"Human-Centric Lighting: A lighting concept which influences our well-being"

Exploring the relationship between awareness and willingness to pay for health-conscious consumers

Juliane Lembcke

Abstract

The results of scientific research in recent years clearly show that light not only helps people to see but also has a great influence on their well-being (Stephan & Heike, 2016). Lighting concepts are usually set to a specific light level with constant luminous intensity and correlated colour temperatures, which is not compatible with people's circadian rhythms. If people are not regularly exposed to dynamic lighting, this can lead to a disruption of the circadian rhythm and thus to health problems. Lighting concepts that focus on the well-being of people are referred to as Human-Centric-Lighting (HCL). These concepts offer the possibility to design lighting holistically and to better adapt it to the circadian rhythm of people. The aim of this scientific work is to understand consumers' awareness and willingness to pay for HCL concepts, as well as their perception of how these products can influence their well-being.

In doing so, prerequisites for well-being in connection with the HCL lighting concept are to be identified to support companies and end consumers with recommendations for action.

The study follows a mixed-methods approach, consisting of 6 in-depth interviews and an online questionnaire, which yielded 99 valid responses.

From the analysis, it can be concluded that socio-demographic factors such as age play a central role in the willingness to pay for Human-Centric Lighting. However, health-oriented people also have a positive attitude towards the lighting concept for promoting well-being, provided they are aware of this lighting concept.

Keywords: Human-Centric Lighting, Awareness, Willingness to Pay, Sociodemographic Factors, Health Consciousness, Subjective Well-Being

Title: "Human-Centric Lighting: A lighting concept which influences our well-being" - Exploring the relationship between awareness and willingness to pay for health-conscious consumers

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Sumário

Os resultados de investigação científica recente sugerem que a luz tem uma grande influência no bem-estar/sulabridade humana (Stephan & Heike, 2016). Os conceitos de iluminação são geralmente mantidos fixos a intensidade de luz constante e temperaturas de cor correlacionadas, que se demonstrou ser incompatível com os ritmos circadianos das pessoas. Sem uma exposição frequente a iluminação dinâmica, cria-se espaço para disrupções no ciclo circadiano, tal como saúde em geral. Aqui serão explorados Human-Centric-Lighting (HCL), conceitos de iluminação centrados no bem-estar humano. Tais conceitos oferecem a possibilidade de conceber iluminação de uma forma holística, melhor adaptando-a ao ritmo circadiano das pessoas. O objectivo deste trabalho é compreender a exposição a consumidores e a sua vontade de pagar pelos conceitos de HCL, assim como a sua percepção de como estes produtos podem influenciar o seu bem-estar.

Para tal, deverão ser identificados pré-requisitos relativamente à ligação entre HCL e o bem-estar a fim de apoiar as empresas com recomendações de ação, assim como os consumidores finais. Este estudo adopta uma abordagem de métodos mistos, consistindo em 6 entrevistas extensas e detalhadas em cônjuge com um questionário online com 99 respostas válidas.

Após análise, verificou-se que fatores socio-demográficos como a idade desempenham um papel central na predisoposição para pagar por conceitos HCL.

Contudo, pessoas direcionadas para saúde mostraram ser apologistas de conceitos de iluminação que promovem o bem-estar, desde que cheguem a ser expostas ao conceito e suas aplicações.

Palavras-chave: Iluminação Centrada no Ser Humano, Exposição, Predisposição Financeira (gasto), Factores Sociodemográficos, Consciência de Saúde, Bem-estar Subjectivo

Título: "Iluminação Antropocêntrica": Um conceito de iluminação que influencia o nosso bem-estar" - a explorar a relação entre consicencialização e vontade de pagar por parte de consumidores que procuram salubridade

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List of Abbreviations

α	Cronbach´s Alpha Coefficient
HCL	Human-Centric Lighting
IoT	Internet of Things
LED	Light-emitting diodes
M	Sample mean
max	Maximum
min	Minimum
n	observations in the sample
N	total sample size
p	p-value
SD	Standard Deviation
se	Standard Error
skew	Skewness
SWB	Subjective Well-Being
USD	US-Dollar
WTP	Willingness to Pay

1. Introduction

1.1. Background

Every year on 16th May, the International Day of Light takes place. In 2017, UNESCO has taken this day as an opportunity to express gratitude towards light and recognize its significance in various domains including science, culture, and art. Additionally, light is crucial in education, sustainable development, medicine, communication, and energy. This day raises awareness that light-based technologies respond to people's needs by providing access to information and enhancing social well-being (International Day of Light, 2022). The results of scientific research in recent years also clearly show that light not only helps people to see but also has a major impact on their health, well-being and vitality (Stephan & Heike, 2016). Until 200 years ago, people spent 90% of their time outdoors. Today, people live predominantly in a civilised environment and thus in biological darkness and spend 90% of their time indoors with electric light (Begemann et al., 1997). Humans have evolved in harmony with the earth's natural lighting cycle. During the course of the day, light levels and correlated colour temperatures fluctuate and are the centre of the 24-hour Human internal clock, which is also referred to as the circadian rhythm (Bierbaumer, 2010). As a rule, lighting concepts are set to a certain light level with a constant luminous intensity and correlated colour temperatures, which is not compatible with the Human circadian rhythm. If people are not regularly exposed to dynamic lighting, this can lead to a disturbance of the circadian rhythm and thus also to health problems (Walerczyk, 2012). Lighting concepts that focus on people´s well-being are described as Human-Centric-Lighting (HCL). These concepts provide the opportunity to design lighting holistically and to bring it more in line with people's circadian rhythms (Blume et al., 2019). A representative study (N= 1006) by the lighting manufacturer Ledvance that surveyed people between the age of 18 and 60 from different educational and income groups, found that around two-thirds of the participants know too little about the biological effect of light on the body, and even doubt it. However, 66% said that they see an advantage in being able to influence the body and mind according to natural needs with the help of artificial light (Ledvance, 2017). This raises the question of why there is little or no awareness of the effects of light on the Human body. Do people already use HCL consciously? What factors and preconditions must be in place so that people use light for the benefit of their well-being? Especially about the increasing number of people suffering from mental illnesses resulting, for example, from not focusing on their well-being, it should not only be in the interest of lighting manufacturers and employers to promote physical health through easy-to-purchase measures but also in the interest of the end consumer.

1.2. Relevance

The scientific relevance of this topic lies firstly in the field of psychology and human behaviour, in particular how lighting can influence the subjective well-being of individuals. The research will contribute to the existing literature on Human-Centric Lighting and its potential benefits on subjective well-being. As a result, value can be added to health promotion technologies.

Secondly, this work contributes from a management perspective. This topic is of great importance as it provides insights into consumer awareness, attitudes as well as payment behaviour towards Human-Centric Lighting. This information is crucial for companies in the lighting industry, for example, as it can influence their strategic decisions regarding product development, marketing and sales. In addition, this study may also have implications for policymakers and architects, as it can help them better understand how to design buildings and spaces that prioritise the well-being of individuals, thus supporting the long-term health of employees. It may also have implications for raising public awareness of the importance of Human-Centric Lighting and its potential benefits for well-being.

1.3. Problem Statement

This scientific work aims to understand consumers' awareness and willingness to pay for Human-Centric Lighting concepts, as well as their perception of how these products can affect their well-being.

In doing so, prerequisites for subjective well-being in connection with the Human-Centric Lighting lighting concept are to be identified to support companies, but also end consumers, with recommendations for action in this context and to simplify purchasing decisions. For this reason, the following research questions can be created:

RQ1: What is the current level of awareness of Human-Centric Lighting?

RQ2: How does awareness of the benefits of Human-Centric Lighting influence consumers' willingness to pay?

RQ3: How does health consciousness influence willingness to pay for Human-Centric Lighting?

RQ4: Is there a relationship between sociodemographic data and willingness to pay for Human-Centric Lighting?

According to the literature, the following hypotheses were formulated:

H1a: The current level of awareness of HCL is low.

H1b: The current level of its benefits among the general public is low.

H2: There is no difference in the awareness of HCL given the willingness to pay

H3a: Willingness to pay groups do not differ in their health consciousness and subjective well-being

H3b: Consumers of HCL are not more health-conscious than other people.

H3c: Consumers of HCL do not prioritize their well-being in their daily lives.

H3d: Consumers of HCL are not more than average willing to invest in products that support their well-being.

H4a: There is no dependency on the willingness to pay for HCL between men and women.

H4b: There is no connection between the willingness to pay for HCL and the participants' age group.

H4c: There is no connection between the willingness to pay for HCL and the participants' Education.

H4d: There is no connection between the willingness to pay for HCL and the participants' Occupation.

H4e: There is no connection between the willingness to pay for HCL and the participants' Income.

H4f: The connection between age group and willingness to pay is not moderated by awareness of HCL.

1.4. Research Methods

To adequately answer the previous research questions, a comprehensive literature review is required to obtain extensive background knowledge on consumer awareness and willingness to pay for a product. Interviews will be conducted to gain up-to-date insight into the topic to be researched. Based on the interviews, but also the review of relevant literature, an online survey will be created and disseminated through various social media platforms. After collecting a sufficient number of responses, the data will be analysed quantitatively and treated using frequencies, measures of dispersion and variability, coefficients and statistical tests as well as regressions.

1.5. Dissertation Outline

In the following, the structure of the thesis is presented. The introduction and presentation of the methods to be carried out are followed by the second chapter, which gives an overview of

the current literature on awareness, willingness to pay, health consciousness in relation to subjective well-being and socio-demographic data, which are discussed in general, but also in relation to the core topic of the thesis. The third chapter describes the methodology used and the data compiled for the study. This is followed by the fourth chapter, in which the results obtained are presented and the legitimacy of the respective hypotheses is examined. The fifth and final chapter provides a summary highlighting the main conclusions and limitations of the study and making recommendations for future research.

2. Literatur Review

2.1. Lighting Industry

The current global economic situation is in a constant state of flux due to so-called megatrends. Advancing digitalisation, demographic change and the growing importance of sustainability are just a few examples (Cioppi et al., 2023). The lighting market is also being shaped by these changes. The dominant technology in this market is "LED lighting". According to Statista, the sales forecast for 2022 is 45,548 million US dollars worldwide (Statista, 2016). Besides the German market leader Osram, the Dutch company Signify and the Korean company Seoul Semiconductor LED play a central role in this market. In addition to the efficient and technical properties of the LED lamp, it is increasingly being used as the basis for smart lighting systems (Juric et al. 2018). Smart lighting systems can generally be classified as smart home systems. Smart lighting stands for intelligent lighting systems that can usually be controlled individually via a smartphone or tablet. In addition, lighting scenes can be adapted to personal everyday life (Juric et al., 2018). In addition to the increasing demand for smart speakers and home entertainment, experts see the greatest growth in the area of smart lighting (Wulf, 2021). Light-emitting diodes (LEDs) have evolved from traditional lamps to an essential part of everyday life due to their high energy efficiency. Apple, Facebook, and Oculus have all purchased micro-LED businesses to assist them in developing an integrated lighting service model. To accomplish this, they are combining fundamental fourth-industrial-revolution technologies such as the Internet of Things (IoT), Big Data, artificial intelligence, and cloud technologies with existing LEDs. Human Centric Lighting (HCL) refers to an LED lighting system built on Fourth Industrial Revolution technologies that maximise energy efficiency and human comfort through lighting control (Kwon et al., 2021).

2.2. Human-Centric Lighting

The concept of Human-Centric Lighting (HCL) can be described as a means of improving emotional well-being, health, sleep quality and productivity through the proper control of existing lighting (K. Houser et al., 2021). Different lighting options influence the visual, as well as non-visual effects of light in Human perception (van Bommel, 2006). The concept creates lighting that mimics natural daylight to help the body enhance natural bodily functions, performance, concentration and well-being. As a smart lighting system, HCL offers not only the improvement of well-being but also the ability to control light intensity and quality while reducing energy consumption as well as the user-specific implementation for individual needs

(Cupkova et al., 2019). Over time, lighting has become a critical component of modern living, with advancements in technology leading to the development of energy-efficient LEDs to replace traditional incandescent and fluorescent lamps (Kwon et al., 2021). HCL is the most sophisticated lighting system because by automatically adapting the colour temperature, illuminance, and colour of the lighting to the biological rhythms of both the user and their surroundings, it enhances biological processes (Figueiro & Leggett, 2021). Different wavelengths of light affect blood pressure, pulse, breathing rate, and brain activity in addition to biorhythms (Dijk & Cajochen, 1997). Therefore Lighting directly affects every aspect of Human existence (Mott et al., 2012). As light and darkness control hormone production, the natural circadian rhythm during the day ensures that an appropriate amount of dopamine, serotonin and cortisol are released (Blume et al., 2019). In Figueiro´s (2013) research, it was found that disruptions to the circadian system caused by exposure to light can lead to various diseases, including sleep disorders and cancer. The study also revealed that HCL (Human Centric Lighting) was successful in alleviating depression and sleep disorders among three different groups, including Alzheimer's patients, adolescents, and shift workers, as demonstrated in the HCL living laboratory experiment. In addition, the studies by Cupokova et al (2019), Figueiro (2013) and Figueiro & Legett (2021) proved how HCL improves the quality of life. The importance of these studies lies in their emphasis on the necessity and influence of adopting HCL. However, they are constrained by the absence of managerial tactics for widespread HCL implementation in industrial settings. (Kwon et al., 2021).

Due to the many technical possibilities and controls at HCL, there is a higher energy requirement compared to an LED solution planned for visual purposes only. To achieve the desired biological effect, higher illuminance levels and blue components in the light are necessary for some places (Klepeis et al., 2001). The most significant business benefits of HCL are in the industrial segments. The emergence of advanced LEDs and lighting controls has enabled the regulation and customization of infrastructure lighting to suit specific needs, presenting additional avenues for expansion within the HCL market (Ferreira et al., 2023). In 2023, the global market for HCL already exceeded USD 1.84 million and it is estimated that the market potential is at a significant level, with a projected compound annual growth rate (CAGR) of 31.01% from 2023 to 2028 (Research and Markets Ltd, 2023). The market is being driven by factors such as increased awareness of the effect of lighting on human health and well-being, the adoption of smart lighting systems, and the rising trend towards energy-efficient lighting solutions. The commercial sector, especially in healthcare, education, and office lighting, is anticipated to drive the market (Research and Markets Ltd, 2023).

2.3. Awareness

The capacity of decision-makers to identify a product's brand is referred to as awareness. The level of awareness that consumers have regarding a product can impact their purchasing decisions, product usage, and ultimately their evaluation of the product's quality (Homburg et al., 2010). Awareness of trends in the field of technologies refers to the interest in new technologies and also the ability to be aware of new technologies that have already gained wide acceptance in the relevant industries or markets (Pandey et al., 2021). This may include the ability of a person to recognise and understand the need for and benefits of these new technologies to benefit health. Similarly, a study by Ferrereira (2023) shows that the more people are aware of the current state of the environment, the more likely they are to use smart home technologies to act in a more environmentally conscious way. Awareness, in this case of the environment, refers to knowledge and recognition of problems, which can then directly but also indirectly affect behaviour (Ha & Janda, 2012). Previous research has found that consumers' awareness of the benefits of a product influences their willingness to adopt practices and purchases based on the benefits. According to Lange et al. (2014). , consumers are more willing to purchase when they believe the benefits outweigh the costs. Furthermore, a study by Nketiah et al. (2022) found a positive correlation between residents' awareness of benefits and their intention to willingness to pay. The relation between awareness and a product brand can not help to increase the development of purchase intention, if awareness of the product is not present (Rossiter & Percy, 1987). Knowledge of the constituents of food is a vital aspect of making healthy food choices in the food industry. It is also a fundamental requirement for acquiring general knowledge (Clarke, 2004). Whether or not an individual decides to purchase a product is impacted by their beliefs about the product or brand, which in turn is influenced by their awareness of the particular product (Kahle et al., 1986). With the consideration of the hypotheses from the interviews, as well as the support of the preceding theory, the following hypotheses can be created:

Hypothesis 1a: The current level of awareness of HCL is low

Hypothesis 1b: The current level of its benefits among the general public is low

2.4. Willingness to Pay

Willingness to pay (WTP) is closely related to purchase intention and refers to the value that consumers associate with a product or service, which is expressed as the maximum amount of money they would pay for a particular product or feature (Breidert et al., 2006). It is also

important to note that there is a correlation between category involvement and willingness to pay. In categories where consumers are more emotionally involved, such as high-involvement products, people are more likely to pay a higher price because they see a benefit in buying the product (Steenkamp et al., 2010). On the contrary, consumers demonstrate a reluctance to pay for products that they perceive as failing to satisfy their individual needs and expectations with regard to product quality and performance. Consequently, an improvement in these particular product attributes would result in a heightened WTP (Hensher, 2010). According to Reynolds, Kolodinsky and Murray (2012), the amount someone is willing to pay for a good is equal to the value of that good, so WTP as a measure of the value of a good reflects the benefit to the individual.

H2: There is no difference in the awareness of HCL given the willingness to pay

2.4.1.   Health Consciousness and Subjective Well-being

In 1993, Moorman and Matulich discovered that individuals who possess a strong sense of health consciousness demonstrate consistent health-related behaviours (Moorman & Matulich, 1993). For this study, health-conscious consumers are defined as those who are willing to pay a certain or higher price for products or services in order to maintain their health at a consistently good level or take preventive health measures. In this context, health is understood as subjective well-being. Following Blanchflower and Oswald (2008), the notion of subjective well-being is based on the extent to which a person is satisfied with their life. Health consciousness is positively related to subjective well-being, as individuals who are more health-conscious tend to report higher levels of well-being (Das et al., 2020). Engaging in health-promoting behaviours, such as regular exercise, healthy eating, and getting enough sleep, can improve physical health outcomes, which in turn can contribute to greater subjective well-being (Diener et al., 2018). Moreover, a healthy lifestyle may also enhance psychological well-being by reducing stress and anxiety and promoting a sense of accomplishment and self-efficacy (Jayanti & Burns, 1998). Diener (2000) defines subjective well-being (SWB) as how individuals evaluate their lives, both emotionally and cognitively. SWB is experienced when people have more positive than negative emotions, engage in enjoyable activities, and are content with their lives (Diener, 2000). Consumers who prioritize their health are particular about the information they employ to continually invest in their well-being, aiming to maintain it in peak condition. They are distinguished by their proactive pursuit of information (Hayakawa, 2017). Health consciousness, according to Gould (2005), is the ability to recognise one's own health state and

the willingness to adopt health-promoting behaviours. Health awareness was found to be the most significant psychological factor influencing consumers' willingness to pay a premium for health and wellness foods in a study by Ali and Ali (2020). However, the influence of health awareness is not limited to food consumer behaviour. According to Xu et al. (2020) attitudes towards purchasing environmentally friendly furniture are favourably affected by health consciousness. Yun et al. (2020) examined how consumers' familiarity with "health-friendly" products and services impacts their purchasing intentions and their willingness to pay a premium for them. Therefore, the following Hypothesis can be formulated:

H3a: Willingness to pay groups do not differ in their health consciousness and subjective well-being

From studies carried out globally, it can be inferred that consumers who are health-conscious and pay attention to their health, are more receptive to marketing communications that are focused on health, purchase products and services that are perceived as promoting health and are willing to pay a higher price for products and services that improve their health. WTP study results play an important role in manufacturers' pricing and product development decisions. In addition to pricing decisions, these studies can help alert consumers' preferences on different product attributes to influence awareness and familiarity about the product. (Stolz et al., 2011). The demand for health-promoting products or products with functional benefits is particularly important as it provides an opportunity to identify which consumer groups are willing to pay more for a particular health benefit and accept this higher price, and how information can influence consumer acceptance and WTP (Dolgopolova & Teuber, 2018).

H3b: Consumers of HCL are not more health-conscious than other people.
H3c: Consumers of HCL do not prioritize their well-being in their daily lives.
H3d: Consumers of HCL are not more than average willing to invest in products that support their well-being.

2.4.2. Sociodemographic Factors

Sociodemographic factors were identified as significant determinants of willingness-to-pay (WTP) values (Dolgopolova & Teuber, 2018). Studies on farm animal welfare found that sociodemographic characteristics have an influence on consumers' willingness to pay. Nielsen (2003) suggests that gender, education, place of residence, and age are factors that influence

people to allocate current resources towards mitigating a future problem. Specifically, individuals aged 50 and above appear to be more inclined to pay for preventative measures against future health threats, even if the cost presents a barrier to purchasing health-promoting products, which may be more challenging for those in low-income populations. The study by Ali and Ali (2020) also shows a relationship between willingness to pay and income, as well as education. Studies based on observation and experimentation have demonstrated that demographic factors have a significant impact on people's purchasing decisions. Divine and Lepisto (2005) investigated how consumers' personal values, psychographic traits, and demographic characteristics affect their food choices and healthy lifestyles. Their research revealed that education and income are crucial demographic variables that greatly influence how much consumers are willing to pay for certain products. The study by Mujuka et al (2021) shows that consumers' willingness to pay for naturally preserved dried mangoes, which are supposed to be good for health, was positively influenced by age, gender and education. Therefore, the following plural Hypothesis can be formulated in detail:

H4a: There is no dependency on the willingness to pay for HCL between men and women.
H4b: There is no connection between the willingness to pay for HCL and the participants' age group.
H4c: There is no connection between the willingness to pay for HCL and the participants' Education.
H4d: There is no connection between the willingness to pay for HCL and the participants' Occupation.
H4e: There is no connection between the willingness to pay for HCL and the participants' Income.
H4f: The connection between age group and willingness to pay is not moderated by awareness of HCL.

Previous studies on WTP have amply demonstrated that product awareness, sociodemographic factors and product attributes determine the WTP for a particular food product (Mujuka et al., 2021). The study by Divine and Lepisto (2005) examined the demographic, personal and psychographic characteristics of consumers as important determinants of a healthy lifestyle. Yun et al. (2020) arguments show that young people have a longer life expectancy than older people and are thus more willing to pay more for green foods than older people, as they benefit from good health. Similarly, they considered that older people with lower household incomes

are less willing to pay for new food features such as organic/green foods. Similarly, psychologically oriented researchers show that consumer behaviour regarding energy consumption, is influenced by psychological factors such as attitudes, emotions and awareness of the environment.

To enhance the comprehension of the current study, Figure 1 provides a visual representation of the conceptual framework. It illustrates the variables of the study, their interrelationships, and the hypotheses to be tested. The conceptual model aims to illustrate the effect of health consciousness and subjective well-being as well as consumer sociodemographic factors on WTP. The moderating effect of HCL awareness is also illustrated in the figure.
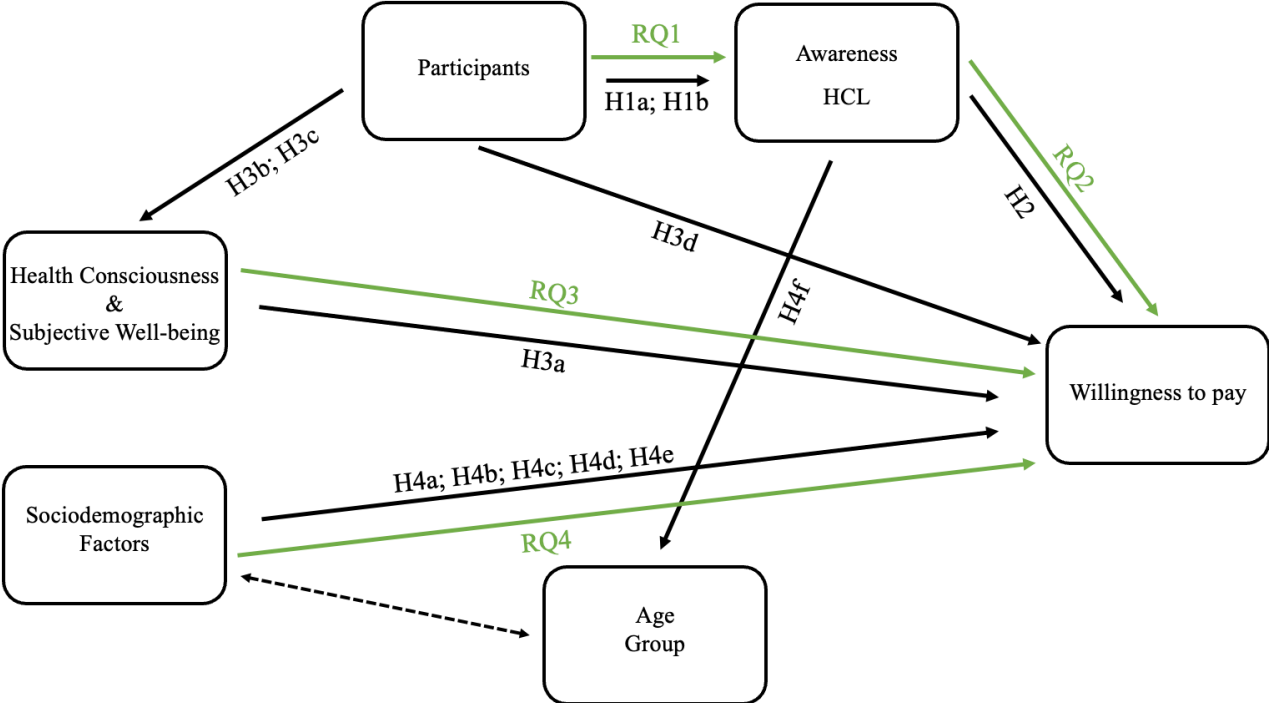

Figure 1: Conceptual Model

3. Methodology

3.1. Research Strategy and design

As mentioned in chapter 1.4, interviews were conducted to provide a general overview of the topic. The interviews were short in order to find out certain tendencies of the interviewees. The main focus of the work was on the online survey. Written, structured and standardized online questionnaires are used to collect data on the level of knowledge and awareness of the participants' health consciousness in connection with subjective well-being and the lighting concept HCL, the WTP for these aspects as well as the sociodemographic data of the participants. Health consciousness and subjective well-being as well as sociodemographic data represent the independent variables, WTP the dependent variable and awareness of the lighting concept HCL serves as a moderator. Written online surveys are a useful tool, as they offer the possibility of being independent of time and space. Thus, contacting the participants can also take place over long distances (Baur & Blasius, 2014). In addition, this method is simple and quick to carry out (Vogel, 2019).

3.2. Primary Data Collection

Structured in-depth interviews were chosen as the primary data collection method as they allow participants to express their personal and unbiased thoughts and beliefs (Seidman, 2006). This is particularly important when it comes to WTP, as well as the purchase intention, for HCL, as there can be differences of opinion when it comes to the acceptance of innovative products (Bruhn, 2007). In addition, the method enables the identification of conflicting individual positions and the collection of valuable complementary information that leads to the development of new research hypotheses. Structured in-depth interviews offer the advantage of capturing an unlimited amount of data and encouraging respondents' spontaneity and willingness to provide information (Allmark et al., 2009). In addition to the online survey, various interviews were conducted at the beginning of the creation of this survey. This served to create a general overview of the extent to which one's own well-being is prioritised and how intensively the respondents deal with the topic of technologies and health.

3.2.1.   In-depth Interviews

A total of 6 people were interviewed to get some idea about the subject matter of this dissertation. Likewise, the insights of the interviewees serve to form new hypotheses.

The interview lasted just under 10 minutes, as the focus of the data collection was on the online survey. In total, three women and three men between the ages of 25 and 67 were interviewed

out of the 6 persons. One respondent is a student and has no income, three people are employed and one person is self-employed. All persons come from the European area, three of them from Germany, one person from Austria and two persons from Portugal. The interviews (Appendix A) contained 5 questions, which were intended to give a brief overview of the subject matter. The following chapters were considered:

- General Attitude towards well-Being
- Usage of technologies for supporting well-being
- Awareness HCL
- Willingness to pay

These 6 interviews also served to generate hypotheses. Hypothesis H1a (The current level of awareness of HCL is low) and H1b (The current level of its benefits among the general public is low) emerged from the interview and were asked again in the online survey. The evaluations of the answers of the respondents are taken up in chapter 4.

3.2.2. Online Survey

To collect data for this study, a quantitative online survey was developed and published using Qualtrics, a web-based online survey tool. The survey was made accessible to the target group through a link generated by Qualtrics and distributed through various channels, including two social media platforms (Instagram and LinkedIn) and personal contacts via the messaging app, "WhatsApp". The direct approach also encouraged participants to forward the link to others to ensure the largest possible sample. Participants were informed of the survey's purpose and given a brief introduction to the survey procedure upon opening the link. The survey emphasized the confidential and anonymous handling of collected data, and participants were given seven to ten minutes to complete the questionnaire between January 29th and February 14th, 2023. All participants answered the same questionnaire. No additional incentives in form of subject hours or financial rewards were given for completing the questionnaire. At the beginning of the participation, the participants were informed about the topic and the objective of the survey and about the anonymity of their data. The first question aimed to ask the participants if they want to participate in the survey or not.

The survey covered four main topics, starting with subjective well-being, respondents' interest in improving it, and its importance to them. Next, shopping behavior was evaluated to determine whether participants purchased products to improve their well-being and their willingness to pay for such products in the past 12 months. The survey then focused on lighting

products, asking about the influence of light on well-being and whether customers considered this when purchasing lighting products. Lastly, respondents rated their opinion of "good lighting." The survey's first segment aimed to collect data that would confirm or disprove hypotheses H1a, H1b, and H3a.

The second section of the survey centred on HCL, where respondents were asked about their awareness of HCL and its benefits and where they learned about it. They were also asked to define HCL, express their interest in learning more, and their believe in its positive effects. Respondents were also asked about the differences between traditional lighting and HCL and whether they used HCL at home or in the office. Finally, they were asked about their willingness to pay on HCL and which factors influenced their purchase decision. The second topic area aimed to prove or disprove hypotheses H3b, H3c, H3d, and H4f.

The final section aimed to emphasize the differences between traditional lighting and HCL. Respondents were asked if they had purchased traditional lighting and how much they had spent on it in the past year. Likewise, in the last section of the survey, the demographic data of the respondents were requested, so that in this chapter the data for the evaluation of the relevant hypotheses H4a-H4e can be collected.

The questionnaire as a whole consists of 35 scales and a total of 64 items, including sociodemographic information. Due to the unfamiliarity of this dissertation topic, the scales were self-formed. They are based on the literature research and the interviews conducted. However, to test the hypotheses and address the research questions, only four scales and their corresponding 40 items are used in the analysis. The missing data in the ordinal scales were replaced by the column median using the imputation function.

3.2.3. Pretest

Prior to distributing the questionnaire on various platforms, a pretest was conducted with 10 participants. The participants were recruited through personal contacts on WhatsApp and in-person conversations. The group consisted of 6 female and 4 male participants between the ages of 27 and 67, all of whom were from Germany, with the exception of one from Portugal. The pretest revealed individual technical issues that needed improvement, such as the requirement to answer all previous points before proceeding to the next question. Additionally, some general instructions were modified to enhance their clarity and comprehensibility.

3.3. Secondary Data Collection

A wide range of secondary sources was collected in the literature research, which included e.g. academic articles, books, company reports and trade journals. These sources covered a wide

range of topics related to the research question and provided valuable insights into previous research findings and perspectives in the field and contributed to the development of the research hypotheses. The use of secondary data sources allowed the study to build on existing knowledge and deepen the understanding of the research topic while ensuring the reliability and validity of the research findings.

3.4. Data preparation and cleaning

For data transformation and statistical analysis, RStudio was selected as the statistical program. The survey data was exported automatically from Qualtrics and imported into RStudio for processing. The Likert scale response options were assigned numerical values ranging from one to five, which allowed for the interpretation of differences between values (Baur & Blasius, 2014). The previously described scales were chosen for this purpose. After recoding the items, the numerical values of each item within each scale were added together and a mean value was calculated for each scale. These mean or total values represented the operationalization of the variables being investigated (Vogel, 2019). To allow further analysis and processing of the data, empty cells in the data matrix are replaced with "N/A", a technique called imputation. A data cleaning method was also used to convert certain values in the data into numeric codes. This was done to support quantitative analysis by recoding values between 1 and 5 as numeric codes (Vogel, 2019).

3.5. Measurement Instruments

Using the psych package in R software, Cronbach's alpha coefficient (α) for each scale was calculated. The analysis showed that all four scales were internally consistent, with Cronbach's alpha coefficients above 0.6 ($\alpha < 0.6$). Finally, the mean of each scale was calculated and added to the original data frame. Detailed information about the measurement tools can be found in the following sections. The complete questionnaire can be found in Appendix B.

To assess the normal distribution of the metric scales, the Shapiro-Wilk test was used. A low p-value resulting from the Shapiro-Wilk test means that the null hypothesis is rejected, indicating that the data are not normally distributed. Since neither the ordinal nor the metric scales correspond to a normal distribution, non-parametric alternatives were used for all parametric tests (Hanusz et al., 2016). Hypotheses H1a and H1b and hypotheses H3b and H3c were tested with one-sided difference tests using the Wilcoxon Signed Rank Test with continuity correction (Dalgaard, 2008). To investigate the potential relationship between willingness to pay for HCL and various demographic factors, the Chi-Square test was used for

analysis. This relates to hypotheses H2b, H2d and H3d. The Kruskal-Wallis rank sum test was used to analyse the data for two hypotheses (H2 and H3a) (Dalgaard, 2008). Lastly, a regression analysis is used to determine the relationship between the WTP variables and the age group to test hypothesis H4f (Blattberg et al., 2008).

3.5.1. Personal Well-Being and Lifestyle Habits

The scale, called "Well-being and Lighting" in R, focuses on measuring people's general well-being in relation to lighting. The scale is complemented by a series of questions related to strategies for improving well-being. Respondents are asked to indicate whether they are interested in improving their well-being and to what extent they prioritise their own well-being. Factors measuring strategies to improve well-being include: getting enough sleep, exposing the body to sunlight, creating a cosy atmosphere at home, reducing screen time on electronic devices, being physically active and eating healthier. Overall, the scale aims to explore the relationship between lighting and well-being, while also examining how individuals rank their own well-being and what steps they take to improve it. The well-being_lighting scale had a Cronbach's alpha of $\alpha = 0.79$, indicating high internal consistency. The answers to the items not used for hypothesis testing were evaluated in Excel and described in chapter 4.2.1.

3.5.2. Attitude and Awareness towards HCL

The "HCL_Usefulness" scale includes four items on the topic of Human-Centric-Lighting (HCL). The questions are designed to measure the participant's level of awareness and interest in HCL, as well as their belief in its potential to improve well-being.The first question asks to what extent the participant agrees with a statement defining HCL. The second question measures the level of awareness of HCL and its potential benefits for well-being. The third question measures the participant's interest in learning more about the benefits of HCL for well-being. Finally, the fourth question assesses participants' belief in HCL's potential to improve well-being. The HCL_usefulness scale had a Cronbach's alpha of $\alpha = 0.69$, indicating moderate internal consistency.

3.5.3. Factors affecting preferences for HCL

The "HCL Characteristics" scale measures the importance of different characteristics when it comes to HCL. The following characteristics are included in the scale: health benefits, customization, energy efficiency, price, compatibility with existing lighting systems or home automation systems, design and appearance, and ease of use. Respondents rate each characteristic on a scale from 1 (strongly disagree) to 5 (strongly agree) based on their

importance. The HCL_Characteristics scale had a Cronbach's alpha of $\alpha = 0.73$ indicating good internal consistency.

3.5.4. Factors influencing traditional lighting preferences

The "TL Characteristics" scale assesses the importance of various factors related to traditional lighting. Participants rate the importance of each factor on a scale from 1 (not at all) to 5 (very important). The factors include design, quality, brand, price, eye-friendly light, number of functionalities (e.g. dimming, personalization, control, etc.), and energy class/energy label. The TL_Characteristics scale had a Cronbach's alpha of $\alpha = 0.62$, indicating moderate internal consistency.

4. Results

4.1. Sample Characterization

A total of 143 participants took part via the online survey link. Two participants denied at the beginning that they wanted to take part in the survey. A total of $N = 99$ participants completed the survey, which represents a percentage of 69.23%. The survey was conducted on a voluntary basis. 59 (60.20 %) males and 39 (39.80 %) females participated in the survey, resulting in a total sample of 99 people. One person indicated that they do not want to mention their gender. The age range of the respondents was from 18 to 74 years. Of the participants, 71.72% were from Germany, and 11.11% indicated Portugal as their nationality. The remaining 17.17% were from different countries such as the UK (3.03%), Austria (1.01%) and Italy (1.01%). The majority of the participants (55.56%) reported their residence in Germany, and 32.32% of them live in Portugal. Only 2.02% reported having a PhD or higher, while 83.84% reported having a Bachelor's or Master's degree. Thirty-one of the participants (31.31%) said they were students, with 60 people saying they were employed or self-employed (60.61%). Within the whole sample, the income distribution was also evaluated. 15.15 % of the respondents have an income of less than 500 €, 30.30 % have an income between 500 and 1000 €, 27.27 % have an income between 1500 and 3000 €, and 17.17 % have an income between 3000 and 5000 €. Only 10.10 % stated that they had a monthly income of more than 5000 €. Further details can be found in Appendix C.

4.2. Descriptive Statistics

Table 1 shows the mean for Wellbeing_Lighting is M=3.94, and the standard deviation is SD=0.5, showing a moderate range of values. The mean of HCL_Usefulness is M=4.03 and the standard deviation is SD=0.2, indicating a high degree of agreement among respondents. HCL_Characteristics has a mean of M=3.98 and a standard deviation of SD=0.57, showing that respondents' responses are more variable. The mean of TL_Characteristics is M=3.48 and the standard deviation is SD=0.59. The median number is 3.43 and the variable is normally distributed with a skewness of 0.2.

Table 1: Mean values and standard deviations of the examined variables (N=99)

	n	mean	sd	median	trimmed	mad	min	max	range	skew	kurtosis	se
Wellbeing_Lighting	99	3.94	0.5	4.07	4.00	0.32	2.00	4.79	2.79	-1,28	2.23	0.05
HCL_Usefulness	99	4.03	0.2	4.00	4.00	0.00	3.00	5.00	2.00	0,65	13.65	0.02
HCL_Characteristics	99	3.98	0.57	4.00	4.03	0.42	2.14	5.00	2.86	-0,93	1.20	0.06
TL_Characteristics	99	3.48	0.59	3.43	3.47	0.64	2.00	5.00	3.00	0,2	-0.34	0.06

In addition to the scales to be tested in order to carry out the hypothesis testing, other items were asked in the survey that are independent of the hypothesis testing but have an influence on the answering of the research questions. These were presented in chapter 3.5.1 and evaluated in the following.

4.2.1. Personal Well-Being and Lifestyle Habits

The responses of the interviewees show that all of them prioritise their well-being and maintain a healthy lifestyle through various activities such as exercise, healthy eating and self-care. Some of the respondents, such as B.L. and V.A., recognise the potential benefits of using technology such as fitness trackers, meditation apps and other tools to support their well-being, while others, such as P.L. and I.W., are open to the idea of using technology to improve their health. However, some of the respondents, such as A.M. and A.C., have already used technologies to support their well-being, e.g. meditation apps, fitness trackers and stress management apps.

In the evaluation of the items in the survey, 47.47 % said that they were interested in improving their well-being, and 50.51 % said that their well-being was important at all. The proportion of product purchases to improve their well-being is high at 77.78%. These include fitness equipment/gym membership, food supplements, natural remedies and lighting products (LED; luminaires; smart home lighting) with lighting products being indicated by only 37% of the participants. The majority of respondents (44.44%) would only spend less than €150 on products to promote their well-being whereas the majority spent less than €350 on their well-being in the last 12 months. Overall, 87.88% said they believe that light affects their well-being, with few saying that their well-being was important to them when buying lighting (15.15%).

4.2.2. Attitude and Awareness towards HCL

In this topic area, interview respondents were asked about their thoughts on using lighting for their well-being and their knowledge of HCL. While some people had never thought about using lighting for their well-being, they acknowledged that lighting can affect mood, energy levels and productivity. Some had heard of human-centred lighting but had not used it themselves. They cited costs and lack of knowledge about the benefits and availability as reasons. Others were open to exploring new technologies that could improve their well-being

and productivity. One person felt that HCL is only useful for people with low vitamin D levels, which is due to a lack of knowledge about HCL.

The items described in chapter 3.5.2 show the survey results in relation to HCL. Around 79.80% of the respondents stated that they had never heard of HCL. Those who said they knew about it had their information from social media or friends & family. Most said they had heard of HCL in connection with work. Likewise, these people indicated which factors were important for the definition. "Lighting solutions that focus on people's needs" (55%), "biologically effective light" (70%) and "lighting concept to increase well-being" (55%) were the factors that received the most agreement in the survey. To test hypotheses H1a and H4f, the percentage of respondents clearly shows the extent to which awareness is present. Only 2.02% stated that they were extremely aware, with 38.38% stating that they were less aware. A positive interest in learning about the well-being benefits of HCL is shown by 43.43%, with 4.04% having no interest. Besides the low awareness, the respondents are also not aware of the use of HCL. 73.74% said that they had not used HCL at home or at work, although 55% are willing to use this lighting concept. The maximum amount respondents would spend on lighting products that enhance well-being is lower at 41% under €150. Only 2% would spend more than 500€ on this. To pick up again on the lack of knowledge about HCL, the results of the question of whether respondents would buy HCL if they knew more about the benefits also show this. 60.61% answered this question with "probably yes".

4.2.3. Factors affecting preferences for HCL

Respondents were asked if they would be willing to pay for HCL if they knew its benefits. B.L. was open to the idea but would prefer it if it was not too expensive (less than 150 €). P.L. saw no personal benefit and was not willing to pay for it. A.M. was interested in HCL and would be willing to pay for it if it was not too expensive. V.A. was willing to pay for it as she has a higher monthly income. I.W. would consider buying it if she had proof of benefits, but as a student affordability would be an issue. A.C. was willing to buy it if it could improve her mood and productivity, as she likes to invest in things that promote her health. This suggests that the income component is an important factor for WTP.

Important factors of HCL were perceived by the respondents as "Health Benefits (53%), Customisation (51%), "Energy Efficiency" (43%), "Price" (44%), "Compatibility" (34%), "Design and Appearance" (44%), as well as "Ease of use" (40%). However, price is not a decisive factor in the definition. The factors that were most important to the respondents for buying HCLs were more access to information (21%), easy installation (16%) and attractive design (15%).

4.2.4. Factors influencing traditional lighting preferences

80% of the participants stated that they had recently purchased lighting equipment. In total, less than €250 had been spent on this in the last 12 months (94%). Besides the most important factors such as quality (46%), price (49%), eco-friendly light (42%) and energy class (36%), the brand is not important to respondents (38%). This comparative data with HCL shows that energy class and price are the most important drivers for purchasing traditional lighting.

4.3. Hypotheses Testing

The dataset consisted of four metrics, Wellbeing_Lighting, HCL_Usefulness, HCL_Characteristics, and TL_Characteristics, which were tested for normality using the Shapiro-Wilk normality test. The Shapiro-Wilk test was deemed appropriate for this dataset because it is suitable for small to medium sample sizes, which was the case here with N=99. Furthermore, the Shapiro-Wilk test is considered more robust than other normality tests as it is less affected by outliers or other deviations from normality.

The dispersion of the correlations is illustrated in the correlation heat map (Graphic 1), which was subjected to further testing to determine its significance.
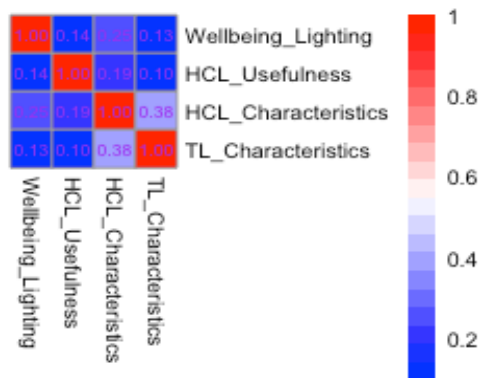
Graphic 1: Correlation heat map of variables

Table 2: Shapiro Wilk Test of metric scales

	Shapiro Wilk Test	p-value
Wellbeing_Lighting	W = 0.91757	0.01151

HCL_Usefulness	W = 0.54178	0.0000000000004614
HCL_Characteristics	W = 0.94862	0.000723
TL_Characteristics	W = 0.95667	0.002494

Results indicated that none of the four metrics was normally distributed, as indicated by the low p-values obtained for each metric (Table 2). The objective of these tests was to determine if the data in each scale conformed to normality, which is a crucial assumption for many statistical analyses (Hanusz et al., 2016). Nine hypotheses are investigated and formulated as null hypotheses. If the tests prove to be significant, the null hypothesis will be rejected, and the research question can be confirmed through falsification.

4.3.1. One-sided difference test

The results of hypothesis H1a showed that the null hypothesis can be rejected as the p-value of 2.422e-05 was below the significance level of 0.05 ($\alpha = 0.05$). This suggests that the level of awareness of HCL (HCL_awareness) is low. Similarly, the results of hypothesis H1b showed that there is insufficient evidence to conclude that the average belief in the benefits of HCL to improve well-being (HCL_Believe_Wellbeing_Improvement) is low, as the p-value was not below the significance level of 0.05 ($\alpha = 0.05$) (p=1). Hypothesis H3b states that HCL users are not more health-conscious than other people. The Wilcoxon rank-sum test was performed between the variables HCL_Usefulness and HCL_used_before. The test yields a p-value of 0.1801, which is greater than the significance level of 0.05 ($\alpha = 0.05$). Therefore, the null hypothesis cannot be rejected. Hypothesis H3c examined that HCL users do not prioritise their well-being in their daily lives. The test was conducted between the variables well-being_lighting and HCL_used_before. The test yields a p-value of 0.05096, which is close to the significance level ($\alpha = 0.05$). Although the null hypothesis cannot be rejected, there is a strong tendency to suggest that HCL users place more value on their well-being than non-users.

Table 3: Results one-sided difference Test

	p
HCL_awareness	0.02422
HCL_Believe_Wellbeing_Improvement	1
HCL_Usefulness	0.1801

HCL_used_before	0.05096

4.3.2. Pearson´s Chi-square Test

Hypothesis H4a states that there is no relationship between gender and willingness to pay for HCL. A chi-square test was conducted to test this hypothesis, which yielded a p-value of 0.1872, meaning that the null hypothesis cannot be rejected. It can be concluded that gender and willingness to pay for HCL are independent variables. Hypothesis H4b states that there is no relationship between age and willingness to pay for HCL. The results of the chi-square test showed that the null hypothesis can be rejected with a p-value of 0.03752, which means that age and willingness to pay for HCL are dependent variables. Furthermore, the results show that the older the participants are, the higher their willingness to pay for HCL. Hypothesis H4c states that there is no relationship between education level and willingness to pay for people-centred lighting. The chi-square test yielded a p-value of 0.06197, which means that the null hypothesis cannot be rejected. Consequently, education and willingness to pay for HCL are independent variables. Hypothesis H4d states that there is no relationship between occupation and willingness to pay for HCL. The chi-square test yielded a p-value of 0.239, which means that the null hypothesis cannot be rejected. Thus, occupation and willingness to pay for HCL are independent variables. Hypothesis H4e states that there is no relationship between income and willingness to pay for HCL. However, the chi-square test yields a p-value of 0.0006424. The null hypothesis can be rejected.

Table 4: Results Pearson´s Chi-square Test

HCL_Willing_To_Spend		
	X^2	p
Gender	61.647	0.1872
Age	37.664	0.03752
Education	30.512	0.06197
Occupation	28.512	0.239
Income	40.57	0.0006424

Pearson's chi-square test was also used to test hypothesis H3d. Hypothesis H3d tests whether HCL consumers are not more willing than average to invest in products that support their well-being. The data analysed showed that participants who had already used HCL were more willing to spend higher amounts on products that support well-being in lighting. The chi-square test yielded a test statistic (X^2) of 18.405 and a p-value of 0.001028. Since the p-value is less

than 0.05 (α = 0.05), the null hypothesis can be rejected, which means that the observed differences in the data are statistically significant. It can be concluded that participants who had used HCL before were significantly more likely to be willing to spend more money on lighting products that support their well-being than participants who had never used HCL. This suggests that there is a link between previous use of HCL and willingness to invest in well-being lighting products.

4.3.3. Analysis of Variance

The analysed dataset contains variables related to HCL, including awareness of HCL (HCL_Awareness) and willingness to pay for HCL (HCL_Willing_to_Spend), as well as a variable related to the importance of well-being in lighting. For hypothesis H2, which investigates whether there is no difference in the awareness of HCL (HCL_Awareness) given the willingness to pay, the Kruskal-Wallis test yielded a significant p-value of $p= 0.02322$. This means that the null hypothesis can be rejected and shows that HCL awareness has an influence on willingness to pay. The boxplot also shows a clear trend in this direction, with higher median values for awareness among groups with higher willingness to pay (Graphic 2).
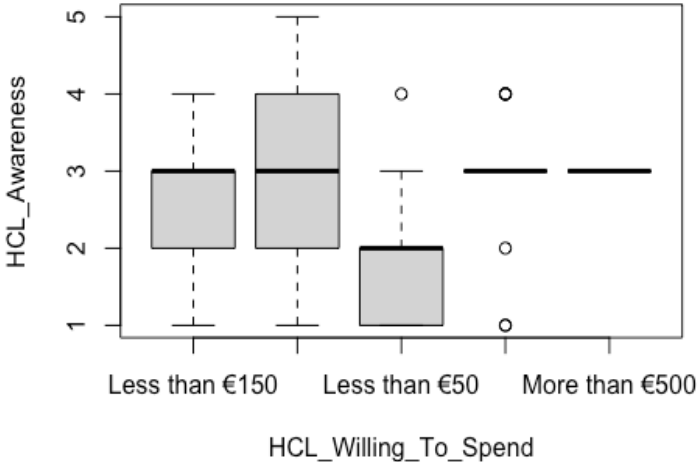
Graphic 2: Boxplot of H2

For hypothesis H3a, which examined willingness to pay groups do not differ in the importance of well-being, the Kruskal-Wallis test yielded a non-significant p-value of $p=0.4$, which means that the null hypothesis cannot be rejected, but there is a tendency for groups with higher willingness to pay to attach more importance to their well-being, as shown in the boxplot (Graphic 3).

4.3.4. Regression Analysis

Graphic 3: Boxplot of H3a
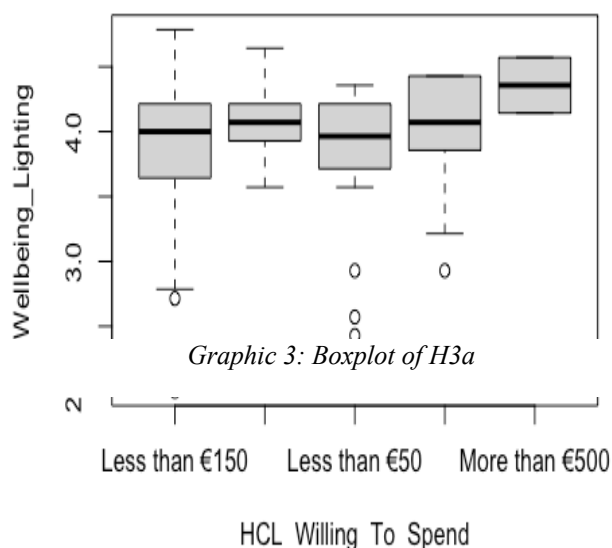
The tested hypothesis H4f served to investigate whether the correlation between age group and willingness to pay is moderated by HCL awareness. The data set used consists of the variables HCL_Awareness and HCL_Willing_To_Spend as well as the specified age group. The results of the linear regression show that HCL awareness has no influence on the relationship between age group and WTP. The coefficient estimates for the interaction terms between HCL_Willing_To_Spend and age group were not statistically significant. Table 5 shows the standard errors (se), p-values (p) and t-values for each combination of HCL_Willing_To_Spend and age group.

Table 5: Results Linear Regression

		se	p	t-value
HCL_Willing_To_SpendLess than €350	*Age group 25-34	1.52545	**0.0294**	**2.219**
HCL_Willing_To_SpendLess than €50	*Age group 25-34	-0.04121	0.9489	-0.064
HCL_Willing_To_SpendLess than €500	*Age group 25-34	-0.84121	0.3129	-0.064

HCL_Willing_To_SpendMore than €500	*Age group 25-34	0.98000	0.5469	0.605
HCL_Willing_To_SpendLess than €350	*Age group 35-44	-0.45455	0.7425	-0.330
HCL_Willing_To_SpendLess than €50	*Age group 35-44	-1.85455	0.1645	-1.404
HCL_Willing_To_SpendLess than €500	*Age group 35-44	-1.95455	**0.0903**	-1.715
HCL_Willing_To_SpendLess than €50	*Age group 45-54	0.64545	0.6690	0.429
HCL_Willing_To_SpendLess than €500	*Age group 45-54	-1.12121	0.4807	-0.709
HCL_Willing_To_SpendLess than €350	*Age group 65-74	2.37879	**0.0339**	**2.160**
HCL_Willing_To_SpendLess than €500	*Age group 65-74	-0.12121	0.9206	-0.100

Table 5 shows that only three p-values are statistically significant. p= 0.0294 for the combination of HCL_Willing_To_Spend under €350 and age group 25-34 years; p= 0.0903 for the combination of HCL_Willing_To_Spend under €500 and age group 35-44 years; and p= 0.0339 for the combination of HCL_Willing_To_Spend under €350 and age group 65-74 years. Nevertheless only the t-value of p=0.0294 (t-value= 2.219) and p=0.0339 (t-value= 2.160) are above 2 (t-value < 2). This means that only these two variables are significant.

Thus, the null hypothesis can be rejected. Spending less than 350€ and age groups 25-34 and 65-74 (interactions) were associated with significantly higher awareness of HCL.

5. Discussion

5.1. Research findings

This scientific work aimed to understand consumers' awareness and willingness to pay for HCL concepts and their perception of how these products can influence their well-being. In doing so, prerequisites for subjective well-being in connection with the HCL lighting concept were to be identified in order to support companies, but also end consumers, with recommendations for action in this context and to simplify purchasing decisions. In order to get closer to this goal, the following research questions were formulated at the beginning:

RQ1: What is the current level of awareness of HCL?

RQ2: How does awareness of the benefits of HCL influence consumers' willingness to pay?

RQ3: How does health consciousness influence willingness to pay for HCL?

RQ4: Is there a relationship between sociodemographic data and willingness to pay for HCL?

An extensive literature review was conducted to gain relevant topic insights for the HCL lighting concept and to explore relevant willingness-to-pay and awareness components. Previous research results were presented and hypotheses to be investigated were created based on this research. The hypotheses should help to relate and investigate the influencing factors of willingness to pay, health consciousness, subjective well-being and sociodemographic data with the awareness and purchase of HCL.

The hypotheses H1a and H1b of this study, which were tested with a one-sided difference test, can be confirmed. Thus, it could be established that the level of awareness of HCL is low. It was also found that the belief in the benefits of HCL for improving one's own well-being is low. These test results are also consistent with the responses from the interviews. In this study, using the one-sided difference test, no statistical significance can be determined. The investigation of hypothesis H3b showed that the potential users of HCL are more health-conscious, so this hypothesis can be confirmed. A one-sided difference test was also used for hypothesis H3c, which also confirmed this hypothesis. Although the values are minimal ($p=0.05096$), there is a tendency to indicate that HCL users attribute a higher value to their well-being than non-users.

The examination of hypotheses H2 and hypothesis H3a were carried out with an analysis of variance. This showed that hypothesis H2 can be confirmed. If the respondents were aware of the concept of HCL, they also had a higher willingness to pay. Thus, there is an influence of

awareness on WTP. The examination of hypothesis H3a showed that this hypothesis can also be confirmed. People with a higher awareness of their well-being also had a higher WTP for HCL.

The investigations of the hypotheses H4a-H4e were carried out with a Pearson's Chi-square test. The confirmation of hypothesis H4a, hypothesis H4c and hypothesis H4d shows that there is no correlation between WTP, gender, educational level and occupation. However, the results for hypothesis H4b and hypothesis H4e show that there is a relationship between WTP and age and income. Hypothesis H4b can therefore be rejected. Furthermore, it was found that the older the respondents were, the higher their WTP was. Similarly, hypothesis H4e can be rejected because the higher the income, the more willing participants are to pay for HCL. The results of hypothesis H3d revealed that participants who had used HCL before were significantly more likely to be willing to spend more money on lighting products that support their well-being than participants who had never used HCL. This suggests that there is a link between previous use of HCL and willingness to invest in well-being lighting products.

Testing the moderator hypothesis revealed that hypothesis H4f can not be confirmed. There is a correlation between age group and WTP moderated by awareness. Participants who tended to have a higher awareness of HCL indicated that they would spend less than €350 and were either in the 25-34 age group or 65-74.

5.2. Limitations and Suggestions for future research

In terms of the sample, the questionable representativeness of the sample should be emphasised. In addition to the 143 active participants, only a full sample of 99 people was interviewed. This is not considered representative. Similarly, a very large number of students and people who may not know much about lamps were interviewed. Similarly, 71 of the respondents were from Germany, which does not make a valid statement about the European or even global lighting market. It was also noticeable that many respondents were not familiar with the topic. Due to the existing knowledge from the author, it was difficult to explain the topic to the non-knowing participants during the survey and to point out differences and advantages. Although there was a reference to the definition of HCL, each participant may have interpreted it differently. If necessary, the sample should already have some interest in technologies and lamps to understand the differences or to be more critical of the answers. With regard to data collection, it should also be mentioned that better research and structuring would have made data collection much easier. In addition, a much more extensive online survey with a longer time interval and more participants would have been necessary to professionalise the research. Perhaps monetary

compensation for the participants would also be desirable. Regarding the measurement of the data, existing scales from already tested studies with a higher consistency would have been necessary. Thus, the usage of self-created scales caused many problems. It should also be looked at again to see whether the hypotheses can be improved. The sociodemographic data did not take into account the nationality and residence of the participants. For the future, one could consider adding more sub categories to the hypothesis tests. For example, to what extent awareness is split between genders or age groups, or whether willingness to pay is quite high overall but lower income respondents have a lower willingness to pay. As far as research on this topic is concerned, there is a clear need for improvement. The topic of HCL is generally very unknown, as are technologies to promote health and well-being, which have not yet been researched too much or supported by studies. The most common studies on awareness, WTP and health consciousness are related to food, which is not the same as lighting. It is also difficult to define HCL, as it is a concept that falls not only in the category of classic luminaires but also in the category of smart home technologies. Most of the research showed the biological effect of HCL, but not in terms of awareness, usage and WTP. So a different focus should have been put on the research from the beginning or even a different topic should have been chosen.

Nevertheless, it is important that the topic of technology and health should continue to be studied. Mental illness is on the rise, as is the use of technologies that affect our bodies. Education about lighting is also an important aspect. Many people do not use artificial light with the knowledge of what effects it has on their bodies. Future research should therefore focus on these issues to create greater awareness and attention for people, so that not only health can be promoted, but also companies can benefit from employing staff with higher productivity, as well as fewer sick days.

5.3. Conclusion

In conclusion, the study has provided valuable insights into the topic of HCL. However, it must be noted that due to the limitations highlighted in chapter 5.2, the findings are insufficient to make recommendations for companies and consumers. The data lack representativeness and the dissertation could have been more thoroughly researched and structured. The complexity of HCL has further complicated the evaluation process.

Despite these limitations, the topic of HCL is of utmost importance, and it is recommended that lighting manufacturers such as Osram or Signify be commissioned to produce case studies on awareness and WTP to further research in this area. The findings suggest that both lighting manufacturers and end consumers must focus on raising awareness and realizing the potential

benefits of HCL. Production companies could benefit from increased turnover in the lighting industry, as health-conscious individuals are more willing to pay for HCL which can increase its demand. Additionally, if potential customers were made aware of the HCL lighting concept, they would be more inclined to invest in the technology, which has been shown to improve health and prevent illnesses and fatigue.

Furthermore, the confirmation of hypotheses that age and income are important factors in WTP serve as a basis for defining target groups, allowing lighting manufacturers to implement targeted marketing strategies. Overall, the study's findings suggest that there is a need for increased awareness of HCL among potential users and for lighting manufacturers to develop targeted marketing strategies to increase demand for HCL products. Additionally, the study highlights the potential benefits of HCL for well-being and encourages individuals to consider investing in such technology to improve their overall health and well-being.

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7. Appendix

7.1. Appendix A – Interviews

In-Depth interviews

Greetings [name], I appreciate your willingness to participate in this interview. My name is Juliane Lembcke, and I am in the final phase of my Master's program in Management with a specialization in strategic marketing at Católica Lisbon School of Business and Economics. My dissertation aimed the understanding of consumers' awareness and willingness to pay for Human-Centric Lighting concepts as well as their perception of how these products can influence their well-being. As a part of my research, I am conducting interviews to gather valuable initial insights into how consumers perceive Human-Centric Lighting and use it for their health and subjective well-being. While I have some general questions prepared, this is intended to be an open conversation, and your input is valuable. Your answers will remain anonymous, and the interview will be recorded for in-depth analysis later. Please keep in mind that there are no right or wrong answers, and I encourage you to provide your candid opinions on the subject. The interview is very short and is expected to take around 10 minutes, and there will be no further contact with you after its completion. Thank you once again for your participation, and let's begin.

Consumers interviewed:

B.L.: German, 61 years old, Female, Housewife

P.L.: German, 67 years old, Male, Mechanical Engineer

A.M.: Portuguese, 25 years old, Female, Interpreter

V.A.: Portuguese, 32 years old, Male, Entrepreneur

I.W.: German, 25 years old, Female, Master's Student in Management

A.C.: Austrian, 56 years old, Male, Product Manager

General Attitude towards Well-Being

1. **Please tell me your attitude towards your well-being.**

B.L.: "My attitude towards my well-being is very important to me, especially at my age. I try to maintain a healthy lifestyle by eating a balanced diet, exercising regularly, and staying socially active. I also make time for self-care activities like reading, gardening, and spending time with my family."

P.L.: "I believe that taking care of myself is crucial for maintaining a good quality of life. As a mechanical engineer, I have a demanding job, and I need to be in good physical and mental health to perform well. I try to stay active by walking and biking, and I enjoy eating healthy food. I also take time for myself by reading and watching movies."

A.M.: "I think it's essential to take care of yourself, especially in a job that can be mentally demanding like interpreting. I try to maintain a healthy balance between work and personal life and prioritize self-care activities like yoga and meditation. I also make sure to stay connected with friends and family."

V.A.: "As an entrepreneur, my well-being is critical for my business success. I try to maintain a healthy work-life balance, which means setting boundaries and taking time for myself. I also prioritize physical exercise and eating well, as I know this helps me stay focused and energized."

I.W.: "Being a master's student in management can be challenging, but I try to prioritize my well-being as much as possible. I make time for regular exercise and eating well, and I also take breaks to do things I enjoy, like reading and spending time with friends. It's essential for me to maintain a healthy work-life balance."

A.C.: "As a product manager, I know that my performance is linked to my well-being. I prioritize exercise, healthy eating, and getting enough sleep to stay focused and productive. I also take breaks to do things I enjoy, like hiking and playing music, to maintain a healthy work-life balance."

Usage of technologies for supporting well-being

2. Have you ever thought about using technologies to support and improve your well-being?

B.L.: "Yes, I have considered using technologies to support my well-being. I've heard about fitness trackers and meditation apps, and I think they could be helpful in tracking my progress and keeping me motivated."

P.L.: "I haven't thought about using technology specifically for my well-being, but I'm open to the idea. I think it could be useful to have a tool that helps me track my exercise or reminds me to take breaks during the day."

A.M.: "Yes, I have used technology to support my well-being. I have a meditation app that I use regularly, and I also use a fitness tracker to monitor my physical activity."

V.A.: "As an entrepreneur, I'm always looking for ways to optimize my productivity and well-being. I've tried a few different apps and tools to help with meditation and mindfulness, and I've also used a fitness tracker to monitor my physical activity."

I.W.: "I haven't thought about using technology specifically for my well-being, but I'm open to the idea. I think it could be helpful to have a tool that reminds me to take breaks or helps me track my exercise and nutrition."

A.C.: "Yes, I have used technology to support my well-being. I have a fitness tracker that helps me monitor my physical activity, and I've also used apps for meditation and stress management."

Awareness Human-Centric Lighting

3. As I can see, you mostly use fitness trackers or apps. Have you ever considered of using Lighting for your well-being?

B.L.: "I haven't considered using lighting specifically for my well-being, but I'm open to the idea. I think lighting can definitely impact your mood and energy levels, so it's worth looking into."

P.L.: "I haven't thought about using lighting for my well-being, but I can see how it could be beneficial. I work in a dimly lit office, and I've noticed that it can make me feel tired and less focused."

A.M.: "I haven't used lighting specifically for my well-being, but I know that lighting can impact your mood and energy levels. I try to get plenty of natural light during the day, and I use warm lighting in my home to create a cosy atmosphere."

V.A.: "I haven't considered using lighting specifically for my well-being, but I'm always open to new ideas. I think lighting can definitely impact your productivity and energy levels, so it's worth exploring."

I.W.: "I haven't thought about using lighting for my well-being, but I'm curious to learn more. I know that lighting can impact your circadian rhythm and sleep patterns, so it could be an interesting area to explore."

A.C.: "I haven't used lighting specifically for my well-being, but I know that lighting can impact your mood and productivity. I try to get plenty of natural light during the day and use warm lighting in my home to create a comfortable atmosphere."

4. If you think of your well-being. Have you ever heard about Human-Centric Lighting? If yes, why are you not using it for your well-being?

B.L.: "I've never heard of human-centric lighting before, but it sounds interesting. If it can improve my well-being, I'd be willing to give it a try."

P.L.: "I've never heard of human-centric lighting, and also haven´t used it myself. I'm not sure how it would work in my office, but I'm open to learning more about it."

A.M.: "I've heard about human-centric lighting. I need to be alert and focused during my work, so anything that can improve my well-being is worth considering. Nevertheless, I did not use it for myself, because I heard it is expensive and I am not sure of its benefits."

V.A.: "I've heard about human-centric lighting, but I haven't used it myself. I'm not sure if it's necessary for my business, but I'm open to exploring new technologies and ideas that can improve my well-being and productivity. I did not use it for myself because I do not know where I can buy it and how this actually works."

I.W.: "I've never heard of human-centric lighting before, but I don't know much about it. As a master's student, I spend a lot of time indoors studying and working, so I do not believe that lighting can help to feel better."

A.C.: "I've heard of human-centric lighting, but I thought it Is just for people who have a low Vitamin D level, which is for me not the case."

Willingness to Pay

5. If you would know about HCL and its benefits, are you willing to pay for it? If yes, how much?

B.L.: "If it can improve my well-being, I would consider paying for it. However, it would depend on how much it costs. I do not need lighting for my health, that is why I do not want to pay very much for it (less than 150€)."

P.L.: "I'm not sure how human-centric lighting would benefit me personally, so I don't think I would be willing to pay for it. I already have a comfortable setup in my home that works for me."

A.M.: "I think it could be beneficial for me as an interpreter who works long hours indoors. I have to take care of my money every month, so if it is not very expensive, I would be willing to pay for it."

V.A.: "Yes I would pay for it. I am self-employed so I have a higher monthly income. That is why I like to purchase a bit more expensive things to improve my well-being."

I.W.: "I've I have proof that it will impact my well-being, I would be willing to pay for it. Nevertheless, I am a student and have no income. I think I would buy it If I can afford it."

A.C.: "If it can improve my mood and productivity, I am very open to buying it. I like to improve my health and am willing to pay for things, which can support this."

7.2. Appendix B – Online Survey

<p align="center">Final Survey Questions</p>

Agree in participants

1. Do you agree to participate in this study?

    a. I agree to participate in this study.

    b. I do not agree to participate in this study.

Introduction

Thank you for participating in this survey. The purpose of this survey is to understand the public's awareness and intentions related to purchasing human-centric lighting products, as well as their perceptions of how these products may impact their well-being.

Your participation in this survey is voluntary and anonymous.

Please answer the questions as accurately and honestly as possible.

Well-being and Lighting

Please assume that the term "well-being" refers to subjective well-being, which refers to the overall evaluation of your life, including your feelings, satisfaction and happiness.

The Satisfaction with Life Scale (SWLS)

WL1: Please indicate how well you agree with the following statements about your life (1=strongly disagree; 5=strongly agree)

    a. In most ways, my life is close to my ideal.

    b. The conditions of my life are excellent.

    c. I am satisfied with my life.

    d. So far, I have gotten the important things I want in life.

    e. If I could live my life over, I would change almost nothing.

WL2: Are you interested in improving your well-being?

    f. Always

    g. Very Frequently

    h. Occasionally

    i. Rarely

    j. Never

WL3: What do you do to improve your well-being? (1=strongly disagree; 5= strongly agree)

    k. Try to get enough sleep

    l. Expose my body to sunlight

    m. Create a cozy atmosphere at home

    n. Reduce Screentime at Laptop, TV and Smartphone

    o. Be physically active

    p. Eat healthier

WL4: How important is your overall well-being to you?

    q. 1=not at all important; 5=extremely important

WL5: How much do you prioritize your own well-being?

    r. 1=not at all important; 5=extremely important

WL6: Have you ever purchased products specifically for the purpose of improving your well-being?

    s. Yes

    t. No

    u. Prefer not to say

WL7 (if yes): Please select all of the products that you have purchased for this purpose:

    v. Exercise equipment / gym membership

    w. Health supplements

    x. Natural remedies

    y. Lighting products (LED; luminaires; Smart Home Lighting)

    z. Other (please specify)

WL8: How much are you willing to spend on products that support your well-being?

    aa. Less than €50

    bb. Less than €150

    cc. Less than €350

    dd. Less than €500

    ee. More than €500

WL9: How much money (€) have you spent in the past 12 months on products that improve your well-being?

    a. Less than €50

    b. Less than €150

    c. Less than €350

    d. Less than €500

    e. More than €500

WL10: Do you think that lighting influences our well-being?

    f. Yes

    g. No

    h. I don't know.

WL11: How much would you say lighting influences our well-being?

    i. 1=not at all; 5=very much

WL12: When purchasing a lighting product, how important are the well-being benefits for you?

    j. Not very important

    k. Not important at all

    l. Neutral

    m. Somewhat important

    n. Very important

WL13: Evaluate the following statement: good lighting… (choose the points which fits the best)

    o. Is necessary for me

    p. makes me see well

    q. lifts my mood

    r. helps me to improve my sleep quality

    s. promotes my well-being

    t. increases my productivity

Human-Centric-Lighting: Awareness, Attitude and purchase intention

HCL1: Have you ever heard about Human-Centric-Lighting and its potential benefits?

    a. Yes

    b. No

    c. I don't know.

HCL2: If you answered "yes" to the previous question, where did you learn about it?

    i. Social Media (Instagram, Facebook, Linkedin etc.)

    ii. Newsletter

    iii. Family & Friends

    iv. TV

    v. From a healthcare professional (e.g., doctor; therapist)

vi. Other (Please specify)

HCL3: On a scale from 1 (strongly disagree) to 5 (strongly agree), if you make an assumption about the definition of Human-Centric-Lighting, how much do you agree with the following sentences (multiple answers possible):

    a. "Human-Centric-Lighting is…."

        i. A lighting solution that focus on people's needs

        ii. Providing the right light for any time of day

        iii. Biologically effective light

        iv. A lighting concept to increase well-being

        v. An automated lighting concept

To answer the following questions of this survey I give you the definition of Human-Centric Lighting:

Human-centric lighting is a type of lighting designed to support the natural rhythms and processes of the human body. It aims to mimic the natural light cycle of the sun and can be adjusted to match the intensity and spectrum of natural light at different times of the day. It can help to improve well-being, productivity, and sleep quality.

HCL4: How aware are you of Human-Centric-Lighting and its potential well-being benefits?

    a. 1=not at all; 5=aware

HCL5: How interested are you in learning more about the well-being benefits of Human-Centric-Lighting?

    b. 1=not interested; 5=very interested

HCL6: How much do you believe that Human-Centric-Lighting can improve our well-being?

    c. 1=not effective; 5=very effective

HCL7: On a scale from 1 (strongly disagree) to 5 (strongly agree), when it comes to Human-Centric-Lighting which of the following characteristics would you consider important?

    d. Health benefits (improve sleep, reduce eyestrain and fatigue)

    e. Customization (suits needs and preferences)

    f. Energy efficiency

    g. Price

    h. Compatibility with existing lighting systems or home automation systems

  i. Design and Appearance

  j. Ease of use

HCL8: Do you know how Human-Centric-Lighting differs from traditional lighting?

  k. Yes

  l. No

HCL9: In your opinion, does human-centric lighting offer any benefits that traditional lighting does not?

  m. Yes

  n. No

  o. I don't know

HCL10: Have you ever used Human-Centric-Lighting in your home or workplace?

  p. Yes

  q. No

  r. I don´t know

HCL11: How likely are you to consider using Human-Centric-Lighting in your home or workplace?

  s. 1=not likely; 5=very likely

HCL12: What is the maximum amount you would be willing to pay for <u>Lighting products</u> that you believe would significantly improve your well-being?

  a. Less than €50

  b. Less than €150

  c. Less than €350

  d. Less than €500

  e. More than €500

HCL13: Do you think you would be more likely to purchase Human-Centric-Lighting products if you know more about the potential benefits for your well-being?

  t. Definitely not

  u. Probably not

  v. Maybe

  w. Probably yes

  x. Definitely yes

HCL14: How likely are you to consider purchasing human-centric lighting in the future, given the functional benefits it offers?

  y. Very unlikely

   z. Somewhat unlikely

   aa. Neutral

   bb. Somewhat likely

   cc. Very likely

HCL15: What factors would need to be present for you to consider purchasing human-centric lighting in the future?

   dd. Lower costs

   ee. more information about the benefits

   ff. Higher energy efficiency

   gg. Easy installation and maintenance

   hh. A wide range of options and styles to choose from

   ii. Customization options to meet specific needs or preferences

   jj. Attractive design or aesthetics

   kk. Other, please specify:

Purchase Intention Traditional Lighting

For the following questions about traditional lighting, please start from the following definition of the term: Traditional lighting is the old way of producing light with incandescent bulbs or tubes that do not adapt to human needs.

TL1: Have you previously purchased traditional lighting products?

   a. Yes

   b. No

   c. I don't know

TL2: How much money (€) have you spent in the past 12 months on traditional lighting products?

   a. Less than €50

   b. Less than €150

   c. Less than €350

   d. Less than €500

   e. More than €500

TL3: On a scale from 1 (not at all) to 5 (very important), how important are the following factors for you when it comes to traditional lighting?

   d. Design

e. Quality

f. Brand

g. Price

h. eye-friendly light

i. Number of functionalities (e.g. dimming, personalization, control, etc.)

j. Energy class/energy label

7.3. Appendix C – Statistical Analysis

Gender

Legend: Female, Male, Prefer not to say

- 60%
- 39%
- 1%

Age Group

Legend: 18 - 24, 25 - 34, 35 - 44, 45 - 54, 55 - 64, 65 - 74, Under 18

- 28%
- 51%
- 8%
- 3%
- 2%
- 7%
- 1%

Nationality

Legend: austrian, british, german, italian, other, portuguese, spanish, swiss

- 72%
- 11%
- 8%
- 1%
- 3%
- 1%
- 3%
- 1%

Residence

Legend: Austria, Germany, Italy, Other, Portugal, Switzerland, UK, Total

- 28%
- 50%
- 16%
- 2%
- 1%
- 3%
- 0%
- 0%

Education

Legend: Apprenticeship, Bachelor, High School, Master, None of the above, PhD or higher, Prefer not to say

- 55%
- 29%
- 5%
- 7%
- 1%
- 2%
- 1%

Occupation

Legend: Employed, Intern, Prefer not to say, Retired, Self-employed, Student, Unemployed, Working Student

- 30%
- 32%
- 17%
- 10%
- 4%
- 3%
- 3%
- 1%

Income

Legend: €500 - €1000, Less than €500, €1500 - €3000, €3000 - €5000, More than €5000

- 31%
- 27%
- 15%
- 17%
- 10%

		Frequency	Percentage
Gender	Female	59	59.60%
	Male	39	39.39%
	Prefer not to say	1	1.01%
Age	Under 18	1	1.01%
	18 - 24	28	28.28%
	25 - 34	50	50.51%
	35 - 44	8	8.08%
	45 - 54	3	3.03%
	55 - 64	2	2.02%
	65 - 74	7	7.07%
Nationality	Austrian	1	1.01%
	British	3	3.03%
	German	71	71.72%
	Italian	1	1.01%
	other	8	8.08%
	Portuguese	11	11.11%
	Spanish	1	1.01%
	Swiss	3	3.03%
Residence	Austria	1	1.01%
	Germany	55	55.56%
	Italy	1	1.01%
	Other	5	5.05%
	Portugal	32	32.32%
	Switzerland	2	2.02%
	UK	3	3.03%
	Austria	1	1.01%
	Germany	55	55.56%

		Frequency	Percentage
Education	Apprenticeship	7	7.07%
	Bachelor	54	54.55%
	High School	5	5.05%
	Master	29	29.29%
	None of the above	1	1.01%
	PhD or higher	2	2.02%
	Prefer not to say	1	1.01%
Occupation	Employed	30	30.30%
	Intern	3	3.03%
	Prefer not to say	3	3.03%
	Retired	4	4.04%
	Self-employed	10	10.10%
	Student	31	31.31%
	Unemployed	1	1.01%
	Working Student	17	17.17%
Income	Less than €500	15	15.15%
	€500 - €1000	30	30.30%
	€1500 - €3000	27	27.27%
	€3000 - €5000	17	17.17%
	More than €5000	10	10.10%
	Total respondents	**99**	**100%**

How important is your overall well-being to you?	
Extremely important	40,40%
Very important	**50,51%**
Not at all important	0,00%
Moderately important	7,07%
Slightly important	2,02%
	100%

How much do you prioritize your own well-being?	
Extremely important	13,13%
Very important	**43,43%**
Not at all important	1,01%
Moderately important	35,35%
Slightly important	7,07%
	100%

Are you interested in improving your well-being?	
Neither agree nor disagree	6,06%
Somewhat agree	40,40%
Somewhat disagree	5,05%
Strongly agree	**47,47%**
Strongly disagree	1,01%
	100,00%

Have you ever purchased products specifically for the purpose of improving your well-being?	
Yes	**77,78%**
Prefer not to say	3,03%
No	19,19%
	100,00%

How much are you willing to spend on products that support your well-being?	
Less than €150	**44,44%**
Less than €350	15,15%
Less than €50	19,19%
Less than €500	9,09%
More than €500	12,12%
	100,00%

How much money have you spent in the past 12 months on products that improve your well-being?	
Less than €150	21,21%
Less than €350	**25,25%**
Less than €50	19,19%
Less than €500	11,11%
More than €500	23,23%
	100,00%

Do you think that lighting influences our well-being?	
Yes	**87,88%**
No	1,01%
I don´t know	11,11%
	100,00%

When purchasing a lighting product, how important are the well-being benefits for you?	
Not important at all	10,10%
Not very important	6,06%
Neutral	21,21%
Somewhat important	**47,47%**
Very important	15,15%
	100%

Evaluate the following statement: Good lighting… (choose the points which fi	
Is necessary for me	14%
makes me see well	16%
lifts my mood	23%
helps me to improve my sleep quality	7%
promotes my well-being	19%
increases my productivity	20%
100%	

	Try to get enough sleep	Expose my body to sunlight	Reduce screentime on Laptop, TV and Smartphon	Be physically active	Eat healthier
Strongly agree	52,53%	38,38%	17,17%	43,43%	41,41%
Somewhat agree	33,33%	35,35%	22,22%	36,36%	38,38%
Neither agree nor disagree	8,08%	17,17%	23,23%	8,08%	10,10%
Somewhat disagree	4,04%	8,08%	29,29%	10,10%	9,09%
Strongly disagree	2,02%	1,01%	8,08%	2,02%	1,01%
	100%	**100%**	**100%**	**100%**	**100%**

Have you ever heard about Human-Centric-Lighting?	
Yes	19,19%
No	**79,80%**
I don´t know	1,01%
	100,00%

Where did you learn about it?	
Family & Friends	31,58%
Work	**36,84%**
Social Media	31,58%
	100%

How aware are you of Human-Centric-Lighting and its potential well-being benefits?	
Extremely aware	2,02%
Very aware	15,15%
Not at all aware	20,20%
Somewhat aware	**38,38%**
Slightly aware	24,24%
	100,00%

How interested are you in learning more about the well-being benefits of Human-Centric-Lighting?	
Extremely interested	7,07%
Very interested	30,30%
Somewhat interested	**43,43%**
Slightly interested	15,15%
Not interested	4,04%
	100,00%

How much do you believe that Human-Centric-Lighting can improve our well-being?	
Extremely effective	5,05%
Very effective	38,38%
Moderately effective	**44,44%**
Slightly effective	12,12%
Not effectice at all	0,00%
	100,00%

Do you know how Human-Centric-Lighting differs from traditional lighting?	
No	48,48%
Yes	51,52%
	100,00%

Does Human-Centric-Lighting offer any benefits that traditional lighting does not?	
I don´t know	25,25%
No	3,03%
Yes	**71,72%**
	100%

Have you ever used Human-Centric-Lighting in your home or workplace?	
I don´t know	11,11%
No	**73,74%**
Yes	15,15%
	100%

How likely are you to consider using Human-Centric-Lighting in your home or workplace?	
Extremely likely	16%
Somewhat likely	**55%**
Neither likely nor unlikely	19%
Somewhat unlikely	7%
Extremely unlikely	3%
	100%

What is the maximum amount you are willing to pay for lighting products that you believe are improving your well-being significantly?	
Less than €150	**41%**
Less than €350	21%
Less than €50	18%
Less than €500	17%
More than €500	2%
	100%

Do you think you would be more likely to purchase Human-Centric-Lighting products if you know more about the potential benefits for your well-being?	
Definitely yes	21,21%
Probably yes	**60,61%**
Might or might not	13,13%
Probably not	5,05%
Definitely no	0,00%
	100,00%

What factors would need to be present for you to consider purchasing human-centric lighting in the future?	
Lower costs	13%
more information about the benefits	**21%**
Higher energy efficiency	12%
Easy installation and maintenance	16%
A wide range of options and styles to choose from	10%
Customization options to meet specific needs or preferences	13%
Attractive design or aesthetics	15%
	100%

	Health benefits	Customization (suits needs and preferences)	Energy efficiency	Price	Compatibility with existing lighting systems or home automation systems	Design and Appearance	Ease of use
Strongly agree	33%	22%	29%	22%	38%	29%	46%
Somewhat agree	53%	51%	43%	44%	34%	44%	40%
Neither agree nor disagree	9%	20%	17%	23%	18%	14%	9%
Somewhat disagree	2%	6%	10%	10%	8%	10%	3%
Strongly disagree	3%	1%	0%	0%	1%	2%	1%
	100%	100%	100%	100%	100%	100%	100%

	lighting solution that focus on people's needs	Providing the right light for any time of day	Biologically effective light	lighting concept to increase well-being	automated lighting concept		
Neither agree nor disagree	10,00%	5,00%	5,00%	5,00%	40,00%		
Somewhat agree	**55,00%**	45,00%	70,00%	55,00%	30,00%		
Strongly agree	30,00%	45,00%	25,00%	40,00%	25,00%		
Somewhat disagree	0,00%	5,00%	0,00%	0,00%	5,00%		
Strongly disagree	5,00%	0,00%	0,00%	0,00%	0,00%		
	100,00%	100,00%	100,00%	100,00%	100,00%		

		How much money have you spent in the past 12 months on traditional lighting products?
Less than €250		94,00%
Less than €500		3,00%
Less than €750		3,00%
		100,00%

		Have you previously purchased traditional lighting products?
I don´t know		2,00%
No		18,00%
Yes		80,00%
		100,00%

	Design	Quality	Brand	Price	Eye-friendly light	Number of functionalities	Energy class/energy label
Extremely important	23%	27%	4%	20%	41%	16%	27%
Moderately important	22%	20%	25%	22%	8%	23%	23%
Not at all important	9%	0%	38%	0%	3%	10%	4%
Slightly important	18%	6%	24%	8%	5%	20%	9%
Very important	27%	46%	8%	49%	42%	30%	36%
	100,00%	**100,00%**	**100,00%**		**100,00%**	**100,00%**	**100,00%**