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Comprehensive Evaluation of a Novel Wireless Mouse Page-turning Laser Pointer Using AHP Method

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Abstract— *This study aims to comprehensively evaluate the novel wireless mouse page-turning laser pointer through the analytic hierarchy process (AHP) method and provide valuable reference information for designers. Firstly, the characteristics and functions of the novel wireless mouse page-turning laser pointer are introduced, and the basic principle and calculation steps of AHP are expounded. Secondly, through the construction of the AHP analysis model, determine the evaluation index system and hierarchical structure model, collect data through questionnaires and expert interviews, establish the judgment matrix and assign values, and then analyze the calculation results, including the ranking weights of the elements of the middle layer and the elements of the scheme layer on the decision target, as well as the consistency ratio and the maximum characteristic value of each index. Through sensitivity analysis, the objects faced by plans A, B, and C are determined. Finally, the research results are discussed, and suggestions for improvement and future research direction are put forward. This study provides an effective method for the evaluation of the novel wireless mouse page-turning laser pointer, which is helpful for designers to develop suitable products.*

Keywords— ***Novel wireless mouse page-turning laser pointer, Analytic hierarchy process (AHP), Comprehensive evaluation, Index system, Sensitivity analysis***

I. INTRODUCTION

With the rapid development of information technology (IT), presentation tools are more and more widely used in education, business, and other fields. A wireless mouse-turning laser pointer has become a multi-functional device combining traditional laser pointers and modern wireless technology, providing users with a more convenient and efficient demonstration experience. It can not only realize the remote control of the PPT presentation page turning function but also integrate the laser indication, multimedia control, and other functions, which greatly enriches the user's use scenario. However, in the current market, full of a variety of different brands and models of products, they have their own characteristics in performance, design, ease of operation, and other aspects. This complex market environment leads to consumers often getting into a dilemma when choosing products. From a design point of view, this highlights the importance of scientific evaluation of products, as it can guide consumers in their purchase. The purpose of this study is to comprehensively evaluate the new wireless mouse page-turning laser pointer through the analytic hierarchy process (AHP) and provide valuable reference information for designers to design a new wireless page-turning pen.

In the research process, the relevant study results of comprehensive evaluation theory and the multi-attribute decision method provide important theoretical basis and method guidance for the construction and analysis of the

index system. For example, Guo's systematic description of the comprehensive evaluation system in comprehensive evaluation theory, method, and application enables us to comprehensively evaluate products from multiple dimensions; Gao's analysis of the system structure and the relationship between elements in principles of systems helps to better understand and build the hierarchical model of wireless mouse page-turning laser pointer evaluation to ensure reasonable and accurate logical relations among elements [14, 18]. At the same time, in terms of weight calculation and analysis, Deng and other scholars' in-depth discussion on the weight calculation method of the analytic hierarchy process in relevant studies is also referred to to ensure the scientific accuracy and reliability of the calculation results [15]. In addition, at the stage of data collection and preliminary processing, Ma's management statistics: data acquisition, statistical principles, SPSS tools, and application research provide references for data collection methods and statistical analysis principles to ensure the validity of data and rationality of analysis [16]. Moreover, Fang's ideas and methods on building a performance evaluation system in strategic performance management also provide useful references for us to determine evaluation indicators based on strategic objectives, making evaluation indicators more targeted and practical [17].

The novel wireless mouse page-turning laser pointer is a modern demonstration aid that integrates wireless communication technology and laser indicating functions. Its main features include, but are not limited to, support for remote page turning control, high-precision laser pointer, multimedia file playback control, and black/white screen switching functions. The product is designed with portability and ergonomics in mind, making it easy to carry and comfortable to use for a long time on a variety of occasions. This paper will focus on these core features in detail and build an A model based on the AHP method to evaluate three representative schemes: Scheme A "Spirit Leap Page Turning Pen", Scheme B "Changyi Page Turning Pen" and Scheme C "Excellent Page Turning Master".

II. METHODS

2.1 Basic Principle of AHP

Analytic Hierarchy Process (AHP) is a combination of qualitative and quantitative decision-making methods proposed by Saaty T.L. [1], a famous American operations research scientist, in the 1970s. It has been widely used in various fields such as society, politics, economy, military, and management. AHP is suitable for multi-index, multi-level, and multi-scheme system comprehensive evaluation and decision, especially for system problems with both qualitative and quantitative factors. It can be relatively simple to carry out a comprehensive evaluation and the best plan decision [2].

The basic principle of AHP is to treat a complex decision problem as a large system, and through in-depth analysis of multiple influencing factors in the system, an orderly hierarchical structure is built among the interrelated factors [3]. Subsequently, experts are invited to make objective judgments on the factors at each level and give quantitative assessments of their relative importance. Based on these judgments, mathematical models are built to calculate the relative weights of all factors in each level and rank them. Finally, according to the ranking results, a decision scheme is made and effective measures are selected to solve the problem.

For the construction method of the hierarchy, the overall goal of the problem should be clearly defined and placed at the top of the hierarchy. Then, according to the nature of the problem and the purpose of the research, the factors affecting the realization of the overall goal are decomposed into several criterion layers; each criterion layer can be further subdivided into several sub-criterion layers, and so on, until it is decomposed into the specific scheme layer that can be directly evaluated or decided.

The establishment of the judgment matrix is based on the pairwise comparison between the factors of the same level in the hierarchy. The 1-9 scale method is usually used for comparison; that is, for two factors i and j, their relative importance is expressed by the numbers 1-9 and their reciprocal. Among them, 1 indicates that the two factors are equally important, 3 indicates that factor i is slightly more important than factor j, 5 indicates that factor i is significantly more important than factor j, 7 indicates that factor i is strongly important than factor j, 9 indicates that factor i is extremely important than factor j, 2, 4, 6, and 8 indicate the middle value of the above adjacent judgments.

2.2 Establishment of Comprehensive Evaluation

Method

According to previous research results, the triangular table survey method is used to ensure the consistency of the constructed index weight judgment matrix. Meanwhile, the "minimum variance" theory in classical mathematics is adopted to determine the relative evaluation level weights of different experts according to the difference level between the actual weights evaluated by different experts and the optimal weights (using the average value). To avoid the subjective differences of individual evaluation experts from having a greater impact on the evaluation results [4]. The specific evaluation process is shown in Figure 1.

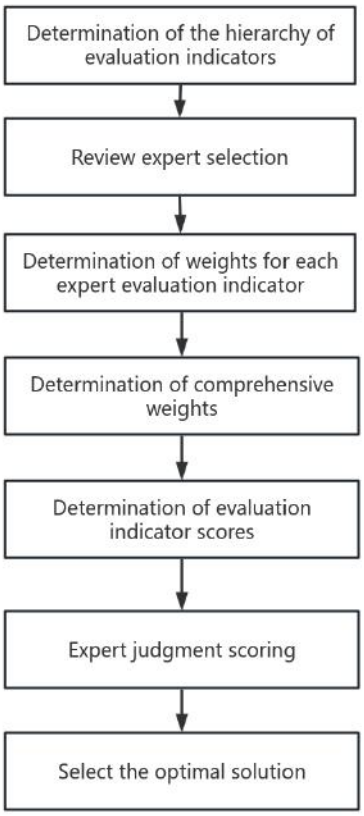

Fig.1 Evaluation Flow Chart

2.3 The application of AHP to solve practical problems can be generally carried out in the following four steps:

Step 1: Establish a hierarchical structure

When AHP is applied to analyze decision problem, first of all, the problem should be organized and hierarchical, and a hierarchical structure model should be constructed. These levels can be divided into three types: the highest level (the purpose level), the middle level (the criterion level), the lowest level (the scheme level). The number of layers in a hierarchical structure is related to the complexity of the problem and the degree of detail that needs to be analyzed, and the number of layers is generally unlimited. The elements in each hierarchy generally control no more than 9 elements [5].

Step 2: Construct all the judgment matrices in each level

The criteria in the criterion layer do not necessarily have the same weight in the objective measurement, and they each have a certain proportion in the mind of the decision maker. Define the judgment matrix $A=(a_{ij})_{nxn}$ by referring to the numbers 1-9 and their reciprocal as scales (see Table 1)

Table 1 Definition of the Judgment Matrix Scale

Scale	Meaning
1	Indicates that two factors are of equal importance when compared
3	When compared with each other, the former is slightly more important than the latter
5	It means that the former is significantly more important than the latter when comparing two factors
7	Means that the former is strongly more important than the latter when compared with the two factors
9	It means that the former is extremely more important than the latter when comparing two factors
2,4,6,8	Represents the median value of the above neighboring judgments
Reciprocal	If the ratio of the importance of factor i to that of factor j is a_{ij}, then the ratio of the importance of factor j to that of factor i is $a_{ji}=1/a$

Step 3: Single rank and consistency test

1) Calculate the consistency index (CI)

$$\mathrm{CI} = \frac{\lambda_{max} - n}{\mathrm{n} - 1} \quad (1)$$

Where λmax is the maximum eigenvalue of the judgment matrix

2) Find the consistency indicator RI, such as Table 2.

Table 2 Average random consistency metrics

n	1	2	3	4	5	6	7	8	9	10	11	12	13	14		
RI	0	0	0.52	0.89	1.12	1.24	1.36	1.41	1.46	1.49	1.52	1.54	1.56	1.58		

Step 4: Hierarchy total sort and consistency check.

Finally, it is necessary to get the ranking weight of each element, especially the scheme in the lowest layer to the target, so as to select the scheme. The consistency test is also needed for the overall ranking of the hierarchy, the synthetic weight of the elements of each layer to the total goal of the system is calculated, and the selected scheme is sorted.

III. AHP ANALYSIS MODEL CONSTRUCTIONS

3.1 Construction of Hierarchical Structure Model

The page-turning laser pointer is the process of concretizing the evaluation content, using key indicators to highly summarize the evaluation content, and decomposing each indicator into specific indicators after comprehensive weighing and scientific analysis. This model sets the target layer as the comprehensive evaluation of the practicability evaluation of the page-turning pen. The criterion layer includes functional practicality, application scenario adaptability, operation convenience, technical stability, battery life, and charging. The scheme layer is A, B, and C [6], as shown in Figure 2.

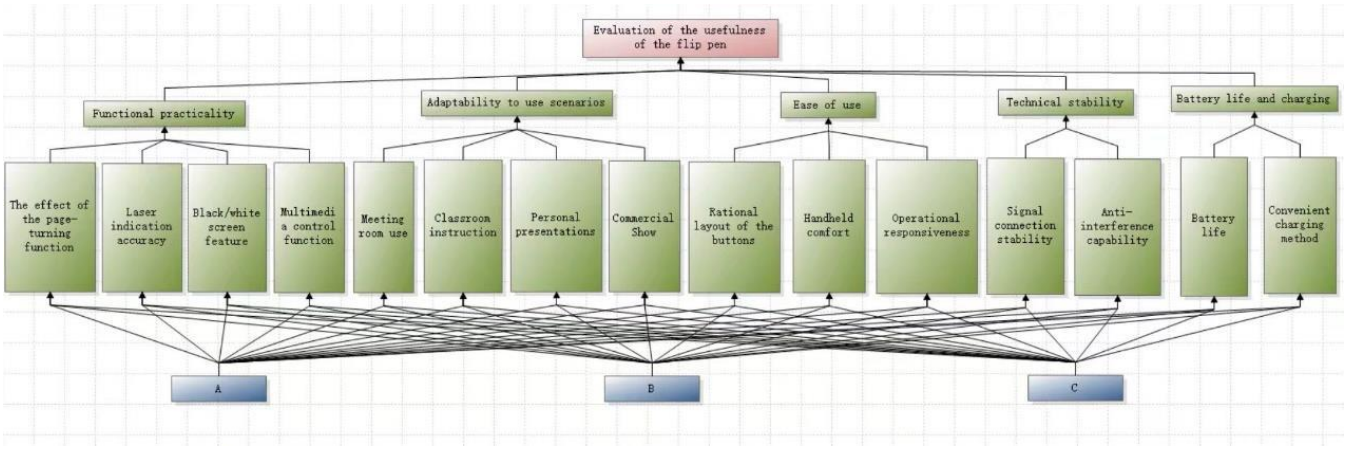

Fig. 2 Structure Model Diagram

3.2 Determine the Evaluation Index System

Establish the standard to measure the pairwise comparison of different evaluation indicators, and construct the matrix of the pairwise comparison results of different indicators. All indicators in each scheme are scored, respectively, and a weighted average is used to calculate the relative weight of each indicator under each scheme by using the results of the previous step. This model determines the evaluation index of the new wireless mouse page-turning laser pointer from the aspects of performance, function, design, price, etc. and refers to the relevant comprehensive evaluation theory and the research results of multi-attribute decision methods [7, 8, 9].

IV. DATA PROCESSING

4.1 Establishment and Assignment of Judgment Matrix

Based on the evaluation of the practicability of the page-turning pen, functional practicability, scene adaptability, operation convenience, technical stability, battery life and charging are taken as the indicators of the judgment matrix (Table 3). In this process, the conventional method of the judgment matrix construction in the analytic hierarchy process and related research cases are used for reference [10,11].

Table 3. Utility Evaluation and Judgment Matrix of Page-turning Pen

Functional Practicability	Use case adaptability	Ease of operation	Technical stability	Battery life and charging
1	2/3	4/3	4/3	4/3
3/2	1	2	2	2
3/4	1/2	1	1	1
3/4	1/2	1	1	1
3/4	1/2	1	1	1

4.2. Function Practicality Judgment Matrix:

There are four sub-indexes under functional practicality: the effect of turning the page function, the accuracy of laser indication, the black screen/white screen function, and the multimedia control function. The judgment matrix is (Table 4).

Table 4 Functional Utility Judgment Matrix

Page-turning function effect	Laser indicating accuracy	Black screen/white screen function	Multimedia control function
1	3	3	2
1/3	1	2	1
1/3	1/2	1	1/2
1/2	1	2	1

4.3. Use Scenario Adaptability Judgment Matrix:

There are four sub-indicators under the adaptability of use scenario: meeting room use, classroom teaching, personal presentation and business performance. Judgment matrix (Table 5).

Table 5 Use Scenario Suitability Judgment Matrix

Meeting room Usage	Classroom instruction	Individual presentations	Business show
1	2	3	2
1/2	1	2	1
1/3	1/2	1	1/2
1/2	1	2	1

4.4. Operation Convenience Judgment Matrix and Weight Calculation:

There are three sub-indexes under the convenience of operation: rationality of key layout, hand-held comfort, and operation response speed. The judgment matrix is (Table 6) :

Table 6 Uses Scenario Suitability Judgment Matrix

Key layout rationality	Handheld comfort	Speed of handling response
1	3	3
1/3	1	2
1/3	1/2	1

4.5. Technical Stability Judgment Matrix and Weight Calculation:

Under the technical stability, there are two sub-indexes: signal connection stability and anti-interference ability. The judgment matrix is (Table 7) :

Table 7 Technical Stability Judgment Matrix

Signal connection stability	Ability to resist interference
1	3/2
2/3	1

4.6. Battery Life and Charging Judgment Matrix:

There are two sub-indexes under battery life and charging: battery life and convenience of charging method. The judgment matrix is (Table 8).

Table 8: Battery Life and Charging Judgment Matrix

Battery life	Easy charging method
1	3/2
2/3	1

V. ANALYSIS RESULTS AND DISCUSSION

5.1 Analysis of Calculation Results

The relevant factors in the first intermediate layer include scenario adaptability, functional practicality, battery life and charging, technical stability and operation convenience, which are quantified to reflect the different importance of these factors relative to the decision goal, that is, the ranking weight (Table 9). Among them, the factor with the largest proportion of weight is the proportion of use scenario adaptability, accounting for 0.3158. The weight of the three middle layer factors, battery life and charging, technical stability and operation convenience, is the same, all of which are 0.1579. It shows that the use of scene has the greatest impact on the first intermediate layer factor, and the direction of the performance of the whole page turning pen is also greater.

The second intermediate layer factor has 15 factors, with the most weight for conference room use, followed by signal connection stability and battery life. These three factors have a larger weight, accounting for almost 0.33 of the weight of the middle layer, and each of the remaining factors accounts for no more than 0.1, among which, the lowest factor is the black screen/white screen function.

Table 9 Ranking Weights of Factors on Decision Objectives in the First Middle Layer

Elements of the middle tier	Weights
Use case adaptability	0.3158
Functional practicality	0.2105
Battery life and charging	0.1579
Technical stability	0.1579
Ease of operation	0.1579

The second intermediate layer is the quantitative representation of the different importance of each relevant factor relative to the decision goal, which is the ranking weight (Table 10).

Table 10 Ranking Weights of Factors in the Second Intermediate Layer on Decision Objectives

Factors in the middle tier	Weights
Meeting room use	0.1336
Signal connection stability	0.1053
Battery life	0.1053
Page turning function effect	0.0891
Key layout rationality	0.0851
Business show Variety	0.0717
Classroom teaching	0.0717
Anti-interference capability	0.0526
Convenient charging method	0.0526
Laser indicating accuracy	0.0478
Multimedia control function	0.0478
Handheld comfort	0.0469
Personal presentation	0.0387
Operational response speed	0.0259
Black/white screen function	0.0258

1. Relevant data of factors in the first intermediate layer on decision-making objectives (Table 11) Page-turning pen consistency ratio: 0.0000; The weight of "page-turning pen" : 1.0000; λmax: 5.0000

Table 11 Relevant Data of Factors on Decision Objectives in the First Intermediate Layer

Paging Pen	Functional utility	Use case adaptability	Ease of operation	Technical stability	Battery life and charging	Wi
Functional utility	1.0000	0.6667	1.3333	1.3333	1.3333	0.2105
Use case suitability	1.5000	1.0000	2.0000	2.0000	2.0000	0.3158
Ease of operation	0.7500	0.5000	1.0000	1.0000	1.0000	0.1579
Technical stability	0.7500	0.5000	1.0000	1.0000	1.0000	0.1579
Battery life and charging	0.7500	0.5000	1.0000	1.0000	1.0000	0.1579

2. Relevant data of functional practicality of elements in the second intermediate layer (Table 12)

Consistency ratio of functional practicality: 0.0039; The weight of "page-turning pen" : 0.2105; Lambda Max: 4.0104

Table 12 Relevant Data on Functional Utility of Elements in the Second Intermediate Layer

Functional availability	Page-turning function effect	Laser indicates fineness	Black/white screen power	Multimedia control function	Wi
Flip page function effect	1.0000	2.0000	3.0000	2.0000	0.4231
Laser indicates fineness	0.5000	1.0000	2.0000	1.0000	0.2272
Black/white screen power	0.3333	0.5000	1.0000	0.5000	0.1225
Multimedia control function	0.5000	1.0000	2.0000	1.0000	0.2272

3. Relevant data on the adaptability of elements in the second intermediate layer to use scenarios (Table 13)

Consistency ratio of use scenario adaptability: 0.0039; The weight of "page-turning pen" : 0.3158; Lambda Max: 4.0104

Table 13 Related Data of the Adaptability of Elements in the Second Intermediate Layer

Suitability of use scenarios	Commercial performance	Individual Presentations	Classroom lectures	Meeting room use	Wi
Business Show Extravaganza	1.0000	2.0000	1.0000	0.5000	0.2272
Individual Presentations	0.5000	1.0000	0.5000	0.3333	0.1225
Classroom lectures	1.0000	2.0000	1.0000	0.5000	0.2272
Meeting room use	2.0000	3.0000	2.0000	1.0000	0.4231

4. Data on the ease of operation of the elements in the second intermediate layer (Table 14)

Consistency ratio of ease of operation: 0.0089; The weight of "page-turning pen" : 0.1579; Lambda Max: 3.0092

Table 14 Data on the Ease of Operation of the Factors in the Second Intermediate Layer

Ease of operation	Key layout rationality	Handheld comfort	Speed of handling response	Wi
Key layout rationality	1.0000	2.0000	3.0000	0.5390
Handheld comfort	0.5000	1.0000	2.0000	0.2973
Speed of handling response	0.3333	0.5000	1.0000	0.1638

5. Data related to technical stability of elements in the second intermediate layer (Table 15)

Consistency ratio of technical stability: 0.0000; The weight of "page-turning pen" : 0.1579; Lambda Max: 2.0000

Table 15 Relevant Data on Technical Stability of Factors in the Second Intermediate Layer

Technical stability	Signal connection stability	Ability to resist interference	Wi
Signal connection stability	1.0000	2.0000	0.6667
Ability to resist interference	0.5000	1.0000	0.3333

6. Data related to battery life and charging of elements in the second intermediate layer (Table 16)

Battery life and charging consistency ratio: 0.0000; The weight of "page-turning pen" : 0.1579; Lambda Max: 2.0000

Table 16 Related Data of Battery Life and Charging of Elements in the Second Intermediate Layer

Battery life and charging	Battery life	Easy charging method	Wi
Battery life	1.0000	2.0000	0.6667
Easy charging method	0.5000	1.0000	0.3333

7. Data related to the effect of the scheme layer on the page-turning function (Table 17)

The consistency ratio of page-turning function effect: 0.0012; The weight of "turning pen" : 0.0891; Lambda Max: 3.0012

Table 17 Related Data of the Effect of the Solution Layer on the Page-turning Function

Page turning function effect	B	C	A	Wi
B	1.0000	0.6667	0.7500	0.2604
C	1.5000	1.0000	1.2500	0.4045
A	1.3333	0.8000	1.0000	0.3352

8. Data related to laser indication accuracy of the solution layer (Table 18)

Laser indicating accuracy consistency ratio: 0.0124; The weight of "turning pen" : 0.0478; Lambda Max: 3.0129

Table 18 Relevant Data of Laser Indication Accuracy in Scheme Layer

Laser indicating accuracy	A	B	C	Wi
A	1.0000	0.7500	0.6667	0.2612
B	1.3333	1.0000	1.2500	0.3895
C	1.5000	0.8000	1.0000	0.3493

9. Data related to black/white screen function of solution layer (Table 19)

Black screen/white screen function consistency ratio: 0.0124; The weight of "page-turning pen" : 0.0258; Lambda Max: 3.0129

Table 19 Data about the Black/White Screen Function on the Solution Layer

Black/white screen function	A	B	C	Wi
A	1.0000	0.7500	0.8000	0.2773
B	1.3333	1.0000	1.5000	0.4135
C	1.2500	0.6667	1.0000	0.3092

10. Data related to multimedia control function at the solution layer (Table 20)

Multimedia control function consistency ratio: 0.0015; The weight of "page-turning pen" : 0.0478; Lambda Max: 3.0015

Table 20 Relevant Data of Multimedia Control Function at the Solution Layer

Multimedia control Functions	A	B	C	Wi
A	1.0000	0.6667	0.6000	0.2395
B	1.5000	1.0000	0.8000	0.3454
C	1.6667	1.2500	1.0000	0.4151

11. Data related to commercial performance at the scheme level (Table 21)

Consistency ratio of commercial performance: 0.0012; The weight of "page-turning pen" : 0.0717; λmax: 3.0012

Table 21 The Relevant Data of the Commercial Performance on the Scheme Layer

Commercial performance	A	B	C	Wi
A	1.0000	0.6667	0.7500	0.2604
B	1.5000	1.0000	1.2500	0.4045
C	1.3333	0.8000	1.0000	0.3352

12. Data related to the presentation of the solution layer to individuals (Table 22)

Individual presentation consistency ratio: 0.0053; The weight of "page-turning pen" : 0.0387; λmax: 3.0055

Table 22 Relevant Data for Individual Presentations at the Solution Layer

Personal Presentation	A	B	C	Wi
A	1.0000	0.6667	0.8000	0.2649
B	1.5000	1.0000	1.5000	0.4277
C	1.2500	0.6667	1.0000	0.3074

13. Data related to classroom teaching at the solution level (Table 23)

The consistency ratio of classroom teaching: 0.0124; The weight of "page-turning pen" : 0.0717; λmax: 3.0129

Table 23 Data Related to Classroom Instruction at Solution Level

Classroom teaching	A	B	C	Wi
A	1.0000	0.7500	0.6667	0.2612
B	1.3333	1.0000	1.2500	0.3895
C	1.5000	0.8000	1.0000	0.3493

14. Data related to the use of meeting rooms in the solution layer (Table 24)

Consistency ratio of conference room use: 0.0012; The weight of "page-turning pen" : 0.1336; Lambda Max: 3.0012

Table 24 Relevant Data for the Use of Meeting Rooms in the Solution Layer

Meeting Room Usage	A	B	C	Wi
A	1.0000	0.6667	0.7500	0.2604
B	1.5000	1.0000	1.2500	0.4045
C	1.3333	0.8000	1.0000	0.3352

15. Relevant data on the rationality of key layout at the solution layer (Table 25)

Key layout rationality consistency ratio: 0.0124; The weight of "page-turning pen" : 0.0851; Lambda Max: 3.0129

Table 25 Relevant Data on the Rationality of Key Layout in the Scheme Layer

Rationality of key Layout	A	B	C	Wi
A	1.0000	0.7500	0.6667	0.2612
B	1.3333	1.0000	1.2500	0.3895
C	1.5000	0.8000	1.0000	0.3493

16. Data related to hand-held comfort at the solution level (Table 26)

Consistency ratio of hand-held comfort: 0.0124; The weight of "page-turning pen" : 0.0469; Lambda Max: 3.0129

Table 26 Data on Hand-held Comfort at Solution Level

Handheld Comfort	A	B	C	Wi
A	1.0000	0.7500	0.8000	0.2773
B	1.3333	1.0000	1.5000	0.4135
C	1.2500	0.6667	1.0000	0.3092

17. Data related to the response speed of the solution layer to the operation (Table 27)

Consistency ratio of operation response speed: 0.0012; The weight of "page-turning pen" : 0.0259; Lambda Max: 3.0012

Table 27 Data on the Response Speed of the Scheme Layer to the Operation

Operational response speed	A	B	C	Wi
A	1.0000	0.7500	1.2500	0.3209
B	1.3333	1.0000	1.5000	0.4131
C	0.8000	0.6667	1.0000	0.2659

18. Data on stability of signal connection at the solution layer (Table 28)

Consistency ratio of signal connection stability: 0.0124; The weight of "page-turning pen" : 0.1053; Lambda Max: 3.0129

Table 28 Data on Stability of Signal Connection at Solution Layer

Signal connection Stability	A	B	C	Wi
A	1.0000	0.7500	0.6667	0.2612
B	1.3333	1.0000	1.2500	0.3895
C	1.5000	0.8000	1.0000	0.3493

19. Data related to the anti-interference capability of the scheme layer (see Table 29)

The consistency ratio of anti-interference ability: 0.0124; The weight of "page-turning pen" : 0.0526; Lambda Max: 3.0129

Table 29 Relevant Data of the Anti-interference Capability of the Scheme Layer

Anti-jamming capability	A	B	C	Wi
A	1.0000	0.7500	0.8000	0.2773
B	1.3333	1.0000	1.5000	0.4135
C	1.2500	0.6667	1.0000	0.3092

20. Data related to battery life of the solution layer (Table 30)

Consistency ratio of battery life: 0.0124; The weight of "page-turning pen" : 0.1053; Lambda Max: 3.0129

Table 30 Relevant Data of Battery Life on the Solution Layer

Battery life	A	B	C	Wi
A	1.0000	0.7500	0.6667	0.2612
B	1.3333	1.0000	1.2500	0.3895
C	1.5000	0.8000	1.0000	0.3493

21. Data related to the convenience of charging mode at the solution layer (Table 31)

Consistency ratio of convenience of charging mode: 0.0124; The weight of "page-turning pen" : 0.0526; Lambda Max: 3.0129

Table 31 Data Related to the Convenience of Charging Mode in the Scheme Layer

Convenience of charging mode	A	B	C	Wi
A	1.0000	0.7500	0.8000	0.2773
B	1.3333	1.0000	1.5000	0.4135
C	1.2500	0.6667	1.0000	0.3092

5.2 Analysis Results

According to the comprehensive weight, the importance of each indicator to the overall evaluation of the product or equipment can be seen. The comprehensive weight of signal connection stability and battery life is higher, indicating that they are more important in the overall evaluation, while the comprehensive weight of multimedia control function, conference room use, business performance, etc. is relatively low.

In practical applications, these weights can be used to focus on and improve the indicators with higher weights, so as to improve the overall performance of products or equipment and user satisfaction. At the same time, some indicators can also be considered according to specific usage needs and scenarios. For example, if it is mainly used for classroom teaching, then the importance of classroom teaching is relatively higher. If more attention is paid to the convenience of operation, it is necessary to pay special attention to related indicators such as the rationality of button layout, hand-held comfort, and operation response speed. This part of the analysis refers to the thinking of multi-criteria decision analysis and relevant research conclusions [12, 13].

5.3 Sensitivity Analysis

5.3.1 Spirit Jump Page Turning Pen

Spirit Jump page turning pen: "Spirit" stands for flexible and sensitive, reflecting the characteristics of convenient operation and rapid response of this page turning pen, which can flexibly respond to various use scenarios. "Yue" gives people a dynamic and positive feeling, symbolizing the functional practicability of the product, which can bring vitality and efficiency to the user's demonstration.

In terms of functional practicality, the page-turning function effect is smooth and natural, the laser indication precision is high, the black screen/white screen function can be accurately pointed to the key content, the black screen/white screen function is fast and stable, and the multimedia control function is also convenient. In terms of adaptability to the use of scenarios, it performs well in the use of conference rooms, and the signal connection is stable, which can meet the basic needs of conference presentation; In the classroom teaching, the operation convenience is reflected, the button layout is reasonable, the handheld comfort is high, and the teacher is convenient to use for a long time; in the personal demonstration, its function can basically meet the needs; in the commercial performance, it may need to further improve its adaptability in some special scenarios. In terms of operation convenience, the operation response speed is fast, the key layout is reasonable, the hand-held comfort is good, and the user can quickly get started and operate. In terms of technical stability, the signal connection stability is good, the anti-interference ability is strong, and it can maintain a stable working state in a complex environment. In terms of battery life and charging, the battery life is reasonable, can meet the needs of daily

use, and the charging method is more convenient, which will not bring too much trouble to users.

Thus, product A, "Lingyue Page-Turning Pen," has good operation convenience, a reasonable button layout, and high hand-held comfort, which is a good choice for students who need to regularly show in class and report in groups. It can help students show their learning results more confidently and improve learning efficiency. Secondly, for ordinary teachers in the classroom teaching scene, product A "Spiritual Jump Page Turning Pen" can meet the basic needs. Its page-turning function is smooth, and the laser instruction precision is high, which is convenient for teachers to explain teaching and highlight in class. Moreover, the price of the product is relatively close to the people, which is suitable for schools or teachers to purchase and use.

In addition, for business office workers, when using in the conference room, the signal connection of product A "Spiritual Jump Page Turning Pen" has good stability, which can ensure the smooth progress of the demonstration process. For some business office people who often need to present meetings, product A "Spirit Jump Page Turning Pen" is a practical tool that can improve the efficiency of meetings and display effects.

5.3.2 Smooth Page Turning Pen

Changyi page-turning pen: "Changyi" has the meaning of smooth and carefree, reflecting the fluency and stability of the page-turning pen in the use process, whether it is the page-turning function or other functions, can let users feel the smooth and unimpeded operation experience. "Yi" conveys a feeling of comfort and ease, suggesting that the handheld comfort of the product is high and easy to use.

Function Practicability: the function performance is balanced; the page-turning function and multimedia control function are slightly prominent. Laser indication accuracy is good; the black-screen/white-screen function can also be used normally. In different use scenarios, it can be better adapted to. When the meeting room is used, it can play its function stably. In classroom teaching, operation convenience is higher and favored by teachers; in a personal demonstration, it can meet the individual needs of users. When performing, it can be further optimized according to the specific situation. In terms of operation convenience, hand-held comfort is higher and operation response speed is faster, but the key layout may need to be further improved to improve the user's operation efficiency. The technical stability is good, the signal connection is stable, and the anti-interference ability is strong, which ensures the reliability of the product in the process of use. In terms of battery life and charging, the battery has strong battery life, which can meet the needs of long-term use, and the charging method is convenient, which provides convenience for users.

Thus, for training instructors usually need to teach in different venues, the adaptability of the use of the page-turning pen is high. Then product B, "Changyi Page Turning Pen," performs well in this respect, can adapt to meeting rooms, classrooms, and other scenarios, has convenient operation, and has practical function. At the same time, it has strong battery life and convenient charging mode, which can meet the needs of training instructors for a long time. For small and medium-sized business owners in the business demonstration, product introduction, and other activities, they need a simple operation and stable function of the page-turning pen. Similarly, the ease of operation and technical stability of product B, "Changyi Page Turning Pen," can meet their needs and help them better display their corporate image and product advantages. For another example, freelancers such as consultants, designers, etc., often use the page-turning pen when communicating with clients and presenting their solutions. The balanced performance and good cost performance of product B, "Smooth Page Turning Pen," make it a choice for freelancers. It is able to meet basic presentation needs without placing too high a financial burden on users.

5.3.3 Excellent Page Turning Master

Excellent page turning Master: "Excellent" means very good, beyond average, highlighting the excellent performance of this page-turning pen in all aspects. It is not only powerful and practical, but also easy to operate and stable technology, which can meet the needs of professional users and high-end users. The word "master" gives the product a professional and authoritative image, making people feel that using this page-turning pen can control the whole audience like a master and improve the presentation effect.

Functional practicability is strong, especially in the multimedia control function, which is excellent; the

page-turning function is also very good; the laser-indicating precision is high; and the black-and-white screen function is stable and reliable. The use of a wide range of scenarios, whether it is a conference room, classroom, personal demonstration, or business performance, can be well adapted to various needs. In meeting rooms and business performance, its powerful function and stability can meet the requirements of professional users; in classroom teaching and personal demonstrations, the ease of operation and user experience have also been well reflected. In terms of operation convenience, the operation response speed is fast, the hand-held comfort is high, the key layout is reasonable, and the user can operate easily. Excellent technical stability, high signal connection stability, and strong anti-interference ability can work normally in a variety of complex environments. In terms of battery life and charging, the battery life is outstanding, which can meet the needs of long-term high-intensity use, and the charging method is convenient, providing users with a better use experience.

Thus, in the face of the professional speaker's higher requirements for the page-turning pen, it needs to have powerful functions and excellent performance. Product C, "Excellent page turning master," should be delivered; its functional practicability is very strong, especially the multimedia control function, which is excellent and can meet the professional speaker's demonstration process of a variety of complex operation needs. At the same time, its technical stability is excellent; to ensure that there will be no failure on important speech occasions. For executives of large enterprises, they need to use high-quality tools to show the strength and image of their enterprises when carrying out important meetings, business negotiations, and other activities. The excellent performance and high-end design of Product C "Excellent Page Turning Master" meet their needs and can enhance the professionalism and authority of the presentation. For researchers, when conducting activities such as academic reports and project reports, a large amount of data needs to be displayed and explained. The ease of operation and functional practicability of product C, "Excellent Page Turning Master," can help them to present more efficiently and improve work efficiency. At the same time, its excellent battery life can also meet the needs of researchers for long-term use.

Thus, through the sensitivity analysis of the influence of factors on decision-making objectives, the functional strengths of different schemes are different and inconsistent, and different preferred schemes are produced for different users (Table 32).

Table 32 Ranking Weights of Factors on Decision Objectives in the Scheme Layer

Alternatives	Weights
Product B "Smooth Turning Pen"	0.3853
Product C "Excellent Page Turning Master"	0.3435
Product A "Spirit Leap Page Turning Pen"	0.2711

VI. CONCLUSION

This paper first determines the index system for evaluating the new wireless mouse page-turning laser pointer, including functional practicality, application scenario adaptability, operation convenience, technical stability, battery life, and charging, and explains each index in detail. Also through the construction of a hierarchical structure model, the target layer, criterion layer, and scheme layer organic combination to provide a clear framework for the evaluation, and then by calculating the maximum eigenvalue of the judgment matrix and its corresponding eigenvector to obtain the weight of each level of factors for the target of the previous layer, and finally synthesize the bottom factor relative to the total target weight ranking. Finally, according to the calculation results, the comprehensive weights of signal connection stability and battery life are higher, indicating that they are more important in the overall evaluation. But the comprehensive weights of multimedia control function, conference room use, and business performance are relatively low.

Through the comprehensive evaluation of the new wireless mouse page-turning laser pointer, the different design schemes have different performance in various indicators and have their own characteristics. Among them, "Excellent Page Turning Master" stands out with its powerful functional practicability, wide application scenario adaptability, and excellent technical stability, especially suitable for professional speakers, large enterprise executives and researchers, and other high-end user groups. In contrast, the "Lingyue page-turning pen"

has a high acceptance among students and ordinary teachers by virtue of its user-friendly price and good cost performance, while the "Changyi page-turning pen" has become an ideal choice for training instructors, small and medium-sized business owners, and freelancers due to its balanced performance.

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