0.111	**0.699**	0.235	0.201	0.28	0.183	0.093
BC01_02	0.227	0.238	0.054	**0.846**	0.346	0.194	0.316	0.293	0.161
BC01_03	0.276	0.216	0.119	**0.869**	0.331	0.280	0.329	0.346	0.222
EC01_01	0.329	**0.837**	-0.037	0.182	0.184	0.297	0.144	0.368	0.591
EA01_01	0.361	**0.769**	0.012	0.218	0.213	0.316	0.243	0.369	0.477
EA01_02	0.303	**0.821**	-0.016	0.176	0.160	0.305	0.180	0.327	0.555
EA01_03	0.347	**0.806**	-0.001	0.229	0.180	0.345	0.185	0.404	0.544
EA01_04	0.383	**0.856**	-0.019	0.228	0.217	0.353	0.247	0.406	0.572
EA01_05	0.364	**0.872**	-0.007	0.227	0.171	0.349	0.181	0.418	0.675
PU02_01	0.370	0.241	0.103	0.233	0.200	**0.782**	0.288	0.370	0.190
PU02_02	0.268	0.253	0.147	0.103	0.192	**0.746**	0.111	0.307	0.273
PU02_03	0.544	0.418	0.104	0.294	0.340	**0.879**	0.307	0.591	0.339
FA01_01	0.123	0.029	**0.861**	0.127	0.140	0.139	0.077	0.146	0.043
FA01_02	-0.003	-0.051	**0.787**	0.061	0.074	0.099	0.047	0.052	-0.043
FA01_03	-0.030	-0.060	**0.668**	0.049	0.043	0.061	0.040	0.050	-0.022
AT02_01	**0.807**	0.412	0.066	0.270	0.290	0.527	0.266	0.596	0.329
AT02_02	**0.864**	0.388	0.046	0.241	0.226	0.420	0.248	0.500	0.320
AT02_03	**0.885**	0.351	0.043	0.242	0.222	0.392	0.236	0.497	0.300
AT02_04	**0.860**	0.292	0.074	0.198	0.210	0.410	0.197	0.461	0.271
AT02_05	**0.861**	0.343	0.072	0.226	0.216	0.448	0.224	0.485	0.306
SI01_01	0.248	0.626	-0.044	0.134	0.139	0.282	0.086	0.343	**0.843**
SI01_02	0.371	0.617	0.021	0.213	0.182	0.302	0.126	0.442	**0.828**
SI01_03	0.287	0.657	0.007	0.184	0.158	0.285	0.095	0.382	**0.856**
SI01_04	0.268	0.529	-0.019	0.131	0.104	0.248	0.026	0.338	**0.832**
SI01_05	0.322	0.495	0.045	0.196	0.144	0.273	0.101	0.386	**0.790**
SI01_06	0.268	0.484	0.017	0.137	0.107	0.290	0.058	0.381	**0.804**
PE01_01	0.228	0.237	0.108	0.297	**0.875**	0.294	0.293	0.322	0.182
PE01_02	0.235	0.168	0.113	0.369	**0.864**	0.250	0.306	0.330	0.129
PE01_03	0.250	0.211	0.115	0.332	**0.920**	0.259	0.337	0.323	0.128
PE01_04	0.264	0.192	0.116	0.350	**0.890**	0.331	0.353	0.376	0.166

	Construct								
Item	AT	EA	FA	BC	PE	PU	PX	PB	SI
PX01_01	0.248	0.199	0.098	0.392	0.355	0.264	**0.904**	0.231	0.087
PX01_02	0.236	0.205	0.063	0.371	0.316	0.259	**0.889**	0.233	0.099
PX01_03	0.257	0.203	0.060	0.332	0.328	0.287	**0.919**	0.210	0.064
PX01_04	0.270	0.222	0.068	0.331	0.342	0.301	**0.926**	0.229	0.102
PX01_05	0.248	0.257	0.058	0.315	0.318	0.303	**0.916**	0.210	0.112
PB01_01	0.537	0.408	0.090	0.316	0.320	0.486	0.216	**0.857**	0.377
PB01_02	0.370	0.303	0.087	0.165	0.184	0.418	0.065	**0.766**	0.350
PB01_03	0.550	0.389	0.160	0.375	0.419	0.455	0.317	**0.851**	0.379
PB01_04	0.538	0.445	0.080	0.290	0.335	0.512	0.196	**0.884**	0.442