

Exploring The Factors Relating to The Design and Development of Smart Lights in China

Heqi Zhao, Khairun Nisa Mustaffa Halabi

Faculty of creative industries, City University Malaysia

Email: 864177747@qq.com, khairun.mustaffa@city.edu.my

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Abstract

This study comprehensively explores various factors pertaining to the development and design of smart lights in China, encompassing economic value, future iterations, innovative features, competitive analysis, sustainability, manufacturing processes, ideology, efficiency, sustainability literacy, production components, and budget considerations. Employing a qualitative research design with random sampling, the study targets producers and designers of Smart Bulbs in China, specifically those actively marketing and advertising their smart bulbs in 2022. Data collection involved interviews, and thematic analysis was utilized for data analysis, identifying eight key themes that informed thematic and framework-based analysis. The study's results highlight the significance of effectiveness and sustainability in smart bulb production, necessitating advanced tools and approaches. Competitive analysis emerged as a common practice among analysts and designers to assess differentiating features and unique selling points. Notably, these bulbs are environmentally friendly as they are mercury-free. Quality, along with factors such as material and labor costs and additional expenses, impacts production. The study holds theoretical and practical significance by contributing to the existing literature on the examined variables, particularly benefiting Chinese smart bulb producers and designers. It underscores the importance of social sustainability in adopting smart lighting solutions and calls for addressing consumer concerns about durability, performance, and reliability. Furthermore, it advocates for integrating sustainable consumer behavior into the context of smart lighting. It's important to note that the study does not encompass all potential factors impacting customer behavior and intentions to purchase smart lighting solutions, leaving room for future research to explore areas like price effects, the utility of LED products, and design elements through longitudinal studies.

Keywords: Development Of Smart Lights, Design Of Smart Lights, Sustainability Awareness, Environmental Sustainability Awareness, Perceived Risk, Intention To Buy Smart Lights, China.

Introduction

The effects of environmental degradation are becoming more generally acknowledged. The entire world has united to safeguard the environment. Consumers are becoming more aware of the environmental impact of their buying patterns, which can help firms achieve a

competitive advantage (Rese et al., 2017). Marketers must understand the impact of increased sustainability awareness on other parts of customer pro-environmental behaviour. The purpose of smart lighting is to save energy, make life easier, and provide a sense of safety and security. Automated controls, such as occupancy and daylight sensors, can alter lighting based on these conditions (Chew et al., 2017). In order to create a specific aesthetic or practical result, light is strategically used through the process of lighting. Task lighting, decorative accent lighting, and ambient light are all included. Lighting accounts for 19 percent of the world's energy consumption and 6 percent of the world's carbon dioxide emissions (Sikder et al., 2018). 76 percent of China's energy consumption comes from industrial and commercial sectors, and 34 percent is used for lighting (Cacciatore et al., 2017; Cheer et al., 2021).

Due to stricter environmental regulations in China, businesses now focus on delivering sustainable products by environmental and societal concerns. The scholars have also explained that in China majorly the societies are literate, and they know the benefits of reusable energy and natural resources as they know sustainability and sustainable development in health and societal ways. According to the study of Kim and Yun (2019), scholars have put great emphasis on the issue of perceived risk and health-related literacy.

The framework of the research study of Laksmidewi and Soelasih (2019) has disclosed that the consumer intentions to buy can be influenced through the product use of ease as the maximum utility of the used product can only be assumed or given by the consumer of that particular product. So, the original idea can also be driven by the consumer. Many studies have studied the role of green behaviour and intentions to buy the product. The findings have suggested a link between customer purchasing intention and green behaviour. The green resources are the only surviving thing left for the people in the harsh time (Ghazizadeh et al., 2012). Especially the people of China need the whole products made with undertaking the green initiatives in mind. Many studies have followed similar patterns and revealed that the background information of the green practices has a vast history. That is why it was taken out for maximum influence on the market of satisfied consumers (Ghazizadeh et al., 2012).

The gap is present in the Chinese market where people are quality-oriented rather than price-oriented and have expressed their feelings about the required green and high-quality products in terms of lights or electricity-related products. They know how the energy is provided and what it costs through the natural resources. However, environmentally cautious people can only disburse the savings into high quality-oriented goods, and they will only respond towards the huge green energy utilisation parameters (Groß, 2015; Haba et al., 2017). The energy cautious people would always suggest using smart energy products or smart lights as they would feel at ease of doing business with the companies having the sources of excess product quality and concerns about the sustainability of the world's energy resources.

The researcher aimed at investigating the relationship between a product and a customer's purchase intention or behavior. On the part of the evaluating merits were the product features, characteristics, utility, benefits, diversity, and sustainability that impact the customer's attitude toward the respective product. The previous studies (Apipuchayakul & Vassanadumrongdee, 2020; Moghavvemi et al., 2020) indicate that the smart household industry especially the lighting market is going through a digital and sustainable transformation which the targeted customers highly welcome. To ensure continuous development, it is necessary to assess the current product designs, services, production procedure and budget, innovation, and efficiencies of the smart bulb which attract customers

and shape their perception towards these products (Moghavvemi et al., 2020). Moreover, fulfilling the customer's needs is also the top priority of this industry therefore evaluating the products from the customer's perspective will assist in yielding significant insights into the offering of the smart lighting industry. Thus, the present section will be focused on multiple product and customer aspects that impact the overall brand image of the companies and influence the customer's behaviors. For the purpose of evaluation, information collected by producers and designers that are currently working in this industry.

Literature Review

Sustainability Awareness

Awareness of social and environmental issues was grown into the twentieth century. With the rapid growth of the knowledge of sustainability, the awareness was also increased by various world stakeholders (Zhu et al., 2015). Global scholars have researched a lot and written up a lot to give huge importance to sustainability and its importance to others (Chang & Watchravesringkan, 2018). The scholars have given rise to the support of sustainability and greatly emphasized the knowledge of sustainability. The societal changes have been given the high arguments by the scholars to the issues of growing sustainability (Chang & Watchravesringkan, 2018; Chen et al., 2018; Chen et al., 2021). According to various scholars, sustainability is for the long run and future concerns without compromising the current performance of the ongoing operations (Chen et al., 2018). The scholars have put great emphasis and provided their arguments that sustainability can be grown along with the hype of greater communication within the societies and countries worldwide (Chu, 2018; Grunert, 2011). This was seen that sustainability awareness was lower in the developing countries as it should be according to the whole situation (Chen et al., 2021; Chu, 2018).

Environmental Sustainability Awareness

According to various scholars, the industrial revolution has brought up greater concerns for overall sustainability including social sustainability. Some scholars have given their views and elaborated that the industrial revolution is about to come (Chen et al., 2021; Chu, 2018). It has been seen that sustainable development is now needed as before as anything else. The study of (Sunthonkanokpong & Murphy, 2019) has given the clear idea that environmental sustainability awareness has spread in the works. Every country talks about it, and some developed ones have taken greater initiatives to tackle this. The scholars have emphasized that every citizen is aware of environmental sustainability as green practices have been inaugurated worldwide to keep the environment clean and neat (Chang & Watchravesringkan, 2018; Chen et al., 2018). Different platforms have given this awareness, and the governments have a greater role to play (Prakash & Pathak, 2017; Stall-Meadows & Hebert, 2011).

Perceived Risk

Perceived risk of consumers is an important barrier factor to purchase behavior. Perceived risk of a consumer can be defined as their belief about the potential negative outcomes from the use or purchase of a product (Akar & Nasir, 2015; Kazancoglu & Aydin, 2018; Lăzăroiu et al., 2020; Pappas, 2016). Various types of risks have been identified in the marketing literature since the appearance of this concept. The seven most commonly quoted risks include financial, performance, physical, psychological, social, time-related, and opportunity cost

risks. Product risks like defects can be associated directly with the product (Khor & Hazen, 2017; Konuk, 2018; Tran, 2020).

Table 1:*Types of Risks*

	Produ ct	Opportuni ty Cost	Informati on	Psychologi cal	Soci al	Physic al	Financi al	Tim e
(Rossi et al., 2015)			✓	✓	,			
(Cheah et al., 2015)	✓	✓	✓	✓			✓	
(Bagozzi et al., 2016)			✓	✓	,			
(Hwang et al., 2016)	✓	✓	✓	✓			✓	
(Khor & Hazen, 2017)	✓	✓				✓	✓	
(Han & Kim, 2017)		✓					✓	
(Ma, 2017)	✓					✓		
(Wang et al., 2018)		✓				✓		
(Marriott & Williams, 2018)		✓					✓	
(He et al., 2018)		✓	✓	✓	,		✓	
(Ariffin et al., 2018)	✓	✓	✓	✓	,	✓	✓	
(Valentini et al., 2018)			✓	✓	,	✓	✓	
(Lăzăroi u et al., 2020)								✓

(Codero ni & Perito, 2020)	✓		✓
(Tran, 2020)	✓	✓	
(Manzo or et al., 2020)		✓	✓

The perceived risks of a consumer are known to impact their buying behavior (Han et al., 2019; Hong et al., 2016; LE & HOANG, 2020). Most studies explored risks in terms of online buying as a consumer that is making an online transaction can tend to be much more reluctant to purchase as buying on the Web can be associated with a large number of risks that can be avoided in a normal traditional mode of shopping (Al-Debei et al., 2015; Casidy & Wymer, 2016; Hong, 2015; Hubert et al., 2017; Pappas, 2016; Q. Yang et al., 2015; Y. Yang et al., 2015).

Perceived Usefulness

In accordance with the research work of various authors, the perceived usefulness is proposed to be the extent according to which any individual believes that a specific product, service, or technology is useful and will enhance productivity in the terms of the outcomes of a specific task (Aren et al., 2013; Bonn et al., 2016). Furthermore, the concept has been defined by various studies as the degree to which an individual believes that a specific product or technology can enhance the overall significance and performance of a specific job (Bukhari et al., 2013; Cheng et al., 2012). During the application of the technology acceptance model, the perceived usefulness is a concept that is treated as an independent construct, referring to the degree to which an individual believes that the application of a specific technology or product can enhance the overall quality and outcomes of a specific task (Islam & Daud, 2011; Jamal & Sharifuddin, 2015). Various studies have taken up perceived usefulness as two of the major variables while applying the technology acceptance model, as there is a significant impact of perceived usefulness on attitude towards a specific product, service, or technology and it also significantly and directly impacts the behavioral intention for the utilization and application of specific product, service or technology (Islam & Daud, 2011; Jamal & Sharifuddin, 2015; Matute et al., 2016). Moreover, according to some studies, the perceived usefulness is also significantly impacted by perceived ease of use. Various authors include perceived usefulness as a major factor in questionnaires for the studies involving the application of technology acceptance model (Moslehpour et al., 2018; Purnawirawan et al., 2012).

Furthermore, authors have repetitively focused on the idea of perceived usefulness as a factor that is believed to be by various individuals to enhance the overall outcome of a specific task, so there is a significant linkage of perceived usefulness with the decision making process as well regarding acquiring and purchase of specific products or services (Aren et al., 2013; Bonn et al., 2016; Bukhari et al., 2013). Furthermore, the overall usefulness can be a result of the overall outcomes and performance of a job performed or a task utilizing a specific product or technology, so this factor can also be compared in between the previous product and the prospect product, to significantly affect the intention to buy a specific product (Moslehpour et al., 2018; Purnawirawan et al., 2012). The perceived risk that is associated with any

product, service, or technology can significantly impact the intention to buy for a customer, so, measuring the perceived usefulness with the perspective of perceived risk can result in a significant impact on the intention to buy as well (Moslehpour et al., 2018; Purnawirawan et al., 2012).

Intention To Buy Smart Lights

According to Moghavvemi et al. (2020), adopting smart lights is largely dependent on and is shaped by consumer behaviour. Businesses must understand consumer behaviour and the factors influencing them to be aware of the benefits of using smart lights. Environmental preservation and energy conservation are rising global issues and are receiving widespread global attention (Zhao et al., 2022). Several global environmental challenges have been propagated by undesirable human behaviour. These challenges include a rise in the sea levels, melting high amounts of snow and ice, causing the atmosphere and oceans to become warmer; consumption of fossil fuels has also been increased to a great extent which results in a higher concentration of emission of greenhouse gas, depletion of natural resources and climatic changes and biodiversity loses with significant harms to humankind and animals as well (Moghavvemi et al., 2020). Consumers' growing concern about the environment has increased their search towards green products that are not harmful to the environment. The demand for green products and sustainable offerings can be attributed to their increased environmental sustainability awareness. Environmental sustainability is now given even more attention and importance than ever before because it concerns how individuals can attain natural resources, clean air and water, healthy communities and improved overall quality of life. In the view of Ibnou-Laaroussi et al. (2020), consumers' intention to purchase green and sustainable products is significantly evident when they have a higher level of awareness regarding environmental sustainability.

Intention to buy has been studied in many contexts in various studies over the past years in the marketing literature (Hajli, 2015; Ismagilova et al., 2020; Ueasangkomsate & Santiteerakul, 2016). However, the purchase of smart lights is not explored to a great degree in the past. Some relevant studies, nonetheless, are summarized in the table below.

Table 2:

Summary of Similar Recent Studies

Study	Relevant Findings	Shortcomings
(Karlin et al., 2018)	Discusses various smart home appliances that can be used for energy management in the future and the intentions of consumers towards their purchase and use	No empirical research on smart lights specifically conducted
(Rahman et al., 2020)	Studied the green purchase behavior of consumers towards energy-saving lights	The variables suggested in the current study are not explored
(Moghavvemi et al., 2020)	Adoption of energy-efficient lighting systems is studied in presence of guilt and pride	The consumer intention antecedents are different as studied in the current study

Method**Strategy and Data collection**

Starting with a data-driven inductive approach to research, themes representing patterns pertinent to how media exposure and usage culture affect people's mental health (anxiety, wellbeing) were initially identified. In light of current theory, a more interpretive analytic approach was employed to interpret clear themes and make sense of hidden relationships between themes (Xu & Zammit, 2020). The present study followed the qualitative design where the analysis techniques focus on elucidating, interpreting, and comprehending gathered data to draw meaningful inferences. Qualitative studies focus on revealing the participants' explicit thoughts and opinions on situations or experiences through codes, themes, and categories (Miles et al., 2018). A random probability sampling technique was also employed to select the respondents for qualitative data collection. The designers and producers of Smart Bulbs in China were incurred in the technique. Only the designers and producers actively marketing and advertising their smart bulbs as of 2022 were included in the sample.

The sample size was set at only 10 producers and designers of smart bulbs in China. Mainly because the sample size selected can compromise a large audience as the synergy in the respective industry is acceptable. Moreover, the responses from the 10 respondents were integrated harmonized as the smart bulbs industry is assumed to be based only on that configured ideology.

Data Analysis Strategy

This current study used thematic analysis to investigate (Braun & Clarke, 2006). Thematic analysis is a qualitative data analysis comprising searching over a data set to detect, analyse, and report on repeating patterns. It is a technique for describing data but also requires interpretation during the selection of codes and the development of themes. A distinctive feature of theme analysis is its adaptability and flexibility to various theoretical and epistemological frameworks and a range of study questions, designs, and sample sizes (Kiger & Varpio, 2020). The interview questions have been attached in the appendix 1.

Findings from the study

The data for the qualitative analysis was collected through the interviews. After transcribing the data it was entered into NVivo to evaluate the key themes present in the data. The procedures followed systematic steps comprising arranging the data, coding and manually evaluating the responses. The main feature of the discussion with the producers and designers of smart bulbs was the assessment of current smart lighting practices and the status of this respective market. The data were scrutinized, and eight themes were found to be present in the data. These themes were then used for the framework-based analysis and thematic. The table below demonstrates the main themes and highlights the key aspects of the information coded among these themes.

Table 3*Main Themes In Data*

Theme	Characteristics
The ideology behind producing bulbs	The smart lighting industry's principles, foundations, cornerstones, and their objective behind smart bulb production.
Tools and techniques	The manufacturing tools and techniques used for these products by evaluating the sustainability ratio and product sustainable designs
Sustainability and advancing	The compliance of these products with the sustainable merits and the progressive development. The factors behind sustainability and possible outcomes.
Competitive Analysis	Due to increased customer demand, the competitive race between the smart bulb production companies. Assessing bulb designs to offer a unique and distinct product in the competitive market.
Company Plan	What the company aims to do in the future in terms of variety, diversity, and product offerings. What kind of features do they aim to introduce in their future products?
Efficiency of smart bulbs	The potential benefits of the smart bulbs in terms of variety and offerings. The smart bulbs' shapes, size, energy efficiency, durability, and lifetime.
Budget	The production budget and the components impact the production cost. The assessment of labor and material costs before developing a budget plan.
Smart Household	The government interest and benefits from the smart household industry. The current status and development of the smart household industry in China.

Framework-based analysis

After identifying the main themes, the data was codified to be analyzed through the framework-based method. This method is a systematic approach to the critical data review and allows the researcher to present it following the major themes. In the present analysis, the transcription was coded and sorted following the major themes, and the unique or different responses are separated to present the overview of interview results.

Table 4.*Framework based analysis*

Theme	Similar response	Unique response
The ideology behind producing smart bulbs	Responsible and sustainable green energy consumption is the major motif behind producing smart bulbs. To progress with the digital revolution, smart bulb production ensures sustainable technology utility for this industry.	Giving customers more convenient options and diverse product is the ideology on which the companies are working. Smart assistance and attractive features are the priority.
Tools and techniques	Smart and novel approaches for the manufacturing of these bulbs. Strengthen by sustainable tools and methods which reduce waste production and provide product quality.	Embodying eco-technology and green manufacturing products for smart bulbs.
Sustainability and advancing	Energy-efficiency of these products is much higher in comparison with the regular bulbs. They are self-contained, durable, and support sustainable digital solutions.	High-quality lighting and positive impacts on mental and physical health is the advanced mark of these products.
Competitive Analysis	Competitive analysis is essential to get a competitive edge in the local and international markets. The merits on which the competitive analysis is mainly done include bulb features, designs, specifications, and offerings.	The analysis is necessary to capture the attention of the target customer market. Design the products the company's competitors don't offer and secure a position in the market by grabbing customer's product value deliverance.
Company Plan	There is continuous room for innovation in this market. The companies plan to launch products supporting more digital and technical assistance. Advanced sensors and controlling or monitoring systems are the base of future products.	To provide the customers with the best home décor appliance in the form of an attractive and diverse variety of home lighting. The features should be included that enhance the décor element of these products.
Efficiency of smart bulbs	In comparison with regular bulbs, they consume less energy and have fewer chances of blast and circuit failures in these bulbs. Fewer carbon footprints and sustainable material use for production enhance the energy efficiency of smart bulbs.	Does not work in manual ways and can be handled easily with the technology i.e. Bluetooth and voice assistance. On this basis, they are convenient and more reliable.
Budget	The production budget depends on the material and labor costs. For pricey and advanced products, sustainable and costly material i.e. sensor semi-conductors and the coating material is used.	The labor process is based on manual methods that consume much of the budget allocation. Besides the inclusion of inspection, the experimental team and tech specialist are also

Smart Household

The government is taking initiatives to expand the smart household industry in China. The future forecast indicates its growth due to the increased customer trends toward sustainable and attractive electricity appliances.

included in the production budget.

The smart household industry is fulfilling the government's dual carbon mission and accomplishing the smart city establishment task with smart lighting. The growth chances are therefore satisfactory in this respective market.

Thematic Analysis

The above section of the analysis highlighted the major themes derived from collected data through interviews. This section will deal with the thematic and word cloud analysis of the transcribed data to evaluate the findings from the respondents' responses. The responses to each of the interviewee questions are evaluated through thematic analysis.

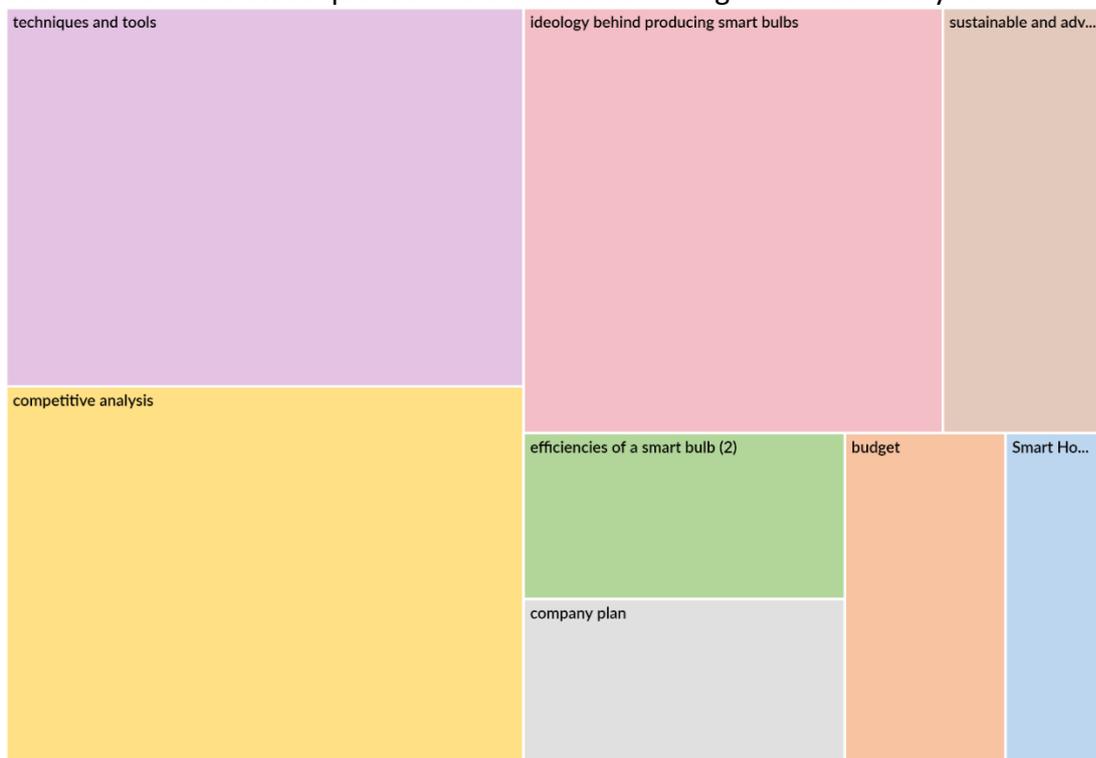


Figure 6 . Themes based on coding references

the best options. Moreover, we use such automation that works as sensors, which sense the movement when a person is coming in or leaving.”

Most techniques and strategies for building such products require authentic research and inspection. Therefore, The companies' techniques include pre and post-inspection processes, making it easy to identify the product fault and potential utility. Besides the tools are not traditional instruments, therefore standard operation techniques are employed by the companies which are the most effective and novel approaches. The installation of smart features is also done with the inclusion of tech specialists in the experimental domains. Along with the labor, the tech and digital teams ensure the effectiveness of the products before they came to the market.

Theme III

The third theme is based on the question that interrogates the compliance of the smart bulb with its design in terms of sustainability and advancement. The traditional bulb consumes enormous energy and is labeled as an energy booster with a massive carbon footprint. Smart bulbs contribute more towards sustainability and consume less energy than traditional lighting. They are built on solid and sustainable structures therefore they are way more advanced than regular lighting. In current households, smart bulbs are not a commodity anymore rather it is becoming a necessity.

Smart lighting is a sustainable solution for households because of its convenient use. The work on wireless networks makes it easy for the customers to control and regulate them independently. The diversity that attracts modern customers is the ability to control the modes, brightness, color, and light. Economic sustainability is a key base of these products along with the enhanced features. They are light on the budget and energy consumption. The non-toxic provision of light is a significant factor in determining its economic and environmental sustainability. These products also align with the energy efficiency objectives these companies desire to achieve. The 9th interviewee explained it as:

“Smart bulbs are designed in such a way that reduces the consumption of energy thus resulting in lesser carbon foots and have a positive sustainable impact on the environment... However, it does not mean that their sustainability impacts the quality of light as it has been observed that a smart bulb provides the same luminosity like an incandescent bulb. The only difference among them is that while providing the same quality of light they reduce the emission of GHG by up to 80% that why they are environment-friendly.”

Theme IV

The fast competitive race of the lighting industry has resulted in many diverse innovative product designs. As customers are picky about the features and specifications of the smart bulb, the tug between competitive companies is observing radical or gradual changes in the product designs and specifications. The competitive analysis, therefore, yields fruitful outcomes for the companies in the form of attractive and competent products compared to the business rivals. Upon asking the opinion about competitive analysis before design moderation, the majority agreed that competitive analysis is one of the smart strategies which gives a competitive edge in the global and country-level market. The comparative analysis of the bulb's features, lifetime, durability, and sensitivity is important before launching the product. This analysis aims to identify the specification that should be added and the features that can be eliminated to make the product distinctive from the rest.

However, ensuring quality and price in this process is essential as described by 3rd interviewee:

“This is an approach usually deployed by every analyst and is a true start while moderating the designs of smart bulbs, designers and analysts tend to perform competitive analysis. Usually, this is done to analyze the unique selling point of competitors, and also it is done to investigate the factors which make these companies distinctive from them.”

Theme V

Along with technological advancement, these bulbs' external design, features, and characteristics are also going through experimentation. The companies are investing in experimenting with teams and processes to innovate the products and bring uniqueness to the future smart bulbs. Changing the shapes and lightening of the bulbs are in demand which is reconsidering the companies to yield a diversity of products for both commercial and household electric appliances. The growing décor attractions in the worldwide community are pushing the lighting market into the creative aspects which along with functionality add value to the home décor as well. In this respect, aligning and installing the electric appliances as a décor component requires home-based, themed, customized shapes, sizes, lights, and overall bulbs designs. In the words of Interviewee 7th the nexus between décor and bulb innovations is the motif of current companies:

“The production of smart bulbs by our company is planning to provide the feature of décor enrichment in which various colors, designs, and light intensities will be added for different kinds of themed decors. These bulbs resonate with different interior designs and multiple spaces to provide a good look of them. Smart bulbs with this feature not only enhance the beauty of interior spaces but can also be efficiently used in outdoor settings.”

Theme VI

The smart bulbs are popular among modern customers due to their efficiencies compared to regular bulbs. As these bulbs are designed for green energy consumption, they are proven more convenient and efficient than the typical incandescent bulbs. The core efficiency of these products lies in their lifecycle. While regular bulbs often have short life cycles because of the heating and blast issues, smart bulbs perform efficient service for vast years. Due to their long-term utility, the products are cost-effective in the long run and preferred by the customers. The efficiency also lies in their manufacturing design and purpose. The material and tools used for the production are more reliable for longer periods than the regular ones. The third interviewee explained the efficiency of the smart bulbs as:

“I can give this answer with an explanation of their manufacturing design as in a typical fluorescent bulb the electric current is passed through a glass tube filled with mercury gas thus as a result of the collision of electrons with mercury items ultraviolet light is produced. Thus, the traditional bulbs use about 85% of their energy to produce light. As compared to it, smart bulbs comprise different light emission diodes, and light is produced by a semiconductor chip with a positive and negative charge terminal.”

Theme VII

The budget and economic value of the products are the central talks in the lighting industry regarding smart bulbs' utility and efficiency. The customer's perceived value and the delivered quality decide the sustenance of the product. This aspect has been dealt with from two perspectives to assess the role of budget in determining customer satisfaction and the

company's profit. Firstly, the interviewees were asked about the worth of smart bulbs in terms of their "under the budget" status. Secondly, the smart bulb designers ask the production budget and the components that drive it to evaluate the budget distribution of these products in the manufacturing or production stage (Gong et al., 2022).

Regarding the former perspective, most responses settled down on the effectiveness of smart bulbs as the budget product which positively impacts the utility bills. As they consume less energy, they do not add financial burden regarding electricity bills. However, these products are pricey, and upgrading the smart bulb system is expensive. The 5th interviewee stated it as: *"These bulbs are quite pricey but worth the cost because of their long-term services. The smart bulbs are 20-30% more efficient in reducing energy consumption than the CFL bulbs. Due to less use of electricity people save money on electricity bulbs which is plus financial point along with maintaining sustainability. It's a completely winning situation in both present and future."*

Theme VIII

The development of the local industry directly or indirectly impacts the overall country's economic or sustainable growth. As China is continuously progressing towards a sustainable future, the industry of smart households is benefitting the country in multiple ways.

China's economic growth in recent years has been followed by environmentalist criticism which is handled by the government initiatives for the smart energy projects. The sustainable technology used for this purpose is likely to change the future direction of this market at both national and international levels. The 9th interviewee summed it up as:

"China is working on the goal to become a world leader in smart city technology which is possible with smart means and smart appliances. Household shifting of smart lighting from conventional one is also included in the bigger picture of smart cities' objective. This way our products are beneficial in achieving sustainable goals and contributing to the national cause set by our country."

Regarding household practices, people's literacy rate and sustainable practices are also evaluated by asking about the Chinese community's adoption rate of smart bulbs. As per the responses, significant change in people's attitude towards these products has been observed. The increased environmental awareness among the Chinese made them shift from regular household appliances to smart household equipment. Due to the encouraging response from the potential customer market, the growth forecast of this industry sees these products at the top of the smart lighting industry (Ting et al., 2022).

Discussion and Conclusion

The objectives related to the study were to investigate various facets of smart bulbs, such as their ideology, manufacturing processes, sustainability, competitive analysis, future versions, innovative features, efficacy, sustainability literacy and practices, economic value, and production components and budget. Since the interview-based methodology is used to achieve the qualitative objectives, the first question and the first theme identified in the study was that the ideology behind producing smart bulbs is to give consumers a more feasible, cost-effective, and individualized lighting experience. Smart bulbs have advanced capabilities like Wi-Fi, Bluetooth, and motion sensors that let customers remotely adjust the brightness, color temperature, and other characteristics of their lights through a smartphone app or voice assistant. Based on these two, it was found that to assure the sustainability and effectiveness of smart bulbs, it may be inferred that producing smart bulbs requires the utilization of

advanced tools and techniques different from traditional ones. Smart sensors control lights to turn on and off in response to human movement. To create smart bulbs, the company uses improved versions of sensors, such as Philips hue sensors. For these three, it was clear that consumers are becoming increasingly interested in advanced lighting products like smart bulbs. These items are more environmentally friendly than traditional incandescent lights because of their energy-efficient design and lower heat factor.

Smart lights' self-contained design also simplifies maintenance, and their angled beam design and aluminum heat sink increase their sustainability. Furthermore, from question four it was found that the critical phase in the design of smart bulbs was competitive analysis. Additionally, it was discovered that designers and analysts typically conduct a competitive analysis to examine the differentiating characteristics of competitors and analyze their unique selling propositions. It is a thorough method that may entail analyzing numerous aspects and components. Question five results concluded that the business intends to introduce fresh versions and features for its smart bulbs. Li-Fi technology is one of them, along with various color lights in various hues, the incorporation of cameras and projectors, the ability to adjust temperature, color, brightness, and voice control through smart home technology.

Question six also found that LED lights are more effective than traditional bulbs. They are more cost-effective long-term, use less energy, and have a longer lifespan. Since smart bulbs don't contain mercury, they are also more environmentally friendly. By theme seven "Budget", it is concluded that although switching to smart bulbs has a significant upfront cost, the long-term financial advantages of energy efficiency and decreased electricity use make it worthwhile. The product's quality and features, labor, material costs, and additional costs like inspection and testing all impact the cost of producing smart bulbs. The last and eighth theme results suggested that the expansion of the Asian smart lighting market is being promoted by the advantages of smart lighting, including improved lighting control, cost savings, and energy efficiency. In general, companies in the smart home industry, especially those specializing in smart lighting, have a lot of opportunities in China.

Implications

Businesses must address consumer concerns about the reliability, performance, and durability of smart lighting devices. They must offer detailed and accurate information about their items, including product warranties, safety certificates, and client testimonials. This study emphasizes how critical health literacy is to using smart lighting technologies. Businesses should consider creating educational initiatives to raise customer understanding of the advantages and disadvantages of smart lighting for health. Customers may become more confident in the security and efficiency of smart lighting solutions. This study emphasizes the significance of social sustainability in adopting smart lighting solutions. Organizations and incentives that motivate companies to adopt social sustainability practices in their operations should be considered by policymakers. This might involve encouraging responsible workplace practices, reducing emissions and waste, and supporting regional communities. This study's overall conclusions have significant implications for organizations and decision-makers that want to encourage sustainable consumer behavior in the context of smart lighting. Businesses may concentrate on creating user-friendly smart lighting while effectively communicating the advantages of social sustainability. Policymakers may concentrate on encouraging firms to create sustainable products that satisfy customer requirements and raise consumer awareness of social sustainability.

Limitations of the Study and future research recommendations

This study's qualitative methodology design has major limitations that should be considered when interpreting the findings. Future studies should overcome these limitations to better understand the link between smart light design attributes and consumer behavior.

Because the current study concentrated on the context of China, future research may repeat the study in several different cultural contexts to see if the results are universal. A longitudinal investigation might be carried out to determine if the correlations shown in this study hold over time. Studying the effects of marketing efforts on customer behavior and intentions to buy smart lighting solutions is a potential area for future study. Future studies may examine how price affects customer behavior and intentions to buy smart lighting systems. Future studies may examine how product placement affects consumer behavior and intentions to buy smart lighting products. Future studies might examine how various smart lighting devices, such as smart bulbs, smart switches, and smart lights, affect user behavior and purchase intentions and what will be the other factors that would be cost-effective. Future studies may introduce new features and benefits of smart bulbs and their effects and usefulness. Future research may conduct to investigate consumer buying intentions, their estimations of the usefulness of LED products, and consumer perceptions. Future studies might look at how different design elements, such as color, form, and size, affect customer behavior and intent to buy smart lighting devices, as well as how the design of smart lighting affects energy use and environmental sustainability and the effects of other mediating factors, such as social norms and trust, on the connections between the design features of smart lights and consumer behavior and purchase intentions.

References

- Akar, E., & Nasir, V. A. (2015). A review of literature on consumers' online purchase intentions. *Journal of Customer Behaviour*, 14(3), 215-233.
- Al-Debei, M. M., Akroush, M. N., & Ashouri, M. I. (2015). Consumer attitudes towards online shopping: the effects of trust, perceived benefits, and perceived web quality. *Internet Research*.
- Apipuchayakul, N., & Vassanadumrongdee, S. (2020). Factors affecting the consumption of energy-efficient lighting products: exploring purchase behaviors of Thai consumers. *Sustainability*, 12(12), 4887.
- Aren, S., Güzel, M., Kabadayı, E., & Alpkan, L. (2013). Factors affecting repurchase intention to shop at the same website. *Procedia-Social and Behavioral Sciences*, 99, 536-544.
- Ariffin, S. K., Mohan, T., & Goh, Y.-N. (2018). Influence of consumers' perceived risk on consumers' online purchase intention. *Journal of Research in Interactive Marketing*.
- Bagozzi, R. P., Belanche, D., Casalo, L. V., & Flavián, C. (2016). The role of anticipated emotions in purchase intentions. *Psychology & Marketing*, 33(8), 629-645.
- Bonn, M. A., Kim, W. G., Kang, S., & Cho, M. (2016). Purchasing wine online: The effects of social influence, perceived usefulness, perceived ease of use, and wine involvement. *Journal of Hospitality Marketing & Management*, 25(7), 841-869.
- Bukhari, S. M. F., Ghoneim, A., Dennis, C., & Jamjoom, B. (2013). The antecedents of travellers'e-satisfaction and intention to buy airline tickets online: A conceptual model. *Journal of Enterprise Information Management*.
- Cacciatore, G., Fiandrino, C., Kliazovich, D., Granelli, F., & Bouvry, P. (2017). Cost analysis of smart lighting solutions for smart cities. 2017 IEEE International Conference on Communications (ICC),

- Casidy, R., & Wymer, W. (2016). A risk worth taking: Perceived risk as moderator of satisfaction, loyalty, and willingness-to-pay premium price. *Journal of Retailing and Consumer Services*, 32, 189-197.
- Chang, H. J., & Watchravesringkan, K. T. (2018). Who are sustainably minded apparel shoppers? An investigation to the influencing factors of sustainable apparel consumption. *International Journal of Retail & Distribution Management*.
- Cheah, I., Phau, I., & Liang, J. (2015). Factors influencing consumers' attitudes and purchase intentions of e-deals. *Marketing Intelligence & Planning*.
- Cheer, J., Ting, H., & Leong, C. (2021). Responsible tourism: a new era of responsibility? *Journal of Responsible Tourism Management*, 1(1), 1-17.
- Chen, C.-C., Chen, C.-W., & Tung, Y.-C. (2018). Exploring the consumer behavior of intention to purchase green products in belt and road countries: An empirical analysis. *Sustainability*, 10(3), 854.
- Chen, X., Li, Y., Davison, R. M., & Liu, Y. (2021). The impact of imitation on Chinese social commerce buyers' purchase behavior: The moderating role of uncertainty. *International Journal of Information Management*, 56, 102262.
- Cheng, S. Y., Tsai, M. T., Cheng, N. C., & Chen, K. S. (2012). Predicting intention to purchase on group buying website in Taiwan: Virtual community, critical mass and risk. *Online information review*.
- Chew, I., Karunatilaka, D., Tan, C. P., & Kalavally, V. (2017). Smart lighting: The way forward? Reviewing the past to shape the future. *Energy and Buildings*, 149, 180-191.
- Chu, K. M. (2018). Mediating influences of attitude on internal and external factors influencing consumers' intention to purchase organic foods in China. *Sustainability*, 10(12), 4690.
- Coderoni, S., & Perito, M. A. (2020). Sustainable consumption in the circular economy. An analysis of consumers' purchase intentions for waste-to-value food. *Journal of Cleaner Production*, 252, 119870.
- Ghazizadeh, M., Lee, J. D., & Boyle, L. N. (2012). Extending the Technology Acceptance Model to assess automation. *Cognition, Technology & Work*, 14(1), 39-49.
- Gong, J., Said, F., Ting, H., Firdaus, A., Aksar, I. A., & Xu, J. (2022). Do Privacy Stress and Brand Trust still Matter? Implications on Continuous Online Purchasing Intention in China. *Current Psychology*. <https://doi.org/10.1007/s12144-022-02857-x>
- Groß, M. (2015). Mobile shopping: a classification framework and literature review. *International Journal of Retail & Distribution Management*.
- Grunert, K. G. (2011). Sustainability in the food sector: A consumer behaviour perspective. *International Journal on Food System Dynamics*, 2(3), 207-218.
- Haba, H., Hassan, Z., & Dastane, O. (2017). Factors leading to consumer perceived value of smartphones and its impact on purchase intention. *Global Business and Management Research: An International Journal*, 9(1).
- Hajli, N. (2015). Social commerce constructs and consumer's intention to buy. *International Journal of Information Management*, 35(2), 183-191.
- Han, H., Yu, J., & Kim, W. (2019). An electric airplane: Assessing the effect of travelers' perceived risk, attitude, and new product knowledge. *Journal of air transport management*, 78, 33-42.
- Han, M. C., & Kim, Y. (2017). Why consumers hesitate to shop online: Perceived risk and product involvement on Taobao. com. *Journal of promotion management*, 23(1), 24-44.

- He, Z., Wu, L., & Li, X. R. (2018). When art meets tech: The role of augmented reality in enhancing museum experiences and purchase intentions. *Tourism Management*, 68, 127-139.
- Hong, I. B. (2015). Understanding the consumer's online merchant selection process: The roles of product involvement, perceived risk, and trust expectation. *International Journal of Information Management*, 35(3), 322-336.
- Hong, L. M., Zulkiffli, W. F. W., & Hamsani, N. H. (2016). The impact of perceived risks towards customer attitude in online shopping. *International Journal*, 1(2), 13-21.
- Hubert, M., Blut, M., Brock, C., Backhaus, C., & Eberhardt, T. (2017). Acceptance of smartphone-based mobile shopping: Mobile benefits, customer characteristics, perceived risks, and the impact of application context. *Psychology & Marketing*, 34(2), 175-194.
- Hwang, C., Chung, T.-L., & Sanders, E. A. (2016). Attitudes and purchase intentions for smart clothing: Examining US consumers' functional, expressive, and aesthetic needs for solar-powered clothing. *Clothing and Textiles Research Journal*, 34(3), 207-222.
- Ibnou-Laaroussi, S., Rjoub, H., & Wong, W.-K. (2020). Sustainability of green tourism among international tourists and its influence on the achievement of green environment: Evidence from North Cyprus. *Sustainability*, 12(14), 5698.
- Islam, M. A., & Daud, K. A. K. (2011). Factors that influence customers' buying intention on shopping online. *International Journal of Marketing Studies*, 3(1), 128.
- Ismagilova, E., Slade, E. L., Rana, N. P., & Dwivedi, Y. K. (2020). The effect of electronic word of mouth communications on intention to buy: A meta-analysis. *Information Systems Frontiers*, 22(5), 1203-1226.
- Jamal, A., & Sharifuddin, J. (2015). Perceived value and perceived usefulness of halal labeling: The role of religion and culture. *Journal of business research*, 68(5), 933-941.
- Karlin, B., Sanguinetti, A., & Ford, R. (2018). Smart home products with energy management implications: Characterizing and comparing adoption, experiences, and outcomes.
- Kazancoglu, I., & Aydin, H. (2018). An investigation of consumers' purchase intentions towards omni-channel shopping: A qualitative exploratory study. *International Journal of Retail & Distribution Management*.
- Khor, K. S., & Hazen, B. T. (2017). Remanufactured products purchase intentions and behaviour: Evidence from Malaysia. *International Journal of Production Research*, 55(8), 2149-2162.
- Kiger, M. E., & Varpio, L. (2020). Thematic analysis of qualitative data: AMEE Guide No. 131. *Medical teacher*, 42(8), 846-854.
- Kim, T., & Yun, S. (2019). How will changes toward pro-environmental behavior play in customers' perceived value of environmental concerns at coffee shops? *Sustainability*, 11(14), 3816.
- Konuk, F. A. (2018). The role of store image, perceived quality, trust and perceived value in predicting consumers' purchase intentions towards organic private label food. *Journal of Retailing and Consumer Services*, 43, 304-310.
- Laksmidewi, D., & Soelasih, Y. (2019). Anthropomorphic green advertising: How to enhance consumers' environmental concern. *DLSU Business & Economics Review*, 29(1), 72-84.
- Lăzăroiu, G., Neguriță, O., Grecu, I., Grecu, G., & Mitran, P. C. (2020). Consumers' decision-making process on social commerce platforms: online trust, perceived risk, and purchase intentions. *Frontiers in Psychology*, 11, 890.

- LE, N. B. M., & HOANG, T. P. T. (2020). Measuring trusts and the effects on the consumers' buying behavior. *The Journal of Distribution Science*, 18(3), 5-14.
- Ma, S. (2017). Fast or free shipping options in online and Omni-channel retail? The mediating role of uncertainty on satisfaction and purchase intentions. *The International Journal of Logistics Management*.
- Manzoor, U., Baig, S. A., Hashim, M., & Sami, A. (2020). Impact of Social Media Marketing on Consumer's Purchase Intentions: The Mediating role of Customer Trust. *International Journal of Entrepreneurial Research*, 3(2), 41-48.
- Marriott, H. R., & Williams, M. D. (2018). Exploring consumers perceived risk and trust for mobile shopping: A theoretical framework and empirical study. *Journal of Retailing and Consumer Services*, 42, 133-146.
- Matute, J., Polo-Redondo, Y., & Utrillas, A. (2016). The influence of EWOM characteristics on online repurchase intention: Mediating roles of trust and perceived usefulness. *Online information review*.
- Miles, M. B., Huberman, A. M., & Saldaña, J. (2018). *Qualitative data analysis: A methods sourcebook*. Sage publications.
- Moghavvemi, S., Jaafar, N. I., Sulaiman, A., & Parveen Tajudeen, F. (2020). Feelings of guilt and pride: Consumer intention to buy LED lights. *PloS one*, 15(6), e0234602.
- Moslehpour, M., Pham, V. K., Wong, W.-K., & Bilgiçli, İ. (2018). E-purchase intention of Taiwanese consumers: Sustainable mediation of perceived usefulness and perceived ease of use. *Sustainability*, 10(1), 234.
- Pappas, N. (2016). Marketing strategies, perceived risks, and consumer trust in online buying behaviour. *Journal of Retailing and Consumer Services*, 29, 92-103.
- Prakash, G., & Pathak, P. (2017). Intention to buy eco-friendly packaged products among young consumers of India: A study on developing nation. *Journal of cleaner production*, 141, 385-393.
- Purnawirawan, N., De Pelsmacker, P., & Dens, N. (2012). Balance and sequence in online reviews: How perceived usefulness affects attitudes and intentions. *Journal of Interactive Marketing*, 26(4), 244-255.
- Rahman, M. S., Hossain, M. I., & Hossain, G. M. S. (2020). FACTORS AFFECTING CONSUMERS'GREEN PURCHASE BEHAVIOR TOWARDS ENERGY SAVING LIGHTS IN BANGLADESH: THE MEDIATING ROLE OF GREEN PURCHASE INTENTION. *International Journal of Information, Business and Management*, 12(3), 19-37.
- Rese, A., Baier, D., Geyer-Schulz, A., & Schreiber, S. (2017). How augmented reality apps are accepted by consumers: A comparative analysis using scales and opinions. *Technological Forecasting and Social Change*, 124, 306-319.
- Rossi, P., Borges, A., & Bakpayev, M. (2015). Private labels versus national brands: The effects of branding on sensory perceptions and purchase intentions. *Journal of Retailing and Consumer Services*, 27, 74-79.
- Sikder, A. K., Acar, A., Aksu, H., Uluagac, A. S., Akkaya, K., & Conti, M. (2018). IoT-enabled smart lighting systems for smart cities. 2018 IEEE 8th Annual Computing and Communication Workshop and Conference (CCWC),
- Stall-Meadows, C., & Hebert, P. R. (2011). The sustainable consumer: an in situ study of residential lighting alternatives as influenced by infield education. *International Journal of Consumer Studies*, 35(2), 164-170.
- Sunthonkanokpong, W., & Murphy, E. (2019). Sustainability awareness, attitudes and actions: A survey of pre-service teachers. *Issues in Educational Research*, 29(2), 562-582.

- Ting, H., Tham, A., & Gong, J. (2022). Responsible Business—A Timely Introspection and Future Prospects. *Asian Journal of Business Research Volume*, 12(2).
- Tran, V. D. (2020). The relationship among product risk, perceived satisfaction and purchase intentions for online shopping. *The Journal of Asian Finance, Economics, and Business*, 7(6), 221-231.
- Ueasangkomsate, P., & Santiteerakul, S. (2016). A study of consumers' attitudes and intention to buy organic foods for sustainability. *Procedia Environmental Sciences*, 34, 423-430.
- Valentini, C., Romenti, S., Murtarelli, G., & Pizzetti, M. (2018). Digital visual engagement: influencing purchase intentions on Instagram. *Journal of Communication Management*.
- Wang, S., Wang, J., Li, J., Wang, J., & Liang, L. (2018). Policy implications for promoting the adoption of electric vehicles: do consumer's knowledge, perceived risk and financial incentive policy matter? *Transportation Research Part A: Policy and Practice*, 117, 58-69.
- Xu, W., & Zammit, K. (2020). Applying Thematic Analysis to Education: A Hybrid Approach to Interpreting Data in Practitioner Research. *International Journal of Qualitative Methods*, 19, 1609406920918810. <https://doi.org/10.1177/1609406920918810>
- Yang, Q., Pang, C., Liu, L., Yen, D. C., & Tarn, J. M. (2015). Exploring consumer perceived risk and trust for online payments: An empirical study in China's younger generation. *Computers in Human Behavior*, 50, 9-24.
- Yang, Y., Liu, Y., Li, H., & Yu, B. (2015). Understanding perceived risks in mobile payment acceptance. *Industrial Management & Data Systems*.
- Zhao, J., Dong, K., Dong, X., & Shahbaz, M. (2022). How renewable energy alleviate energy poverty? A global analysis. *Renewable Energy*, 186, 299-311.
- Zhu, D. H., Chang, Y. P., & Chang, A. (2015). Effects of free gifts with purchase on online purchase satisfaction: The moderating role of uncertainty. *Internet Research*.