# How Negative Space on Shopping Websites Influences Users' Purchase Behavior

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**Abstract—Purchase behavior trend of online shopping customers is predicted in this paper via a Negative Space-Trust Model. Based on cognitive psychology, this model we build mainly focuses on the influences of three types of negative space proportion in e-commerce webpage design (negative space proportion of page content, of effective content, of quality content) on user trust leading to different purchase behaviors for online shopping websites. After analysis, we make an equation to describe the model so that it is easier for people who use this method to estimate whether the e-commerce webpage design is reasonable. Then some examples are made to verify our model and a prediction is also included.**

***Keywords-e-commerce;user experience;negative space proportion (NS proportion);trust; NS-Trust Model***

## I. INTRODUCTION

With the development of the electronic commerce [1-4], a lot of e-commerce platforms have emerged in China during last ten years. Similar with e-commerce websites in western countries, these websites are divided in two types: e-mall and e-shop [6, 11, 17].Although there already have been a complete market segmentation, the webpage design is differential in quality according to business scale. It no doubt overburdens consumers that many site builders, who ignoring the function of negative spaces especially in small and medium sites, always eager to show as much information as possible to fulfill the whole webpage. From usability and artistic quality of website design, negative space is used to specify design theme, simplify page elements, save bandwidth, guide visual route, focus main information, alleviate visual fatigue, create feelings of permeability and of layering [5, 8]. So it is directly related to user experience.

As we all know, trust is the key to success for business both online and offline. Many trust models in physical market places have been existed compared with virtual market online. They studied trust in management, finance security, business behavior and other fields [7, 12-16] with lacking trust model in interface design. There is a great need for us to find out the relationship between trust model and webpage visual design. Negative space is an important feature in interface design so that we can put it into consideration when we discuss the trust impact on user purchase behavior [9]. It is an essential research in e-commerce website design that negative space is evolved in trust which affects the final consumer purchase decisions [10, 16-18].

As a skill broadly used in art , architecture, music and other phenomenon in life, negative space have two meanings traditionally:(a)non-real meaning part; (b)relationship with other elements. In our paper Negative space is defined as the space except content entity in the interface. See Table Ⅰ, based on user-centered design negative space is including blank parts of page, large color range area, background of regular graphic combination, the range of ad [8].

TABLE I. WEBPAGE NEGATIVE SPACE TYPES

| Types |
|---|
| Blank parts of page |
| Large color range area |
| Background of regular graphic combination |
| The range of ad |

Currently some scholars study negative space from the view of esthetics and emotion [8, 19]. They discovered relevance of esthetic and emotional function with website usability and consumer satisfaction, as a result, they concluded proportions for negative space design. Leshan Lee have proposed four kinds of interface design user model: mental model, task model, study model, and error model [19]. Though some website design research involved trust model in user study, it's less talked about the influence of negative space on trust due to the authors' knowledge.

In our paper, we build a trust model as a bridge connecting negative space design with user purchase decision. Then we put this model into practice to verify whether it is true. In part 1, we propose the negative space parameters we would use. Analysis and our model are discussed in part 2. Also part 2 will be devoted to model verification with the 'Taobao' and 'Tmall' website. Part 4 would be a conclusion of our study.

## II. ANALYSIS ON EFFECT FACTORS OF NEGATIVE SPACE(NS)

### A. *Extraction of Characteristic Parameters of NS*

The function of the way NS displayed shouldn't be ignored to users' trust. In our paper, we nominate three types of NS factors for the latter analysis.

#### 1) *NS Proportion in Page Content*

Page content is a concept that means the whole things on screen when open a website. It includes navigation bar, logo of website and e-shop, information of e-shop, product

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images, product descriptions, price and discount price, delivery information, size information, color information, number selection box(including inventory quantity), “purchase now” and “add to cart” button, similar products recommendation, successful transaction amount, total assessment number. NS proportion in page content is area except above information.

*2) NS Proportion in Effective Content*

The upper left corner is always noticed at the first glance of webpage, so it can contribute to the charisma of webpage to attract visitors for long time stop. We call the information in this area effective content, including product images, product descriptions, price and discount price, delivery information, size information, color information, number selection box(including inventory quantity), “purchase now” and “add to cart” button, similar products recommendation, successful transaction amount, and total assessment number. NS proportion in effective content is the upper left corner area except above information.

*3) NS Proportion in Quality Content*

Large pictures of commodity have a big impact on people’s eyesight. Visitors can easily crash on product when they saw images of interest. So quality content is the space of product images. NS proportion in quality content is the upper left corner area except above information.

### *B. Effect of NS on the Shopping Process Flow*

In the previous study, when we build mental model to construct the process of user experience to the target product, it varies from users’ identity, personality, surroundings, and clicking context, and the user-centered shopping website design is under the same situation. Then we make some analysis on cognitive effect of negative space to mental models shown in Fig.1.

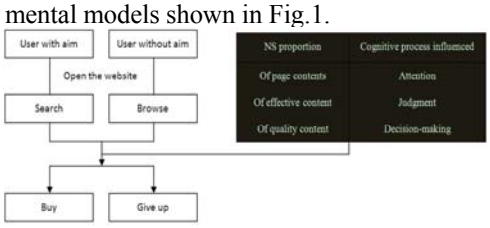


Figure 1. Analysis of NS proportion on online shopping flow with cognitive psychology

The next step what the user will do after a first glance of webpage is based on whether the user has an aim. This aim is a definite commodity they expect. When people make final decisions of buying or giving up, different types of NS proportion will affect people’s different stages of cognitive process. The proportion in page contents will make a difference on visitors’ attention; the proportion in effective content will influence users’ judgments; and the proportion in quality content will truly impact on design-making process. Users with an aim will directly use the navigation bar or search bar to find out what he want online, at the same time the other kind of users will be attractive by the webpage design or not, what will have a big influence on behaviors about purchase.

## III. NS-TRUST MODEL

Trust is the key factor that influences users’ potential purchase motivation [15], then we discuss because of negative space, how trust is affected so that users’ behavior changes.

### *A. Extraction of Characteristic Parameters of Model*

*1) Parameters of User Trust*

According to the user trust factors (user experience, user expectation, retailer friendliness, retailer responsibility, retailer honesty, and user evaluation) we have extracted the numerical constants to assess the degree of factor influence. Using existing trust evaluation system, we make our parameters like these:

*(a) Description Score (score of 1 to 5):* description is perfectly matched for commodity.

*(b) Service score (score of 1 to 5): t*he customer is completely satisfied with the service.

*(c) Delivery score (score of 1 to 5):* the delivery speed is perfectly suited for the customer need.

*(d) Credit score of buyer (score of 1 to 5):* the accumulation of scores which previous sellers give on buyer trust credit (1point for good, 0 point for so so, -1 point for unsatisfied from sellers).

*2) Parameters of User Behavior*

There are many factors which cause different users’ behaviors, and what we discuss in our paper is relevance between factor trust and user behaviors. The trust of user in websites which causes different purchase behaviors mainly influenced by NS proportion is about ‘give up purchasing’, ‘compare with the similar’, ‘know more’, ‘collect ’, and ‘purchase’ as shown in Table II.

TABLE II. USER BEHAVIOR SCORE COMPARISON TABLE

| Behavior | Give up | Compare with similar | Know more | Collect | Purchase |
|---|---|---|---|---|---|
| Relevance with factor trust | -- | - | 0 | + | ++ |

### *B. NS-Trust Model Construction*

*1) NS-Trust Model*

According to previous analysis, we have already had suitable parameters and then build following relationship model which is showed in table III. Question mark is represented complexity and uncertainty in about relationship.

TABLE III. NS-TRUST MODEL

| NS proportion | | Trust factors | Trust parameters | | User behaviors(B) |
|---|---|---|---|---|---|
| Of page content(a%) | ? | User experience<br>User expectation<br>Retailer friendliness<br>Retailer responsibility<br>Retailer honesty<br>User evaluation | Credit score of buyer(C) | = | Purchase; Collect; Know more; Compare with similar; Give up. |
| Of effective content(b%) | | | Service score(S)<br>Delivery score(D)<br>Description score(R) | | |
| Of quality content(c%) | | | | | |

Through analysis, we get following regulation in Table IV, Table V, Table VI.

TABLE IV. TRUST PARAMETERS WITH NS PROPORTION

| | a↑ | b↑ | c↑ |
|---|---|---|---|
| Credit score of buyer(C) | + | 0 | 0 |
| Service score(S) | + | 0 | - |
| Delivery score(D) | 0 | - | 0 |
| Description score(R) | + | 0 | - |

TABLE V. USER BEHAVIOR WITH TRUST PARAMETERS

| | Credit score of buyer(C) | Service score(S) | Delivery score(D) | Description score(R) |
|---|---|---|---|---|
| Increasing values of trust parameters promotes users to buy | yes | yes | yes | yes |

TABLE VI. USER BEHAVIOR WITH NS PROPORTION

| | a↑ | b↑ | c↑ |
|---|---|---|---|
| Whether promotes users to buy | +++ | - | -- |

*2) NS-Trust Model Math Equation*

Through Table V, all increase in value of C, S, D, R will promote user to buy products. Then we assume that these four parameters have the same promoting force to user purchase behavior.

See Table IV and V, for purchase behavior, a makes a passive function, and b, c make negative impacts.

Absolute value ratio about the promoting force of a and the inhibitory force of b and c is 3:1:2, see Table VI.

Simply, we could think of the relationship between user behavior (make it x) and a, b, c is as follows:

$$x = 3a - b - 2c, \tag{1}$$

But pay attention to the normal situations, there is a scale of a, b, c, and it cannot be value in random in [0, 1]. So we assume:

$$a, b, c \in [1/3, 2/3], \tag{2}$$

And then

$$x \in [-1, 1]. \tag{3}$$

So we can make a hypothesis around the relationship between scale of B and user behavior, as listed in Table VII.

TABLE VII. DETERMINATION OF USER BEHAVIOR SCOPE

| User behavior | Give up | Compare with the similar | Know more | Collect | Purchase |
|---|---|---|---|---|---|
| Scope of x | [-1,-0.6] | (-0.6,-0.2] | (-0.2,0.2] | (0.2,0.6] | (0.6,1] |

## C. Verification of NS-Trust Model

In this paper we will analyze this issue with the three examples of air conditioners, as listed below.

Bearing in mind that all the NS proportions of effective content (i.e. the value of 'b') are with little difference between most websites, approximately 1/2, as well as the least contribution in the fluctuation of x led by 'b' comparing with 'a' and 'c'. So we discuss the influence of 'a' and 'c' firstly, and then the third example will include the difference in b.

(1) We search the same air conditioners at the website of www.taobao.com, which is a famous site for online shopping in China, and we have found out different sales quantity of different sellers. According to this, we analyze that the smaller c is, the more customers, and the higher sales quantity. Through our research, the sales quantities of Fig.2 (a) and Fig.2(b) are 35 and 4 respectively, so there is more NS proportion in Fig.2(a) with much higher sales quantities.

(a) (b)

Figure 2. Two pictures of same air conditioners found in website of www.taobao.com

(2) In example 2, total sales quantities of all air conditioners in two different websites are compared. For example of www.taobao.comand www.tmall.com, in Fig.3 it is obvious that for NS proportion of page content(i.e. the value of 'a'), TMALL >TAOBAO. We search the air conditioner in these two websites, and the top-ten best sellers, the sales quantities are listed in Table VIII and Table IX.

TABLE VIII. TOP-TEN BEST SELLERS OF AIR CONDITIONERS IN TAOBAO AND TMALL

| Sales quantity ranking | TAOBAO | TMALL |
|---|---|---|
| 1 | 1141 | 1175 |
| 2 | 778 | 1154 |
| 3 | 747 | 1142 |
| 4 | 746 | 1111 |
| 5 | 583 | 917 |
| 6 | 581 | 738 |
| 7 | 581 | 717 |
| 8 | 513 | 669 |
| 9 | 496 | 644 |
| 10 | 492 | 635 |
| Total | 6658 | 8902 |

(a) (b)

Figure 3. Homepage of: (a)www.taobao.com; (b)www.tmall.com

TABLE IX. VALUES OF A,B,C,X

| value | TAOBAO | TMALL |
|---|---|---|
| a | 1/5 | 2/3 |
| b | 1/4 | 2/3 |
| c | 1/3 | 2/3 |
| x=3a-b-2c | -19/60 | 0 |
| Sales quantity/month | 41 | 861 |

For sales quantities of air conditioners, TMALL is greater than TAOBAO, and our previous suppose of NS proportion is verified by this fact.

(3) We choose two different air conditioner sellers, one in TAOBAO, and the other one in TMALL. For example, both of two sellers are selling the same type of same brand

air conditioner online which is Kelon KFR-35GW, and the webpages as in Fig.4.

(a)www.taobao.com (b)www.tmall.com

Figure 4. Same air conditioners in two sellers' webpages

The value of a,b,c are as in table IX.According to table IX,we have found that the size of x is closer to the sales quantities of two sellers.

## IV. CONCLUSION

In this paper, we provide a model to predict the user online purchase behaviors according to corresponding negative space proportion. We have discussed several examples in section 2.3, and basically verified the reliability of our model. In our future work, much more factors will be added into our NS-trust Model, such as NS shape, texture and location etc., to be closer to reality. Some work is now under way.

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