Academic Journal of Business & Management

ISSN 2616-5902 Vol. 1, Issue 1: 54-62, DOI: 10.25236/AJBM.190109

Analysis of the Online Shopping Software Selection Based on Analytic Hierarchy Process

------Take Tao Bao and Jing Dong as an example

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ABSTRACT: *The arrival of the network economy era has promoted the rapid development of e-commerce. Online shopping has become a normal phenomenon in human life. Since then, online shopping software has emerged in endlessly, which has brought people difficulties in choosing. This paper establishes a hierarchical structure model and uses the analytic hierarchy process to analyze the factors affecting the choice of consumer online shopping software. It draws the conclusion that there are differences between the choice of consumer online shopping software in real life and the choice of software through comprehensive data analysis and makes a brief analysis of the differences.*

KEYWORDS: *Online shopping software; Hierarchical model; Analytic hierarchy process*

1. The Current Situation of Online Shopping

After about 20 years of development and maturity, the e-commerce industry has entered a comprehensive and deep stage of development. With the introduction of a number of e-commerce support policies, the development of logistics and online payment supporting industries, and the rapid popularization of e-commerce websites and applications, more and more integrated and vertical e-commerce enterprises have begun to emerge, while traditional industries such as leisure food have also constantly involved in e-commerce mode. The scale of e-commerce model has been continuously improved, and its operation is becoming more and more standardized.

First, the scale of online shopping market is increasing. The rapid development of e-commerce drives the rebuilding of consumption pattern at the retail end, and the

ISSN 2616-5902 Vol. 1, Issue 1: 54-62, DOI: 10.25236/AJBM.190109

consumer habits of online shopping have gradually formed. According to the survey data statistics, the scale of online shopping users in China has been growing steadily from 2013 to 2016, with an annual composite growth rate of 17%, which is very rapid. In 2017, the number of online shopping users in China reached 540 million, more than 500 million in 2016. In 2018, the number of online shopping users in China exceeded 600 million.

Second, the proportion of mobile online shopping has increased. With the rapid popularization of mobile Internet and the gradual improvement of mobile payment means, e-commerce mode can provide users with convenient consumption experience without time and space constraints, further strengthen the penetration of social life services in various fields, and more closely integrate with daily consumption. As of December 2018, the number of online shopping users in China reached 610 million, an increase of 14.4% compared with the end of 2017, accounting for 73.6% of the total number of Internet users. The number of mobile Internet shopping users reached 592 million, an increase of 17.1% compared with the end of 2017, and the proportion of mobile Internet shopping users reached 72.5%.

Third, online shopping software promotes the growth of online shopping volume. At present, the development of e-commerce conforms to the trend of the times and greatly promotes economic growth. From the current situation of online shopping, we can see that online shopping mainly depends on mobile transactions, people can buy their own needs at any time through mobile devices. The demand for online shopping has brought the development of mobile phone online shopping software, so a variety of online shopping software on mobile phones emerge in an endless stream. In turn, the emergence of a variety of online shopping software has promoted the growth of online shopping volume.

With the routinization of mobile phone online shopping, the emergence of online shopping software has posed a difficult problem for consumers to choose online shopping. The quality and price of goods sold on various shopping software are different, which makes it more difficult for consumers to choose economical and affordable goods among many online shopping software. Therefore, in order to ensure that consumers can buy affordable goods, we must first choose the right shopping software.

2. The Selection Method of Online Shopping Software

2.1 The Analytic Hierarchy Process

American operations researcher Saaty put forward the famous Analytic Hierarchy Process (AHP) in the early 1970s. Analytic Hierarchy Process (AHP) is a decision-making method based on the decomposition of elements related to decision-making into objectives, criteria and schemes. This method has the advantages of system, flexibility and conciseness[1].

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2.2 Principles and Procedures of Analytic Hierarchy Process

To solve practical problems by using analytic hierarchy process (AHP) modeling, the following four steps can be taken in general.

Step 1: Establish hierarchical structure model.

When using AHP to analyze decision-making problems, we should first organize and hierarchize the problems and construct a hierarchical structure model. These levels can be divided into three categories: the highest level (target level), the middle level (criterion level), and the lowest level (scheme level). The number of layers in the hierarchical structure is related to the complexity of the problem and the degree of detail that needs to be analyzed. The number of layers is not limited. In general, no more than nine elements are dominant at each level[1].

Step 2: Construct all judgment matrices in each level

The proportion of each criterion in target measurement is not necessarily the same at the criterion level. In the minds of decision makers, each criterion has a certain proportion. The judgment matrix is defined by quoting numbers 1-9 and reciprocal as scales A=$(a_{ij})_{n\times n}$ (See Table 1) [1].

Table 1 Scaling Definition of Judgment Matrix

Scale	Meaning
1	It means that the two factors are of equal importance
3	The former is slightly more important than the latter
5	The former is more important than the latter
7	The former is strongly important than the latter
9	The former is extremely important than the latter
2,4,6,8	Represent the median value of the above adjacent judgments
Reciprocal	If the ratio of factor i to factor j is a_{ij}, then the ratio of factor j to factor i is a_{ji}=1/a_{ij}

Step 3 Hierarchical Single Sorting and Consistency Check

(1) Computational Consistency Index

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

Among them, λ_{max} is the maximum eigenvalue of the judgment matrix.

(2) Find consistency indicators RI (See Table 2) [1].

Table 2 Average Random Consistency Index

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

(3) Computational Consistency Ratio CR

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$$\mathrm{CR} = \frac{CI}{RI}$$

When CR < 0.10, the consistency of judgment matrix is acceptable. Otherwise, the judgment matrix should be corrected appropriately.

(4) Step 4 Hierarchical Total Sorting and Consistency Check

Finally, we need to get the ranking weight of each element, especially in the lowest level, so as to select the scheme. Consistency test is also needed for the hierarchical total ranking, which calculates the composite weights of the elements of each layer on the total objective of the system, and ranks the selected schemes[1].

2.3 Arithmetic Average Method of Weight Calculating Method

Since each column in Judgment A approximately reflects the distribution of weights, the arithmetic mean of all column vectors can be used to estimate the weights, which is expressed as follows.

$$W_i = \frac{1}{n}\sum_{j=1}^{n}\frac{a_{ij}}{\sum_{k=1}^{n} a_{kj}}, \qquad \text{i=1,2,……, n}$$

The calculation steps are as follows.

(1) The elements of a are normalized by column, that is $\frac{a_{ij}}{\sum_{k=1}^{n} a_{kj}}$.

(2) Add the normalized columns together.

(3) The weight vector is obtained by dividing the added vector by n.

3. The Choice of Online Shopping Software—Taking Tao Bao and Jing Dong as an Example

3.1 Comparison of Advantages and Disadvantages between Tao Bao and Jing Dong

Tao Bao and Jing Dong are two kinds of online shopping software with high recognition. Therefore, this paper only compares Tao Bao and Jing Dong, two representative shopping software.

First, commodity quality. Most of the goods in Jing Dong are self-owned goods with reliable quality; Tao Bao is operated by third parties with uneven quality and needs to be identified by the buyers themselves. Second, the speed of delivery. Most of the goods in Jing Dong are self-operated. Self-operated stores deliver goods quickly. Most cities can arrive the next day. A few are operated by third parties, and the delivery speed is relatively slow. Tao Bao commodities are all operated by third parties. The delivery speed is totally determined by the seller, and the delivery speed is uncertain. Third, commodity prices. Jing Dong commodities are brand-guaranteed.

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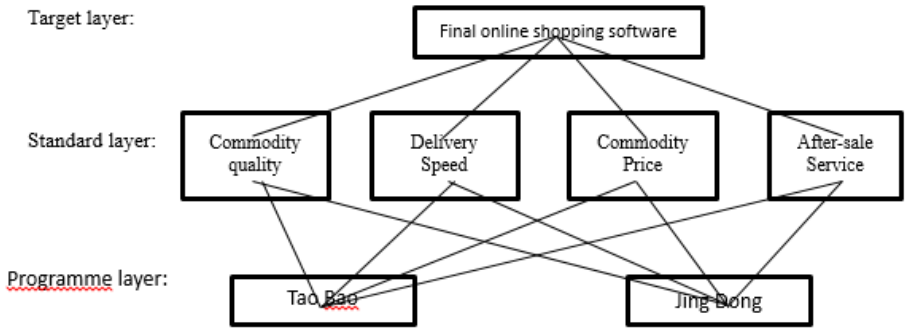
They are all genuine products, and their prices are slightly higher. Tao Bao belongs to a third-party business commodity, which has the risk of buying fake goods, but the price is relatively cheap. Fourth, after-sales service. Jing Dong has good after-sales service, strict implementation of the three national packages, and quick return and exchange of goods. After-sales service of Tao Bao commodities is uncertain, which depends entirely on third-party operators.

3.2 Establish Hierarchical Structure Diagram

According to the four factors that affect the choice of shopping software, the following hierarchical structure chart is established.



3.3 Weight Calculation

(1) The four factors of commodity quality, delivery speed, commodity price and after-sales service are expressed by x_1, x_2, x_3 and x_4 respectively. The four factors are compared in two ways.

Judgment of four comparative factors by consumers. x_1 is obviously more important than x_2; x_1 is slightly more important than x_3; x_1 is slightly more important than x_4; x_3 is slightly more important than x_2; x_4 is slightly more important than x_2; x_3 is slightly more important than x_4.

(2) Establish comparison matrix for calculation

Establish a comparison matrix.

$$\begin{vmatrix} & x_1 & x_2 & x_3 & x_4 \\ x_1 & 1 & 5 & 3 & 3 \\ x_2 & \frac{1}{5} & 1 & \frac{1}{3} & \frac{1}{3} \\ x_3 & \frac{1}{3} & 3 & 1 & 3 \\ x_4 & \frac{1}{3} & 3 & \frac{1}{3} & 1 \end{vmatrix}$$

Consistency test.

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$$A=\begin{vmatrix} 1 & 5 & 3 & 3 \\ \frac{1}{5} & 1 & \frac{1}{3} & \frac{1}{3} \\ \frac{1}{3} & 3 & 1 & 3 \\ \frac{1}{3} & 3 & \frac{1}{3} & 1 \end{vmatrix}$$

Column vectors are normalized as follows.

$$\begin{vmatrix} \frac{15}{28} & \frac{5}{12} & \frac{9}{14} & \frac{9}{22} \\ \frac{3}{28} & \frac{1}{12} & \frac{1}{14} & \frac{1}{22} \\ \frac{5}{28} & \frac{1}{4} & \frac{3}{14} & \frac{9}{22} \\ \frac{5}{28} & \frac{1}{4} & \frac{1}{14} & \frac{3}{22} \end{vmatrix}$$

Seek row sum and Normalization.

$$\begin{vmatrix} 0.5011 \\ 0.0768 \\ 0.2630 \\ 0.1591 \end{vmatrix}=W^{(2)}$$

$$AW=\begin{vmatrix} 2.1541 \\ 0.3177 \\ 1.1377 \\ 0.6442 \end{vmatrix}$$

$AW=\lambda W$

$\lambda=\frac{1}{4}\times\left(\frac{2.1541}{0.5011}+\frac{0.3177}{0.0768}+\frac{1.1377}{0.2630}+\frac{0.6442}{0.1591}\right)=4.20$

$CI=\frac{\lambda_{max}-n}{n-1}$ CI=0.067.

Table lookup 2 RI=0.89.

$CR=\frac{CI}{RI}=\frac{0.067}{0.89}=0.08<0.1$

Pass the consistency test.

The maximum eigenvalues of the four criteria were calculated and the consistency test was carried out.

Commodity quality: $A_1=\begin{vmatrix} 1 & \frac{1}{3} \\ 3 & 1 \end{vmatrix}$

Column vector normalization: $\begin{vmatrix} \frac{1}{4} & \frac{1}{4} \\ \frac{3}{4} & \frac{3}{4} \end{vmatrix}$

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Seek row sum and Normalization: $\begin{vmatrix}\frac{1}{4}\\ \frac{3}{4}\end{vmatrix}=W_1$

$A_1W_1=\begin{vmatrix}\frac{1}{2}\\ \frac{3}{2}\end{vmatrix}$

$A_1W_1=\lambda_1W_1$

$\lambda_1=\frac{1}{2}\times\left(\frac{\frac{1}{2}}{\frac{1}{4}}+\frac{\frac{3}{2}}{\frac{3}{4}}\right)=2$

$CI=\frac{\lambda_{max}-n}{n-1}$

CI=（2-2）/（2-1）=0

Pass the consistency test.

Delivery speed: $A_2=\begin{vmatrix}1 & \frac{1}{5}\\ 5 & 1\end{vmatrix}$

Commodity prices: $A_3=\begin{vmatrix}1 & 3\\ \frac{1}{3} & 1\end{vmatrix}$

After-sale service: $A_4=\begin{vmatrix}1 & \frac{1}{3}\\ 3 & 1\end{vmatrix}$

$W_2=\begin{vmatrix}\frac{1}{6}\\ \frac{5}{6}\end{vmatrix}$ $W_3=\begin{vmatrix}\frac{3}{4}\\ \frac{1}{4}\end{vmatrix}$ $W_4=\begin{vmatrix}\frac{1}{4}\\ \frac{3}{4}\end{vmatrix}$

Similarly, the delivery speed, commodity price and after-sale service are calculated separately. $\lambda_2=2$, $\lambda_3=2$, $\lambda_4=2$.

Pass the consistency test.

Calculate the weights of Tao Bao and Jing Dong.

$$W^{(3)}=\begin{vmatrix}\frac{1}{4} & \frac{1}{6} & \frac{3}{4} & \frac{1}{4}\\ \frac{3}{4} & \frac{5}{6} & \frac{1}{4} & \frac{3}{4}\end{vmatrix}$$

$$W=W^{(3)}W^{(2)}=\begin{vmatrix}\frac{1}{4} & \frac{1}{6} & \frac{3}{4} & \frac{1}{4}\\ \frac{3}{4} & \frac{5}{6} & \frac{1}{4} & \frac{3}{4}\end{vmatrix}\begin{vmatrix}0.5011\\ 0.0768\\ 0.2630\\ 0.1591\end{vmatrix}=\begin{vmatrix}0.3751\\ 0.6249\end{vmatrix}$$

So by calculating the weight of Tao Bao is 0.3751, and that of Jing Dong is 0.6249.

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4. Conclusion

Through the comprehensive calculation of the indicators involved in the selection of shopping software in the above model, the result shows that the selection of Jing Dong is better than Tao Bao under the comprehensive conditions. But this is not the case in real life. In actual online shopping, Tao Bao is still used more than Jing Dong. The reasons are as follows.

First, the range of commodities is different. Tao Bao sells a wide range of goods, only you cannot imagine, not you cannot buy; while Jing Dong commodities are mainly electronic products, other daily necessities are also involved, but the types of goods are still less than Tao Bao. Now people's main way of choosing goods has gradually changed from shopping malls to shopping online stores as part of their recreational life. Browse does not necessarily need to buy, the main interest is in "browse", lies in whether you can find cheap and high-quality goods in many different prices of the same kind of goods, and Tao Bao coincides with the current people's online shopping habits, Tao Bao focuses on "choosing". From the perspective of Chinese traditional culture, people subconsciously have the idea of "not afraid of not knowing goods, but afraid of comparing goods with goods". Therefore, Tao Bao has Chinese traditional color. The shopping process in Jing Dong is simple, efficient and time-saving, but the price is slightly higher. For most consumers who like comparison, the attraction is slightly lower than Tao Bao.

Second, shopping habits also have potential effects. Tao Bao was officially launched to the public in 2003, while Jing Dong was officially launched online in 2004. When Tao Bao appeared in 2003, people were still curious about this new thing, and began to try online shopping. Then it became irremediable, forming an online shopping boom. A year later, Jing Dong came out, but at this time most consumers have become accustomed to using Tao Bao online shopping. Their curiosity about online shopping has passed, and their attention to Jing Dong is slightly lower than Tao Bao. But many people still compare the two and choose the best one.

Third, there are differences in the ways of making profits. Jing Dong is a B2C model, Tao Bao is a C2C model, simply speaking, Jing Dong model is a business to customers, basically selling their own things, so it is more secure. Tao Bao model is a customer to customers, each shop is different, some may be agents, some are selling their own things, in terms of quality assurance is weak. Tao Bao is mainly profitable by website advertisements, as well as providing special services to special members, etc. It is not profitable by selling goods, so Tao Bao can depress the prices of merchants. Most of the Jing Dong Mall is directly operated, and most of the goods are their own. The price cannot be too low, which leads to higher prices than Tao Bao.

Because of the above reasons, most people still choose Tao Bao with lower price in real life. However, with the continuous development of social economy, people's living standards are constantly improving. Now there is a trend that people pay more attention to the quality of goods and after-sales service. Price is no longer so

ISSN 2616-5902 Vol. 1, Issue 1: 54-62, DOI: 10.25236/AJBM.190109

important, and the number of people who choose Jing Dong shopping will continue to increase. But in general, Tao Bao and Jing Dong still have their own advantages. Consumers should make rational choices according to their own needs when shopping online.

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