

The influence of e-commerce algorithms on Consumers' behaviour

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Abstract. With the development of the Internet and data analysis technology, the e-commerce platform continues to optimise the e-commerce algorithm system, improve consumers' online shopping experience and willingness, reduce the time cost of consumers' retrieval of commodity information, achieve accurate marketing, and increase sales. Therefore, it is of great significance to understand the functions and characteristics of the algorithm and how does it affects consumers' shopping decisions. Based on collating relevant literature on consumer decision-making, online shopping behaviour, and algorithm recommendation system, a process model of an algorithm system affecting shopping decisions is constructed. Conduct a questionnaire survey to analyse the impact of the algorithm system on shopping decisions through a series of data. The following conclusions are drawn: The influence of the algorithm system is inevitable and strong, but it still needs to be improved, such as improving the accuracy of product recommendations. In addition, the development of an algorithm recommendation system is optimistic.

Keywords: e-commerce; algorithms; consumers' behaviour.

1. Introduction

This dissertation focuses on the impact of algorithm systems on shopping decisions, specifically analysing the factors that affect consumption and consumption decisions, online shopping behaviours and processes, e-commerce algorithms and their functions, and the relationship between algorithmic systems and online shopping behaviours and shopping decisions.

An algorithm is a set of instructions for solving a problem or accomplishing a task (Lucas Downey, 2022)^[1]. The algorithm of e-commerce is an tool for providing users with product recommendation services. It is a working system that consists of several parts working together to complete the service of recommending products. This working system is called an algorithm system, or algorithm recommendation system.

Above all, this paper collates and studies relevant literature including consumer decision-making, online shopping behaviour, and algorithm systems. It lays a foundation for in-depth research on the relationship between algorithm systems and shopping decisions.

In the second place, the relationship between the algorithm system and online shopping behaviour and process is analysed, and a flowchart of the impact of an algorithm system on shopping decisions is summarized. After that, a questionnaire was designed to investigate the impact of algorithm systems on shopping behaviour and decision-making.

Finally, summarize the research conclusions are summarized. Including explaining the impact of the algorithm system on shopping behaviour, the role and extent of the algorithm system on shopping decision-making, and puts forward corresponding suggestions for the improvement of the algorithm system.

2. Research review

2.1. What is customers' consumption?

'Consumption' is 'an economic behaviour of human beings to satisfy their own desires through customer goods' (Li, 2013)^[2]. Consumption can also be understood as the customers' behaviour from a psychological perspective. In this sense, it is the external manifestation of the customer's psychology.

For customers, consumption means buying things with money. For enterprises, it is to satisfy customers' desire to buy, or stimulate the desire to buy, and sell goods. To understand consumption, it is very important to understand the causes of customer demand, the way customers meet their own customer demand, and the factors that affect customer choice.

2.2. The three factors that affect consumption decisions

There are many studies that focus on purchasing decisions, mostly discussing personal traits and psychological factors, social and cultural factors, and corporate marketing factors.

Philip Kotler and Kevin Lane Keller (2014) proposed a simple decision-making model that believes that consumer behavior is influenced by two factors: marketing stimuli and external environmental stimuli. Consumers with different cultural, psychological, and other characteristics will make different purchasing decisions.^[3]

Howard and Sheth (1969) believe that internal factors, external factors, output or outcomes, stimulus or input factors can affect consumption decisions. External factors include: financial condition, time pressure, personality, and culture; Internal factors include perception and learning; Stimulation or investment factors include stimulation from products, marketing, and social stimulation from families, relevant groups, and social classes.^[4]

The second class of factors are the *psychological factors*, mainly including: *feeling, motivation, experience, attitude, and personality*. Feeling refers to the idea that different people who look at the same item in different ways come to different conclusions. Motivation refers to the internal capacity to motivate a person's actions toward a certain goal. Experience includes changes in one's behaviour as a result of information and experiences. Attitudes consist of knowledge and positive and negative feelings about goals. Personality refers to the fact that people differ in personalities. Some personalities are not necessarily eye-catching, but everyone has them. (Xu, 2003)

The third factor is *social influences*. Social influences include *roles and families, relevant groups, social class and culture*. Roles refer to: each of us occupies a certain position in organizations, institutions or groups, and has a role associated with each position. Family roles are closely related to shopping decisions. The relevant group refers to the recognition of the group by the individual, and the adoption and acceptance of the values, attitudes and behaviours of the group members. A social class is an open group of people of similar social status. Culture refers to the sum of material and spiritual wealth created by human beings and is the crystallization of human labour. (Xu, 2003)

2.3. Online shopping and customer behaviour

2.3.1 What's online shopping?

The organisation for Economic Cooperation and Development defines e-commerce as commercial transactions occurring over open networks, such as the Internet. Both business-to-business and business-to-consumer transactions are included. (OECD,1998)

Business-to-customer (B2C) e-commerce is the buying and selling activities carried out by the demander and the supplier on the virtual market constructed by the network. It can be defined as 'the process of selling products and services directly between a business and consumers who are the end-users of its products or services.' (Will, 2023)^[5]

B2C encompasses electronic sale business for enterprises and online shopping for customers. Online shopping is the behaviour of customers to purchase goods through the Internet, which is the typical purchase behaviour on the Internet.

2.3.2 The process of online shopping

The online purchase process proposed in<UNCTAD B2C E-COMMERCE INDEX 2016>is as follows: (Torbjorn Fredriksson, 2016)^[6]

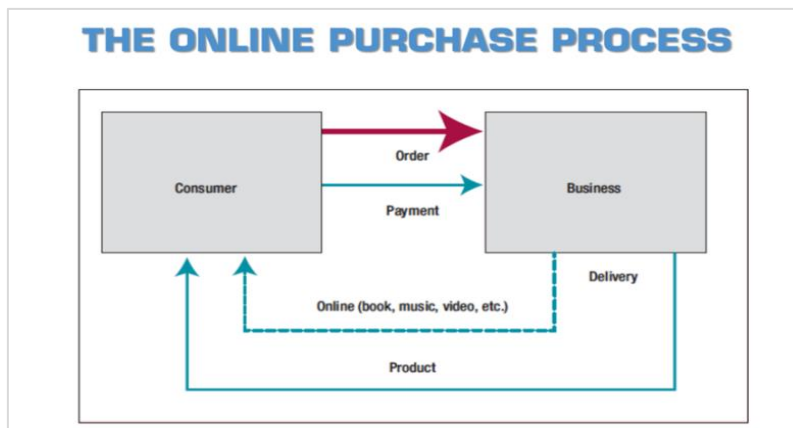


Figure 1: The online purchase process (Source: Torbjorn Fredriksson)

The basic process of online shopping generally includes prepurchase preparation, purchase, and an after-sales stage.

Specifically, it includes several links such as customer browsing commodity information, selecting commodities, confirming purchases, paying for goods, selecting logistics and distribution, and after-sales service.

2.4. What is an e-commerce algorithm?

There is no uniform definition of an e-commerce algorithm. The common view is that e-commerce algorithms provide personalised product recommendations to users (Sinha, Srivastava, 2021)^[7].

Each customer will leave a variety of ‘activity traces’ when purchasing things online. Web-sites or shops use algorithm system to create a unique profile for each customer to continuously record their shopping process, analyse their personal preferences, and automatically recommend products to customers based on this information. (Ren, 2021)^[8]

3. Discussion / Development

3.1. The Model of algorithm system Influencing shopping behaviour

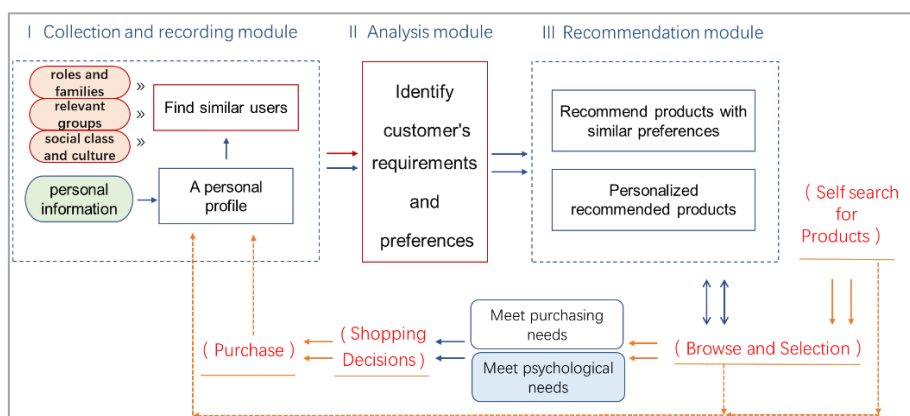


Figure 2: The Model of algorithm system Influencing shopping behaviour (Source: Author self-drawn)

This model can help observe the impact and role of algorithmic systems on shopping decisions. The factors in the model mainly come from two aspects: the three working modules of the algorithm system, and the online shopping process.

The working process of the algorithm system is completed through three modules: collection and recording module, analysis module, and recommendation module. (Wang Liping, Wang Quanquan, 2020) The main task of the collection and recording module is to collect user information, including basic customer information, browsing and purchasing records, and determine similar groups based

on this. The work of the analysis module is to match products with corresponding categories and features through a series of computational logic. The job of the recommendation module is to filter and select candidate products, and present the final recommended products.

The online shopping process mainly includes finding products, browsing and selecting products, purchasing and paying. The final step is to reach a shopping decision.

3.2. Theoretical Considerations

3.2.1 The action process of algorithm system on shopping behavior

Module 1, a collection and recording module for collecting user information, recording basic information and purchasing behavior of customers, and extracting behavioral and attribute data to determine similar groups. Module 2, analysis module, inferring customer shopping preferences and needs, and matching candidate products. Module 3, recommendation module, filters and selects products based on inferred preferences and needs, and adjusts and recommends products based on real-time browsing data from customers.

Specifically, the algorithm recommendation system generates personal profiles for each user based on their personal information, analyses and infers their shopping needs based on this information, and recommends products to customers. In addition, search for similar user groups and recommend products to customers based on their consumption preferences. After browsing and selecting recommended products, users find products that can meet their purchasing and psychological needs, and then make a shopping decision, ultimately completing the purchase.

3.2.2 Analysis of the function of algorithm system

In an ideal world, people would always make optimal decisions that provide them with the greatest benefit and satisfaction. In economics, rational choice theory states that when humans are presented with various options under the conditions of scarcity, they would choose the option that maximizes their individual satisfaction.(WILL KENTON 2023)^[9] It seems that if we are completely rational, we will make the optimal consumption decision ourselves, algorithm does not need to exist.

But the fact is that in the environment of online shopping, facing massive product information, people do not make choices under " the conditions of scarcity ". Moreover, people cannot achieve complete rationality, because we often take shortcuts in our decision-making, we are affected by things like social influences and external factors, as shown in the following image, random factors, psychological factors, and social factors all affect our shopping decisions:

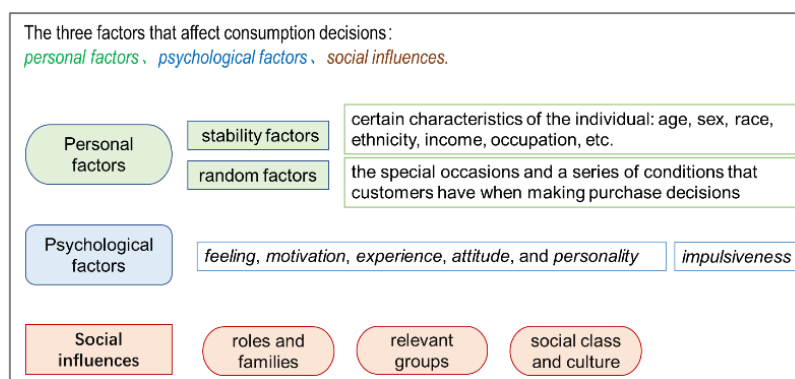


Figure3: The three factors that affect consumption decisions (Source: Author self-drawn)

For the work of e-commerce algorithm system. Among these factors, personal information in the stability factor is the foundation of the user's personal profile. The occupational and family roles in social factors are powerful references for finding similar groups. Psychological factors are important throughout the entire shopping process, and algorithmic recommendation systems recommend products that meet the individual characteristics of consumers by inferring their needs and motivations. Only products that meet the psychological needs of users will lead to the realization of consumption.

The algorithm has considered what we want and need, and also has filter out things that may persuade us to purchase, so it helps us make those shortcuts in our decision-making: it shows us a product and makes us think it's a good product to buy, it's a product we need, it influences our choice to busy accepting that product.

The influence of algorithm comes from how effective they can be and to what extent consumers can accept them. First of all, the impact of algorithm recommendations on consumer purchasing decisions is inevitable. From searching for products, browsing information, comparing and selecting, to determining purchase intention and final payment, there is an algorithm recommendation system at every step.

However, the effectiveness of algorithmic systems may also fail. For a product that consumers once wanted to purchase, they may have already bought or do not want to buy, but the algorithm system may still provide relevant recommendations because psychological needs are not reflected in the shopping behavior of browsing or selecting products, and the recording module of the algorithm system cannot capture relevant information, resulting in inaccurate recommended products.

4. Empirical Evidence

4.1. Basic characteristics of respondents

The demographic characteristics of the survey questionnaire are as follows: in terms of gender, there are 122 males, accounting for 41.08%; There are 174 women, accounting for 58.59%. In terms of age, there are 17 people under the age of 18, accounting for 5.72%; 121 people aged 19-30, accounting for 40.74%; 78 people aged 31 to 45, accounting for 26.26%; There are 80 people aged 46 and above, accounting for 26.94%.

4.2. Respondents' consumption attitudes and preferences

(1) The advantages of online shopping

Table 1: What attracts you to online shopping?

options	Subtotal	Proportion
Convenient and quick to save time	233	78.45%
Complete range of products	200	67.34%
Unlimited shopping time	189	63.64%
low price	168	56.57%
Easier to compare similar products	155	52.19%
Some products are hard to find in physical stores	127	42.76%
Novel way of shopping	82	27.61%
other	6	2.02%

Among the advantages of online shopping, 'convenient and quick to save time' has the highest number of votes, which reflects the basic function of the algorithm: filter through mass product information to saving time. Another time related option-'Unlimited shopping time', received the third highest number of votes, indicating that for Chinese consumers, the biggest attraction of online shopping comes from the time factor. The practicality and convenience functions of the algorithm are effective.

(2) The select preference in the product finding stage

Consumers are more likely to look up goods themselves on e-commerce platforms or shopping sites, it is the highest vote getter with 71.72%. Second and third are 'friends' recommendations' and 'algorithm system's recommendations', which have about the same impact on the product discovery segment, with 52.86% and 51.85% respectively.

This reflects the limited influence of algorithm recommendations, as consumers are more willing to trust their own and friends' recommendations. In a virtual shopping environment, more practical and physical things are more likely to generate trust. The algorithm system needs to be combined with offline communities to play a greater role.

Table 2: How do you usually search/discover products?

options	Subtotal	Proportion
Search queries on shopping sites/e-commerce platforms	213	71.72%
recommended by friends	157	52.86%
Product recommendation on shopping websites/e-commerce platforms	154	51.85%
blogger planting grass	99	33.33%
through advertising	58	19.53%
other	11	3.7%
(null)	2	0.67%

(3) The attitude towards personalized recommendations

The following data shows that most consumers can see the products they want to buy in the recommendation. There are 64.31% of respondents select that 'sometimes I need to buy', 23.91% of respondents select that 'basically all I want to buy'.

Table 3: Are the products recommended to you by shopping websites/e-commerce platforms often what you need?

options	Subtotal	Proportion
Yes, basically all I want to buy	71	23.91%
Sometimes I need to buy	191	64.31%
often not	34	11.45%
(null)	1	0.34%

Of course, this number still needs to be further improved, and algorithm recommendations need to be more accurate in determining consumers' interests and needs. This is also illustrated by the data below, which shows that the likelihood of being attracted to a personalised recommendation when there is no need to shop is low.

Table 4: According to your purchase experience, have you ever been attracted by the products recommended by the website/platform when you have no shopping needs?

options	Subtotal	Proportion
yes, often	64	21.55%
yes, sometimes	94	31.65%
yes, occasionally	106	35.69%
there has never been	31	10.44%
(null)	2	0.67%

1) Age and acceptant attitude

Firstly, according to research data, there is a clear trend: as age increases, the number of consumers who choose 'do not accept' gradually decreases, while the number of choosing 'casual' gradually increases. It can be seen that the attitudes are no longer so scattered, and more people have shifted from a positive attitude to a casual attitude.

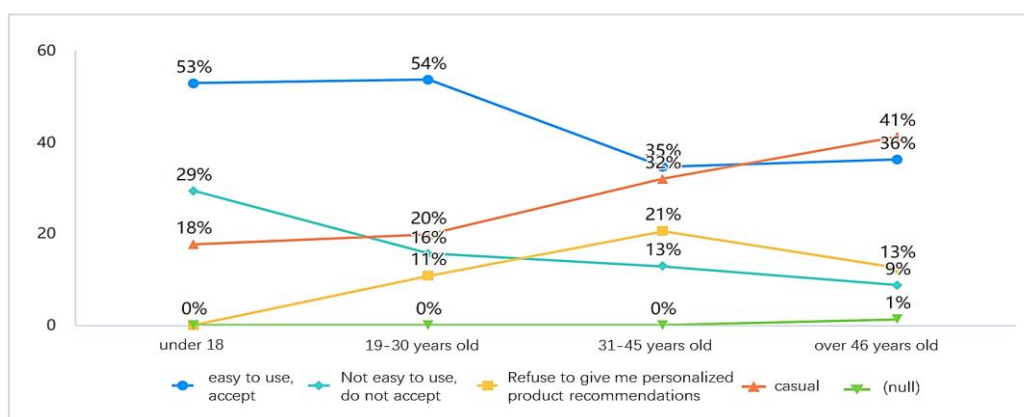


Figure 4: The attitude of algorithm recommendation in different age groups (Source: Author self-drawn)

In addition, if ‘casual’ is considered as passive acceptance, both ‘acceptance’ and ‘casual’ are positive data for algorithm recommendation system, while ‘non acceptance’ and ‘rejection’ are negative data. The two sets of data in the four age groups are: 71%, 74%, 67%, 78%, and 30%, 26%, 33%, 21%, indicating that consumers’ acceptance and non-acceptance of algorithm recommendation system are not significantly affected by age.

Table 5: Age and attitude of algorithm recommendation

Age \ Attitude	accept	do not accept	refuse	casual	(null)	Subtotal
under 18	9(52.94%)	5(29.41%)	0(0.00%)	3(17.65%)	0(0.00%)	17
19-30 years old	65(53.72%)	19(15.70%)	13(10.74%)	24(19.83%)	0(0.00%)	121
31-45 years old	27(34.62%)	10(12.82%)	16(20.51%)	25(32.05%)	0(0.00%)	78
over 46 years old	29(36.25%)	7(8.75%)	10(12.5%)	33(41.25%)	1(1.25%)	80

2) Gender and acceptant attitude

The following group of data shows that compared to men, women are more accepting of personalized product recommendations. 48.85% of female consumers felt 'easy to use and accepted', while 36% of male consumers' chose 'accepted'. The number of votes clearly expressing 'do not accept' or even 'refuse' is higher among men than among women.

Table 6: Gender and attitude of algorithm recommendation

Gender \ Attitude	accept	do not accept	refuse	casual	(null)	Subtotal
men	44(36.07%)	26(21.31%)	18(14.75%)	34(27.87%)	0(0.00%)	122
women	85(48.85%)	15(8.62%)	22(12.64%)	51(29.31%)	1(0.57%)	174

This indicates that women have a higher preference for personalized product recommendations, the algorithm has a greater impact on female consumers.

4.3. The impact of e-commerce algorithms on respondents' purchasing decisions

(1) Age and influence of algorithm recommendation system

In terms of age, the influence of algorithm recommendation system on shopping tends to weaken as the age increases. As can be seen from the following data, when there is no demand for shopping, the consumption often due to platform recommendation decreases significantly with age. ‘Sometimes consumption due to platform recommendation’ increases with age, while ‘never’ consumption due to platform recommendation increase with age. It can be seen that the older you are, the more rational you are.

Table 7: The frequency of consumption generated by products recommended by algorithms when there is no need for shopping in different age groups

Age \ Frequency	Yes, often	Yes, sometimes	Yes, occasional	Never	(null)	subtotal
under 18	5(29.41%)	4(23.53%)	6(35.29%)	1(5.88%)	1(5.88%)	17
19-30 years old	33(27.27%)	36(29.75%)	42(34.71%)	10(8.26%)	0(0.00%)	121
31-45 years old	15(19.23%)	25(32.05%)	30(38.46%)	8(10.26%)	0(0.00%)	78
over 46 years old	10(12.5%)	29(36.25%)	28(35%)	12(15%)	1(1.25%)	80

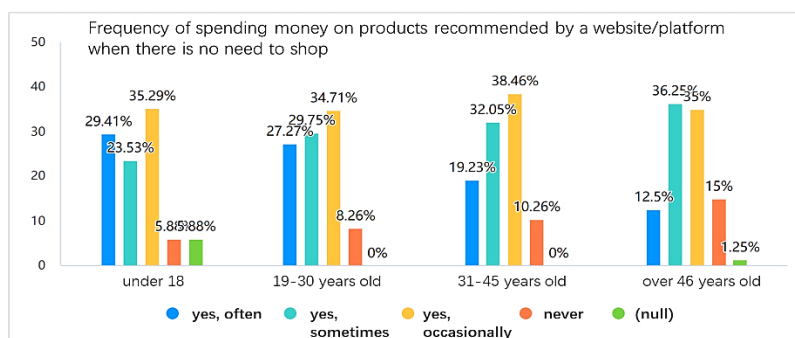


Figure 5: The frequency of consumption generated by products recommended by algorithms when there is no need for shopping in different age groups (Source: Author self-drawn)

(2) Consumer’s perception and the influence of algorithm recommendation system

From the frequency data of purchasing personalized recommendation products, it can be seen that consumers who know the algorithm recommendation function use the personalized recommendation function more. The algorithm system has greater influence on consumers who know it.

Table 8: Frequency of purchasing recommended items with or without knowledge of recommendation algorithm

Know or not \ Frequency	often	sometimes	Occasionally	never	(null)	Subtotal
Know	79(41.80% c)	62(32.80%)	44(23.28%)	3(1.59%)	1(0.53%)	189
Have no idea	21(19.63%)	53(49.53%)	32(29.91%)	1(0.93%)	0(0.00%)	107

The following data also illustrates this point. Compared with consumers who know the algorithm recommendation function and those who do not, consumers who know it are more willing to pay attention to personalized recommended products. The more understanding, the greater the likelihood of using it.

Table 9: The preference of finding product with or without knowledge of recommendation algorithm

Know or not \ preference	More inclined to pay attention to the products recommended by the website/platform	Products that are more inclined to self-search	almost	Subtotal
Know	46 (24.34%)	124 (65.61%)	19 (10.05%)	189
have no idea	18 (16.82%)	77 (71.96%)	12 (11.21%)	107

However, regardless of whether they are aware of this feature or not, consumers have shown a greater willingness to ‘self-search’, indicating that the role of algorithm recommendations is still great room for development.

(3) Consumer's judgment on the influence of algorithm recommendations

From the feelings of consumers participating in the questionnaire survey, algorithm recommendation has a significant impact on shopping decisions. 45.45% of consumers with an impact score of more than 7 points and a total of 83.5% of people rated their influence at least 4 points.

Table 10: How much impact do you think the personalized product recommendation of the e-commerce platform has had on your shopping decision?

options	Subtotal	Proportion
10 points (full impact)	20	6.73%
7-9 points (greater impact)	115	38.72%
4-6 points (average influence)	113	38.05%
1-3 points (with minor impact)	43	14.48%
0 points (no impact at all)	5	1.68%
(null)	1	0.34%

5. Discussion and Summary

5.1. The functional design of the algorithm recommendation system is effective

Among the reasons why consumers are willing to choose online shopping, the most important one is convenience and quick to save time, which show that the filtering function of the algorithm recommendation system is effective: it helps save time, makes consumers feel convenient, and thus increases consumption.

5.2. Accuracy of personalized recommendation algorithm

The accuracy of product recommendation in the algorithm system is not high enough to accurately determine consumers' interests and needs.

5.3. The influence of algorithm recommendations is limited

In the product finding stage, the influence of the personalized recommendation function of the algorithm ranks after ‘self-search’, and its degree of influence is almost the same as ‘friends’ recommendation’. Moreover, whether or not they have know the algorithm recommendation function, consumers still prefer to search products by themselves.

However, the data also shows that the more consumers know this function, the more likely they are to be willing to use it, and the greater its impact. Therefore, we can look forward to the improvement and development of algorithm recommendation systems.

6. Conclusion

6.1. Algorithm system works at every stage of online shopping

The general process of online shopping can be summarized as follows: discovering goods - browsing and selecting goods - determining purchase (i.e., achieving a shopping decision) - placing an order for payment. In special cases, the ‘discovering goods’ phase can be directly transitioned to the ‘determining purchase’ phase.

At every stage before consumption is achieved, the algorithm system is working, which is also the main original intention of designing this service. In addition, from ‘discovering products’ to ‘browsing and selecting products’ to ‘determining purchase’, the length of time spent ‘browsing and selecting products’ can reflect the degree of effectiveness of the algorithm system. The more accurately its product recommendations correspond to consumers' purchasing needs and psychological needs, the shorter the browsing and selection time, which means that its role is more remarkable.

The completion of online shopping is a process of continuously strengthening the purchase intention, as well as a process of meeting the psychological needs of customers. The algorithm system confirms the purchase intention by analysing the personal preferences of customers, and corresponds the purchase intention through personalized product recommendations to drive shopping decisions.

6.2. Algorithm system plays an obvious and strong role in shopping decision-making

Among the reasons why consumers are willing to choose online shopping, the most important is convenience and quickness, which reflects that the filtering function of the algorithm recommendation system is effective, helps consumers save time, makes consumers feel convenient and fast, and thus increases consumption behaviour.

The research data also proves the inevitability of the role of the algorithm system: the vast majority of people have experienced ‘not having a shopping plan originally, but being attracted by the products recommended by the algorithm and shopping’. The algorithm system is effective in analysing individual preferences, and its effect is obvious.

6.3. The role of the algorithm system needs to be improved

Research data shows that nearly 44% of respondent show a positive attitude towards the algorithm system's product recommendation, but 27% of respondent do not accept or even reject this feature. In the product discovery segment, the influence of the algorithm recommendation function ranks after ‘self-search’ and is almost as influential as ‘friends’ recommendation’, which shows that its influence is limited. If the algorithm recommendation combines the influence of offline communities, it can play a greater role.

Furthermore, the accuracy of algorithm system product recommendation needs to be improved. The algorithm system is not accurate enough to judge consumers' interests and needs. Consumers' personal profiles can be further improved through their purchase and browsing records or analysis of similar groups, thereby improving the accuracy of recommendations.

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