

# **DOCTORAL (Ph.D.) Thesis**

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

Created

**SANDRA SCHNEIDER**

**VALUE OF THE SUBMISSION**

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# **1. RESEARCH BACKGROUNDS AND OBJECTIVE**

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., 2017; 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. 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.

*Objective 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.

## **2. 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.

## 2.1. 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<sub>1</sub> and H<sub>2</sub> were formulated for this purpose:

H<sub>1</sub>: The greater the environmental awareness, the greater the perceived usefulness of frugal household appliances.

H<sub>2</sub>: 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<sub>3</sub> and H<sub>4</sub> were formulated:

H<sub>3</sub>: The greater the financial advantage, the greater the purchase behavior intention regarding frugal household appliances.

H<sub>4</sub>: 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<sub>5</sub>: The greater the sustainable innovativeness, the greater the purchase behavior intention regarding frugal household appliances.

H<sub>6</sub>: 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<sub>7</sub> and H<sub>8</sub> were formulated for this purpose:

H<sub>7</sub>: The greater the subjective norm related to frugal household appliances, the greater the purchase behavior intention regarding them.

H<sub>8</sub>: 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<sub>9</sub> and H<sub>10</sub> were formulated to test the relevance of performance expectation for perceived usefulness and the perceived ease of use of frugal household appliances:

H<sub>9</sub>: The greater the performance expectation of a frugal household appliance, the greater its perceived usefulness.

H<sub>10</sub>: 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 was 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 an 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<sub>11</sub> and H<sub>12</sub> were formulated:

H<sub>11</sub>: The greater the perceived behavioral control regarding the purchase of a frugal household appliance, the more positive the attitude toward using it.

H<sub>12</sub>: The greater the perceived behavioral control regarding the purchase of a frugal household appliance, the greater its perceived ease of use.

Hypotheses H<sub>1</sub>–H<sub>12</sub> were formulated based on various research studies. The following hypotheses, H<sub>13</sub>–H<sub>17</sub> were derived from the TAM model (Davis, 1989).

H<sub>13</sub>: The greater the perceived usefulness of a frugal household appliance, the more positive the attitude toward using it.

H<sub>14</sub>: The greater the perceived usefulness of a frugal household appliance, the greater the purchase behavior intention of buying it.

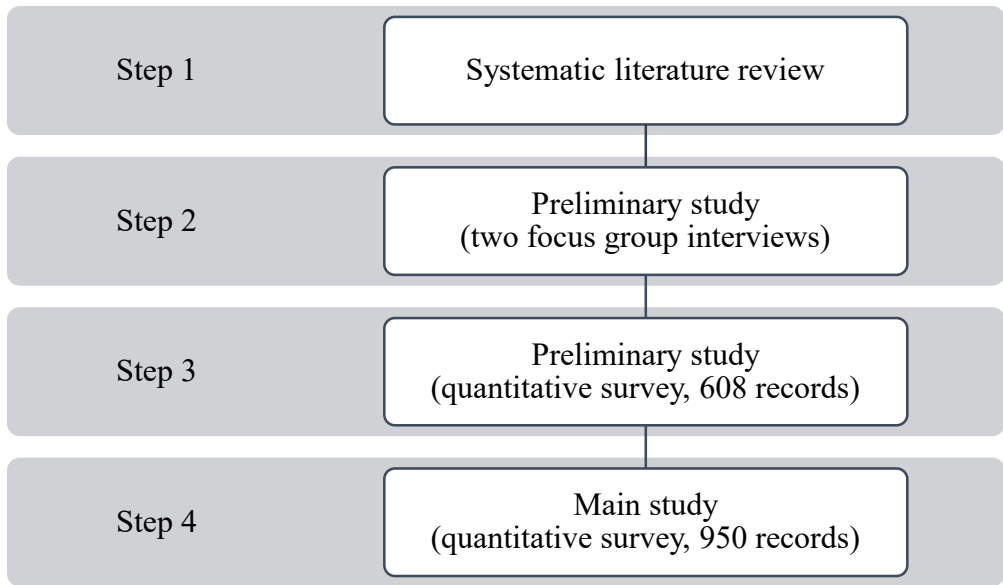
H<sub>15</sub>: The greater the perceived ease of use of frugal household appliances, the greater their perceived usefulness.

H<sub>16</sub>: The greater the perceived ease of use of frugal household appliances, the more positive the attitude toward using them.

H<sub>17</sub>: The more positive the attitude toward using frugal household appliances, the greater the purchase behavior intention of buying them.

## **2.2. 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 1**). 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. In this study, only the results of the main study (Step 4) are presented.



**Figure 1**  
Mix-methods research process

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.

## **2.3. Quantitative research: partial least squares**

### **2.3.1. Methodology**

Variance-based structural equation model (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). 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).

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 1** shows a formatively measured construct and nine reflectively measured constructs. The analysis in this study was performed using SmartPLS version 3.3.3 software (Sarstedt et al., 2021).

### **2.3.2. Operationalization of the model constructs**

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 1**). Except for subjective norm, all the constructs were operationalized reflectively. “Subjective norm” was operationalized formatively. The following **Table 1** shows the operationalization of the 10 constructs of the model.

**Table 1**

## Operationalization of the constructs

| <b>Construct (source)</b>   |  |
|---|--|
| <b>Item</b>   |  |
| <hr/>   |  |
| 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.   |
| <hr/>   |  |
| 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.   |
| <hr/>   |  |
| 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.                                 |
| <hr/>   |  |
| 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.                                      |
| <hr/>   |  |

**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.  |

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#### **2.4. 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](https://www.soscisurvey.de) from March 19 to May 13, 2021. The questionnaire had 56 questions that took about 10 minutes to answer.

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) and too fast response behavior (Leiner, 2019) were eliminated. 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).

## **2.5. 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 2** below).

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

## 2.6. 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. The evaluation of the reflective constructs was based on internal consistency reliability, convergence validity, and discriminant validity. The formative construct was evaluated 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.

### 2.6.1. 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 2** 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  $\leq 0.001$ , 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 2**

Excerpt descriptives, loadings and significances

| <b>Item</b> | <b>Mean value</b> | <b>Standard deviation</b> | <b>Loadings</b> | <b>Standard deviation</b> | <b>T-Statistic</b> | <b>P value</b> |
|-------------|-------------------|---------------------------|-----------------|---------------------------|--------------------|----------------|
| BC01_01     | 5.58              | .143                      | 0.699           | 0.033                     | 21.099             | <0.001         |
| BC01_02     | 5.44              | 1.38                      | 0.846           | 0.018                     | 45.917             | <0.001         |
| BC01_03     | 5.36              | 1.37                      | 0.869           | 0.013                     | 68.000             | <0.001         |
| EA01_01     | 4.52              | 1.34                      | 0.837           | 0.012                     | 70.302             | <0.001         |
| EA01_02     | 5.73              | 1.29                      | 0.769           | 0.017                     | 46.055             | <0.001         |
| EA01_03     | 4.57              | 1.25                      | 0.821           | 0.015                     | 55.857             | <0.001         |
| EA01_04     | 4.77              | 1.29                      | 0.806           | 0.014                     | 56.357             | <0.001         |
| EA01_05     | 4.98              | 1.28                      | 0.856           | 0.010                     | 83.678             | <0.001         |
| EA01_06     | 4.61              | 1.49                      | 0.872           | 0.008                     | 111.674            | <0.001         |
| PU02_01     | 5.29              | 1.51                      | 0.782           | 0.021                     | 37.877             | <0.001         |
| PU02_02     | 4.25              | 1.61                      | 0.746           | 0.024                     | 30.665             | <0.001         |
| PU02_03     | 5.19              | 1.32                      | 0.879           | 0.008                     | 114.891            | <0.001         |
| FA01_01     | 4.41              | 1.67                      | 0.861           | 0.064                     | 13.437             | <0.001         |
| FA01_02     | 4.28              | 1.74                      | 0.787           | 0.098                     | 7.995              | <0.001         |
| FA01_03     | 4.46              | 1.78                      | 0.668           | 0.125                     | 5.358              | <0.001         |
| AT02_01     | 5.79              | 1.13                      | 0.807           | 0.017                     | 47.208             | <0.001         |
| AT02_02     | 5.54              | 1.35                      | 0.864           | 0.013                     | 66.915             | <0.001         |
| AT02_03     | 5.51              | 1.36                      | 0.885           | 0.009                     | 99.198             | <0.001         |
| AT02_04     | 5.42              | 1.38                      | 0.860           | 0.011                     | 75.199             | <0.001         |
| AT02_05     | 5.30              | 1.39                      | 0.861           | 0.011                     | 81.065             | <0.001         |

| <b>Item</b> | <b>Mean value</b> | <b>Standard deviation</b> | <b>Loadings</b> | <b>Standard deviation</b> | <b>T-Statistic</b> | <b>P value</b> |
|-------------|-------------------|---------------------------|-----------------|---------------------------|--------------------|----------------|
| SI01_01     | 3.40              | 1.55                      | 0.843           | 0.013                     | 67.381             | <0.001         |
| SI01_02     | 4.28              | 1.57                      | 0.828           | 0.012                     | 70.343             | <0.001         |
| SI01_03     | 3.77              | 1.44                      | 0.856           | 0.011                     | 80.579             | <0.001         |
| SI01_04     | 3.20              | 1.50                      | 0.832           | 0.013                     | 65.316             | <0.001         |
| SI01_05     | 3.96              | 1.57                      | 0.790           | 0.015                     | 52.149             | <0.001         |
| SI01_06     | 3.30              | 1.55                      | 0.804           | 0.016                     | 49.386             | <0.001         |
| PE01_01     | 5.35              | 1.28                      | 0.875           | 0.012                     | 74.415             | <0.001         |
| PE01_02     | 5.54              | 1.31                      | 0.864           | 0.017                     | 50.975             | <0.001         |
| PE01_03     | 5.62              | 1.20                      | 0.920           | 0.008                     | 108.545            | <0.001         |
| PE01_04     | 5.34              | 1.28                      | 0.890           | 0.010                     | 87.225             | <0.001         |
| PX01_01     | 6.42              | 0.93                      | 0.904           | 0.017                     | 54.448             | <0.001         |
| PX01_02     | 6.31              | 0.97                      | 0.889           | 0.014                     | 62.793             | <0.001         |
| PX01_03     | 6.41              | 0.94                      | 0.919           | 0.010                     | 90.449             | <0.001         |
| PX01_04     | 6.33              | 0.97                      | 0.926           | 0.008                     | 118.593            | <0.001         |
| PX01_05     | 6.37              | 0.93                      | 0.916           | 0.010                     | 93.496             | <0.001         |
| SN02_01     | 3.96              | 1.43                      | 0.822           | 0.034                     | 24.335             | <0.001         |
| SN02_02     | 4.55              | 1.39                      | 0.578           | 0.053                     | 10.951             | <0.001         |
| SN02_03     | 3.94              | 1.45                      | 0.360           | 0.060                     | 5.994              | <0.001         |
| SN02_04     | 4.70              | 1.23                      | 0.750           | 0.039                     | 19.479             | <0.001         |
| SN02_05     | 4.46              | 1.25                      | 0.920           | 0.024                     | 37.566             | <0.001         |
| PB01_01     | 4.76              | 1.41                      | 0.857           | 0.012                     | 73.913             | <0.001         |
| PB01_02     | 3.67              | 1.71                      | 0.766           | 0.017                     | 43.828             | <0.001         |
| PB01_03     | 5.26              | 1.40                      | 0.851           | 0.012                     | 73.489             | <0.001         |
| PB01_04     | 4.36              | 1.58                      | 0.884           | 0.009                     | 95.397             | <0.001         |

The internal consistency reliability, was evaluated by Cronbach's  $\alpha$  ( $>0.7$ ), 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  $\alpha$  (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.

Discriminant validity was then tested using the cross loadings, the Fornell-Lacker criterion, and the HTMT correlation ratio.

**Table 3**

Fornell-Larcker Criterion

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

The cross loadings show that the correlation of the items with the assigned constructs was higher than with the remaining latent constructs. HTMT thresholds did not exceed 0.85 due to the conceptually different constructs. For the Fornell-Larcker criterion (**Table 3**) shows that the correlations between the latent variables were smaller than the root of the AVE. Thus, all the constructs met the requirements of discriminant validity (Hair et al., 2021).

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

### 2.6.2. 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 4** below shows that all the VIF values were below 3; thus no collinearity problems were indicated.

**Table 4**

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 4** 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 2**). 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.

## 2.7. 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. 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.

Subsequently, the height of the path coefficients and the significance of the path coefficients were evaluated (see **Table 5**). 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).

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. The indirect path  $BC \rightarrow PE \rightarrow AT \rightarrow PB$  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  $PU \rightarrow AT \rightarrow PB$  was above 0.1. Thus, these stand as mediators in their respective relationships. **Table 5** shows that the path coefficient of hypothesis H3 of  $FA \rightarrow PB$  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 5**) and significant path coefficients of the indirect relationships. 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 5**

Path coefficients and significances

| <b>Construct</b>                        | <b>Hypothesis</b> | <b>Path coefficient</b> | <b>Standard deviation</b> | <b>T-statistic</b> | <b>P values</b> |
|---|-------------------|-------------------------|---------------------------|--------------------|-----------------|
| <b>Perceived Usefulness (PU)</b>        |                   |                         |                           |                    |                 |
| 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          |
| <b>Perceived Ease Of Use (PE)</b>       |                   |                         |                           |                    |                 |
| PX → PE                                 | H10               | 0.256                   | 0.033                     | 7.829              | ≤0.001          |
| BC → PE                                 | H12               | 0.284                   | 0.034                     | 8.356              | ≤0.001          |
| <b>Attitude Toward Using (AT)</b>       |                   |                         |                           |                    |                 |
| 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           |
| <b>Purchase Behavior Intention (PB)</b> |                   |                         |                           |                    |                 |
| 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          |

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 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 5**). 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.

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. 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.

In addition, the effect sizes ( $f^2$ ) of the exogenous constructs were assessed. 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.

Subsequently, the predictive relevance  $Q^2$  was calculated for the endogenous constructs. The values showed that all the endogenous constructs had a predicted relevance ( $Q^2$  values: AT = 0.240; PE = 0.156, PU = 0.172, PB = 0.376). These were evaluated as small and medium predict relevancies.

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

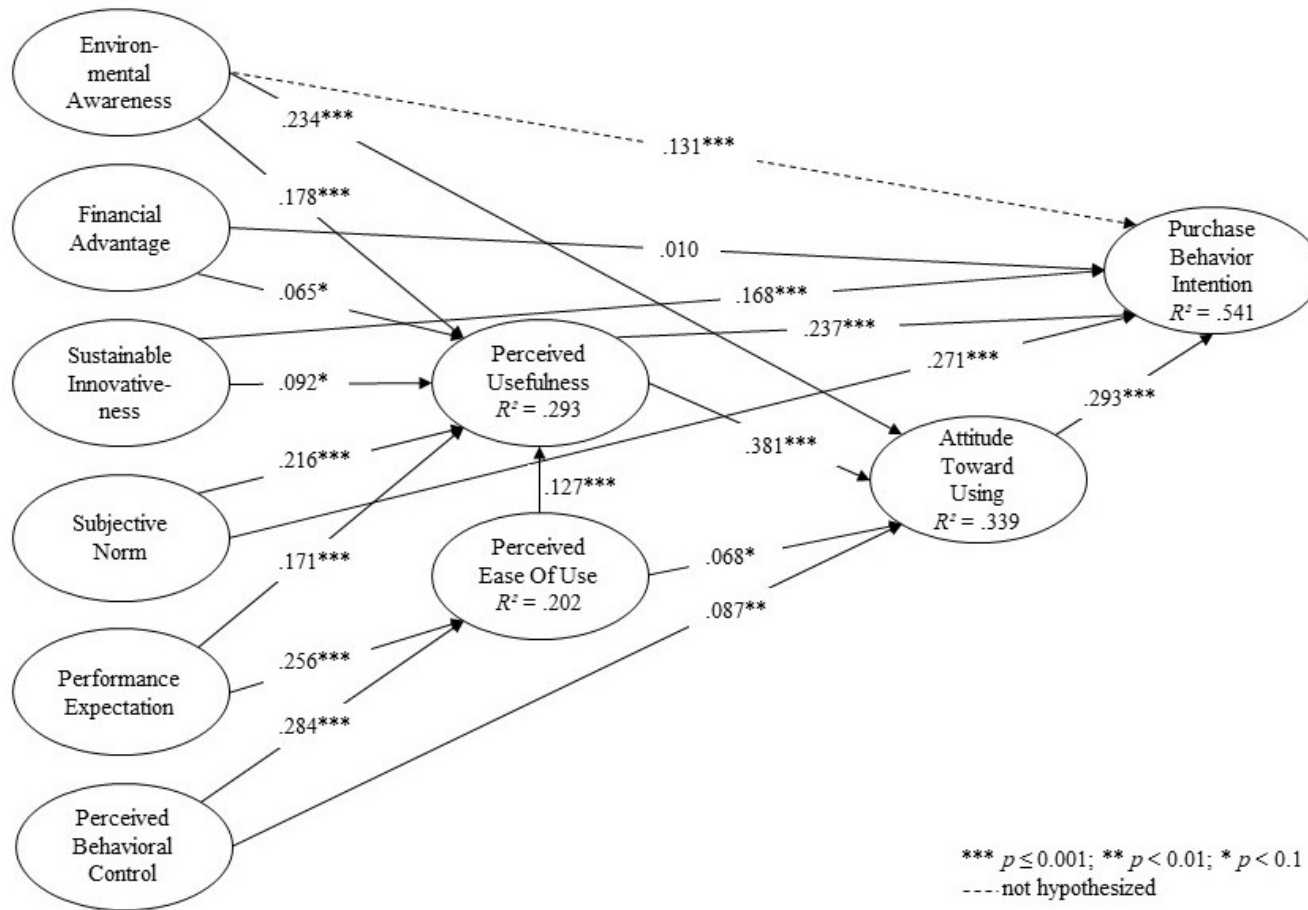
### 3. RESULTS

**Figure 2** shows the results of the structural model and refers to the  $R^2$ , path coefficients, and significances of the model. Sixteen of the seventeen hypotheses were confirmed.

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

Financial advantage showed a small direct effect on perceived usefulness ( $\beta = 0.065, p \leq 0.1, f^2 = 0.005$ ) and no effect on purchase behavior intention ( $\beta = 0.01, p = 0.674$ ). 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 ( $\beta = 0.168, p \leq 0.001, f^2 = 0.048$ ), which was further strengthened by the indirect effects on the total effects ( $\beta = 0.201, p \leq 0.001$ ). The effect on perceived usefulness showed a small influence ( $\beta = 0.092, p \leq 0.1, f^2 = 0.006$ ).



**Figure 2** Research model with path coefficients, significance and R<sup>2</sup>

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

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

A small direct influence can be seen in perceived behavioral control on attitude toward using ( $\beta = 0.087, p \leq 0.01, f^2 = 0.009$ ). 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.

#### **4. CONCLUSION AND SUGGESTIONS**

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 (Herstatt & Tiwari, 2020). 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 several 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 2.4). 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. 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.

## **5. 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).

## **6. CONCLUSION**

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.

## **7. LIST OF AUTHORS' PUBLICATIONS IN THE FIELD OF THE DISSERTATION**

### **Scientific papers**

Brückel, S., & Schneider, S. (2019). Factors Influencing Consumer Behavior to Purchase Sustainable Cosmetic Products in a German Context. *Regional and Business Studies*, 11(2), 13-24, <https://doi.org/10.33568/rbs.2405>.

Schneider, S. (2020). Combining the characteristics of sustainability, frugal innovations and washing machines in the industrial nations – A literature-based analysis of the common features for future sustainable developments. *Journal of Economic Development, Environment and People*, 9(2), 50–59. <https://doi.org/10.26458/jedep.v9i2.659>.

Schneider, S. (2021). Purchase intention of frugal household appliances among generation y in Germany – modified tam approach. *Marketing and Management of Innovations*, 5(2), 303–313. <https://doi.org/10.21272/mmi.2021.2-25>.

### **Presentation**

Brückel, S., & Schneider, S. (2019). Factors Influencing Consumer Behavior to Purchase Sustainable Cosmetic Products in a German Context, *International Conference on Sustainable Economy and Agriculture*, November, 19.

Schneider, S. (2021). Analysis of factors influencing the purchase intention of frugal innovations in Generation Y using the example of household appliances, *15th Annual International Conference on Economics and Business*, March, 4.

### **Abstract in proceedings**

Brückel, S., & Schneider, S. (2019). Factors Influencing Consumer Behavior to Purchase Sustainable Cosmetic Products in a German Context, Diána, Koponicsné Györke; Róbert, Barna (eds.) Abstracts of the International Conference on Sustainable Economy and Agriculture, p. 114.

Krol, B., Schneider, S., & Boßow-Thies, S. (2020). Acceptance of Voice Assistants to control Smart Home Services – Digital Natives vs. Digital Immigrants, Proceedings of the 49th Annual Conference of the European Marketing Academy, A2020-63383, 11 p.