

User Experience Enhancement Strategy of LED Desk Lamp using IPA Model

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Abstract

LED desk lamps are widely used in modern life as one of the lighting products. However, only a few studies focus on the user experience (UX) of LED desk lamps. Therefore, this study adopts the importance-performance analysis (IPA) model, with the aim of exploring strategies to enhance the UX of LED desk lamps. We evaluated the key factors of UX based on the importance and actual performance of LED desk lamps for users. By analyzing the results, we proposed strategies to improve LED desk lamps, thereby potentially improving the consumer experience and market competitiveness of LED desk lamps.

Keywords: LED desk lamp; user experience; product design and development; IPA model

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DOI: <https://doi.org/10.21834/e-bpj.v8iS115.5091>

1.0 Introduction

The LED desk lamp has an LED (Light Emitting Diode) as the light source, which has the advantages of energy saving, environmental protection, and long life (Ye et al., 2020). It has become one of the most commonly used lighting equipment in households, offices, and other indoor environments. According to a report analysis (Grand View Research, 2023), the global LED desk lamp market continues to grow, and it is estimated that by 2025, the LED desk lamp market size will reach US\$13.37 billion, with a compound annual growth rate of 15.2%. In addition, in recent years, understanding and improving user experience (UX) has become increasingly important for new product development, as it can help companies better understand user needs to obtain new products that are more user-satisfying (Norman & Verganti, 2014), which means that the way a new product provides consumers with a good UX has a significant impact on business success (Wang & Lai, 2023). However, few studies have focused on the UX of LED desk lamps, and previous studies have focused more on functionality and technology.

Therefore, this study aims to use the method of the IPA model to explore how to improve the UX of LED desk lamps. First, we used the Norman theory to analyze and understand the important factors of consumers' experience with LED desk lamps, identifying the important factors affecting the user experience; secondly, we used IPA model to evaluate the performance of LED desk lamps on these critical factors, gaining insights into the users' needs and expectations; finally, we proposed corresponding improvement strategies. It is hoped that these strategies will provide targeted suggestions to manufacturers and designers, potentially improving the consumer experience and market competitiveness of LED desk lamps.

2.0 Literature Review

2.1 LED desk lamp

The LED desk lamp has become one of the most widely used lighting devices in daily life (Huang et al., 2015), and its UX plays an important role in the product design and development process (Hassenzahl, 2018). In addition, research shows that UX is crucial to product success and market competitiveness (Yang et al., 2019), especially for products such as LED desk lamps; UX is even more

crucial for consumers. In fact, a good UX can improve the functionality, ease of use, and comfort of LED desk lamps, thus meeting users' needs and winning their satisfaction (Yao et al., 2017). In recent years, improving product user experience, increasing consumers' stickiness to products, and providing users with experience and value in various imaginable ways has become an important goal of many companies, which requires companies to pay attention to how to provide excellent UX (Hsu & Chen, 2018). However, there are relatively few studies on the UX of LED desk lamps. One of the reasons may be that LED desk lamps, as lighting products, emphasize more on functionality and technology. Therefore, the research mainly focuses on colour temperature (Huang, 2015; Chen & Ge, 2017), heat dissipation (Chu et al., 2015; Ekpu et al., 2022), and anti-glare (Ye et al., 2020; Lai et al., 2014) and other technical aspects. This technology-oriented research mainly focuses on the performance and functions of LED desk lamps and pays less attention to the user's feelings and experiences.

Therefore, in the design and development of LED desk lamps, it is important to focus on UX, design products that meet user expectations through an in-depth understanding of user behaviour, needs and preferences, and create a good experience for users so as to establish a good user-product relationship and promote the market success of the product.

2.2 User experience (UX)

UX refers to the overall impression and idea of the user when directly or indirectly using the system, product, or service (Yoon et al., 2022; Hassenzahl & Tractinsky, 2006). Considering the user's preference, the product or service in question features or functions, and how users interact with them in various situations (Yang et al., 2023). Over time, user experience has become an important part of product and service design (Son & Kim, 2023).

In order to improve customer satisfaction, designers must understand market needs and develop concepts from a user experience perspective to help businesses maintain a competitive advantage in a crowded market (Yang et al., 2023). In this context, we explored the factors related to LED desk lamps considered by users at three levels of Norman user experience theory, mainly including instinct level, behaviour level, and reflection level information. Furthermore, Norman (2013) emphasized the need to extend human-centred design to activity-centred design, on the grounds that successful products are those that satisfy people's needs while performing some kind of activity. At the same time, these products should match the needs of the event and provide services in a way that people can perceive and understand (Norman, 2005). Therefore, this research combines Norman's theory to effectively investigate users' experiences and ideas, understand the relevant factors of LED desk lamp user experience demand design, and strive to achieve the purpose of reaching a consensus between consumers' perceptions of actual product design and expected benefits.

3.0 Methodology

This study employs a series of methods and steps to explore user experience enhancement strategies for LED desk lamps using the IPA model to achieve the research objectives.

3.1 Factor collection

We used interviews and literature surveys to gain an in-depth understanding of the factors related to users' experience of using LED desk lamps, then combined with Norman's three levels of screening and aggregation, and finally established an evaluation system.

3.2 Questionnaire survey

The questionnaire has two parts: the first part contains demographic information (gender, age, and profession) and information on the behavioural characteristics of the LED desk lamp users (hours of use a week, when use, and why use). The second part of the study is based on a 5-point Likert scale to evaluate the importance and performance of users on each attribute of the LED desk lamp. The sample was drawn from users of LED desk lamps aged 18-60 in Sanming, Fujian Province, China. We use convenience sampling and expand the participants through snowball sampling. In total, we distributed 300 online survey forms and received 269 validly completed forms.

3.3 IPA model

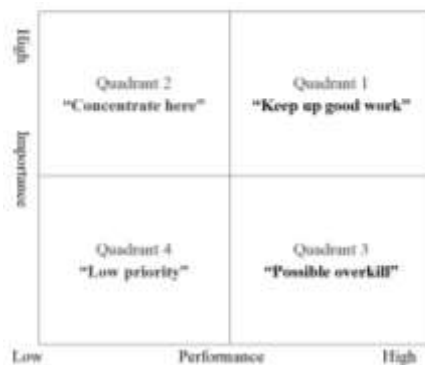


Fig. 1. IPA two-dimensional grid

Importance-performance analysis (IPA) was originally used to understand which product or service attributes companies need to focus on to achieve customer satisfaction (Martilla & James, 1977). A popular tool widely used to understand customer satisfaction and determine the priority of service quality improvement (Bacon, 2003), it is a two-dimensional grid based on the importance of quality attributes and quality-related performance (Matzler et al., 2004), as shown in Fig. 1. This study used the IPA method to classify and analyze the factors and propose optimization suggestions and directions based on the analysis diagram.

4.0 Findings

4.1 Establish evaluation system index

We identified four criterion items with a total of 15 index items, as shown in Table 1, and provided the underlying data for the subsequent study.

Table 1. Evaluation system index

Criterion layer	Index layer
Styling features	Aesthetics of shape (C1)
	Aesthetics of colour (C2)
	Product styling (C3)
	Human scale for ergonomics considerations (C4)
Practical features	Simplicity of operation (C5)
	Energy saving and environmental protection (C6)
	Adjustability of the equipment (C7)
	Storability of the equipment (C8)
Characteristics of humanistic environment	Culture as embodiment (C9)
	Emotional interactivity (C10)
	Adaptability to the environment of use (C11)
Material characteristics	Water resistance (C12)
	Durability of the material (C13)
	Ease of cleaning of the material (C14)
	Texture of the material (C15)

4.2 Questionnaire reliability analysis

The questionnaire on the importance of user experience factors reached a good level of reliability for respondents using LED desk lamps (overall Cronbach's Alpha = 0.843), as did the performance questionnaire (overall Cronbach's Alpha = 0.811). The Cronbach's Alpha values for all indicators in both questionnaires were above the recommended value of 0.6 (Van et al., 2015), indicating good reliability of the questionnaires.

Table 1. Subject questionnaire information

Categories	Subcategories	Frequency	Percentage
Gender	Male	148	55%
	Female	121	45%
Age	18-28	198	74%
	29-50	67	25%
	51-60	4	1%
Profession	Student	182	68%
	Employed	87	32%
Hours of use a week	1-2 hours	3	1%
	2-4 hours	15	6%
	4-6 hours	32	12%
	More than 6 hours	219	81%
When use	While reading	46	17%
	While writing	83	31%
	While drawing	6	2%
	While working on computer	115	43%
	While another task	19	7%
Why use	When need additional lights	232	86%
	To save energy	12	5%
	Others	25	9%

4.3 Descriptive analysis

Demographic summary of 269 validly returned questionnaires, 18-28 years old (74%), students (68%), more than 6 hours (81%), and when need additional lights (86%), accounted for the largest portion of respondents in terms of age, profession, hours of use a week

and why use, respectively.

4.4 IPA result

Based on the results obtained from the calculations, an IPA chart was prepared for the factors, as shown in Fig. 2.

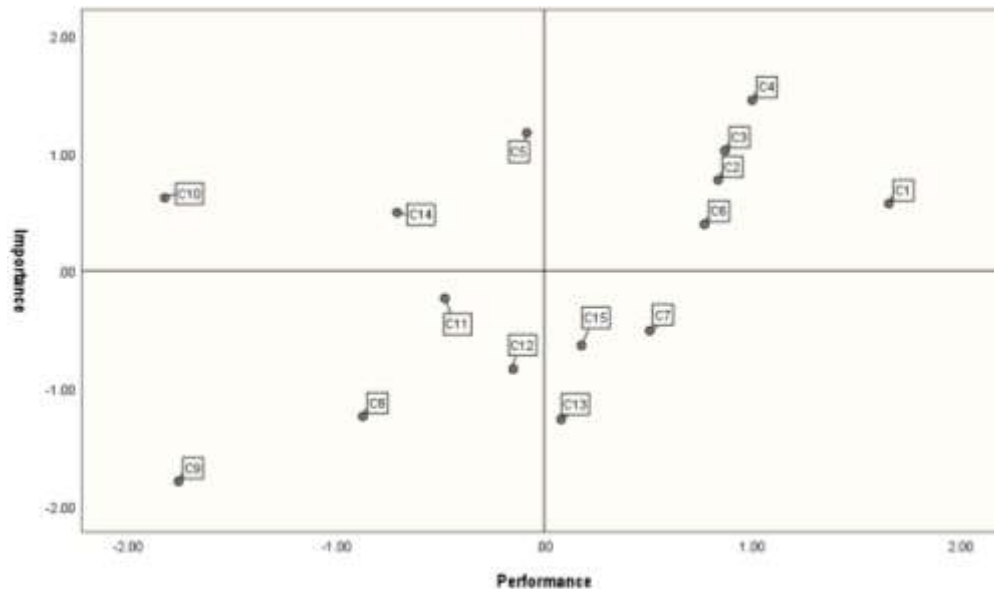


Fig. 2. IPA diagram

The following factors findings were taken from the IPA results:

1. "Keep up good work" represents high importance and high performance, indicating that these factors are key to the users and have higher customer satisfaction with these factors, including the evaluation factors: aesthetics of shape (C1), aesthetics of colour (C2), product styling (C3), human scale for ergonomics considerations (C4), energy saving and environmental protection (C6).
2. "Concentrate here" represents high importance and low performance. The factors in the area are important for users, but the product performance is relatively poor, user evaluation satisfaction is low, and we need to strengthen repair and improvement, including evaluation factors: simplicity of operation (C5), emotional interactivity (C10), and ease of cleaning of the material (C14).
3. "Possible overkill" represents low importance, high performance, and high user evaluation but is a secondary advantage and can allocate more resources to improve the second quadrant (Matzler et al., 2004), including evaluation factors: adjustability of equipment (C7), durability of materials (C13), and texture of material (C15).
4. "Low priority" represents low importance and low performance; this part of the factors is not the most important to customers, and the satisfaction evaluation is low. These factors are obviously not problems because they are relatively minor. If there are no improved properties in quadrant 2 (Matzler et al., 2004); in that case, it should be improved, including evaluation factors: storability of equipment (C8), culture as embodiment (C9), adaptability to the environment of use (C11) and water resistance (C12).

5.0 Discussion

In recent years, companies have realised the importance of user experience and have begun to put users at the heart of their needs and expectations. However, research on the user experience of LED desk lamps as a lighting product is still in the development stage. To advance the user experience of LED desk lamps, suggestions for the design and development of LED desk lamps are put forward based on the results of the IPA model.

5.1 Continued consolidation of the shape features of LED desk lamps

In general, products with novel appearances and unique shapes are more likely to stimulate the senses of users, give people a pleasant feeling, and can establish a positive connection between consumers and products. The shape is a key factor in product design. Users can more easily and intuitively perceive the appearance of products from multiple perspectives (Naderi et al., 2020). Therefore, it is necessary to design an attractive LED desk lamp shape that is in harmony with the modern living environment, focusing on the smoothness and simplicity of the lines and combining the function and form of LED desk lamps to create unique design elements and provide personalized options to attract different consumer groups. At the same time, it provides various colour options to meet individual preferences and needs of consumers. Considering that colour subtly affects our lives (Nascimento et al., 2021), it is suggested that the choice of colour should reduce complexity, consider the visual scale of different colours, and reduce the discomfort caused by visual experience, to meet the needs of visual performance. In addition, a variety of LED desk lamp style options are provided, such as modern, simple, retro, etc., to meet different consumers' preferences for styles and home decoration needs. In particular, consider the principles

of ergonomics, design ergonomic desk lamp shapes and angles to ensure a comfortable user experience and appropriate lighting effects, and provide adjustable light brightness and colour temperature to meet the lighting needs of different users in different scenarios.

5.2 Attach importance to the practical function of LED desk lamp

Products that meet consumer needs should have good operation methods, especially an intuitive and simple operation interface, so that consumers can easily understand and use various functions and adjustment options of LED desk lamps. It is recommended to provide clear operation guidelines and instructions to help users get started quickly and make full use of the functions of the LED desk lamp. In addition, today's society places more emphasis on environmental sustainability, and the use of energy-saving equipment will inevitably increase (Pode, 2020), adopting energy-efficient LED lighting technology, reducing energy consumption, and extending the service life of LED desk lamps. Use environmentally friendly materials and manufacturing processes to minimise the impact of LED desk lamps on the environment during production and use. At the same time, it provides a variety of adjustable parameter options, such as light brightness, colour temperature, light direction, etc., to meet the individual requirements of different consumers for lighting needs. Combined with intelligent control technology, it realizes functions such as remote control and timing adjustment, provides more convenient equipment adjustability, and has a compact and easy-to-storage LED desk lamp structure, which is convenient for consumers to store and carry when not in use. Available in foldable, retractable, or rotatable designs to suit different space and storage needs.

5.3 Emphasize emotional experience on a deeper level

The design and development of LED desk lamps need to dig deeply into the aspects that generate deep emotions for users. In addition, the data shows that users' emotional satisfaction is low, so three suggestions are proposed: first, consider the use of LED desk lamps in different cultural backgrounds and aesthetic preferences, and design for cultural adaptation. Integrate local cultural elements into product design to enhance consumers' emotional resonance and cultural identity; second, provide LED desk lamps with emotional interaction functions, such as adjustable light colour and brightness, to meet the needs of users in different emotional states. Combining intelligent technology to achieve emotional interaction with users, such as through voice control or touch sensing, helps to attract consumers' attention and meet expectations, thereby increasing consumers' desire to interact with products; third, deepens the interaction between the product-consumer-environment (Ding et al., 2022), considering the light requirements of different usage environments, such as working environment, learning environment, and leisure environment, providing multiple modes and preset options. According to the characteristics of different environments, functions such as light adjustment and timing switches are provided to adapt to the needs and habits of consumers in different scenarios.

5.4 Accelerate the improvement of materials

In China, the development of the circular economy is a major strategy for economic and social development and an important way to achieve carbon peak regulation and carbon neutrality, this means focusing on maximizing the functionality and longevity of materials and products (Roithner et al., 2022). In this case, the utilization of materials is particularly important. First, the waterproof design and materials are adopted to ensure normal operation and long-term durability of the LED desk lamp in a humid environment. Second, use high-quality materials and manufacturing processes to ensure the durability and long-term reliability of LED desk lamps. It is recommended to provide multi-step structured scenarios for product performance and quality testing during the production testing phase, using fatigue simulation to predict accurate service life. Third, use anti-fouling coatings or materials to reduce the adhesion of dust and stains, making it easier to clean and keep LED desk lamps clean; because of the characteristics of electromagnetic reactions and easy to attract impurities during use, lamp holders and lampshades will be damaged during use absorb dust. As the time unit increases, more dust will settle, affecting use. Fourth, consider the visual effects and tactile properties of different materials, such as metal texture, wood grain texture, etc., to meet consumers' requirements for product appearance and tactility.

6.0 Conclusion & Recommendations

This study focuses on exploring strategies to enhance the user experience of LED desk lamps using the IPA model. First of all, by using the Norman user experience theory to analyze and understand the key factors that affect the user experience of LED desk lamps, such as aesthetics of shape, aesthetics of colour, product styling, human scale for ergonomics considerations, and other factors, and through IPA model, it is concluded that the user's "Importance-performance" 4-quadrant matrix, further analysis of relevant factors, and proposes improvement strategies, we hope to improve the experience and consumer satisfaction of LED desk lamps, thereby enhancing their market competitiveness, and providing useful references and guidance to LED desk lamp manufacturers and designers will help improve the user experience.

The limitation of this study is that its scope was limited to Sanming City, China, and expansion of the study sites could be considered in the future to obtain more generalized results. In addition, this research also only discusses user experience when using the LED desk lamp from a theoretical perspective. Further research needs to be conducted for design development or manufacturing processes by other researchers in the future. Overall, the study provides valuable insights and practical guidance for LED desk lamp designers, manufacturers, and related industries to enhance the user experience and drive innovation in this area. Future research can explore specific aspects of the user experience and provide more targeted strategies and recommendations to further enhance the consumer experience and market competitiveness of LED desk lamps.

Acknowledgements

The authors would like to thank the Research Management Center (RMC), UiTM, for granting ethical approval and the respondents who participated in this study.

Paper Contribution to Related Field of Study

This study contributes to product development, LED desk lamp studies, and user experience-related areas.

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