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COMBINATIVE VALUE CREATION IN PURCHASING BEHAVIOR

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ABSTRACT

Consumers' daily purchasing behavior is used as an example, observing decision-making processes to determine the optimal combination of several product items. Heuristics focusing on combinative value were identified that lead efficiently to satisfactory decision-making.

Keywords: *Purchasing behavior, Combinative value, Value creation, Decision-making*

1. INTRODUCTION

In people's daily lives, problems often arise that fall under the category of combination optimization. Examples could be consideration of a dinner menu, planning of a room interior, or selection of a set of fashion coordinates within a given budget. At such times, how do people think, and upon what solutions do they decide?

Combination optimization problems can be thought of as mathematical problems. It is known that many such problems are NP-hard problems and that it is difficult to obtain exact optimal solutions. Accordingly, approximate solution strategies such as the greedy method, the local search method, or heuristics are often used to obtain solutions that are sufficiently accurate, although not guaranteed to be optimal. In recent years there has been active research in metaheuristics such as genetic algorithms and annealing methods for the purpose of obtaining highly accurate solutions, although such methods may be slow in producing those solutions. [1][2][3][4]

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In combination optimization problems in everyday life, it is rare to go to the trouble of using difficult mathematical algorithms such as those described above to obtain solutions. In most cases, however, people arrive at reasonably satisfactory combinations that satisfy the limiting conditions within a short time. From this we can infer that when human beings deal with combination optimization problems in everyday life, each person derives a solution by engaging in decision-making based on some type of heuristic or context. In addition, there is a significant difference between mathematical combination optimization problems and those encountered in everyday life, which is whether combinations are regarded as simple individual sums. Although individual value exists in products and information, value increases or decreases as a result of combination. Simply put, 1 plus 2 plus 3 does not necessarily make 6: it might make 10 or 5 in particular circumstances. In many combination optimization problems in everyday life, the objective is to create a high-value combination from an overall perspective, and it is important to focus on creating new value through making advantageous combinations.

In today's era of diversified consumer preferences, studies on what products consumers choose and why they do so when faced with many options are essential and widely used in product planning and marketing. However, many such studies are limited to circumstances in which consumers select a single product from among similar options, such as when purchasing a ballpoint pen or a mobile telephone. For this reason, it is important to examine and analyze people's thought processes at the time they create combinations that they judge to have high value as they select multiple products from among many options. The nature of the high-value combinations created as a result is also of great interest.

In this research the authors observed consumers' decision-making processes when deciding on combinations of multiple products as an example of combinative value creation in everyday life. Specifically, we discuss buying behavior in the purchase of 300 yen worth (3.36 dollars) of snacks. The subjects of the experiment shopped as usual and recorded information on the products purchased and their thought processes during shopping. We examined the data obtained thereby from the perspective of combinative value in consumer busying behavior.

2. THE IMPORTANCE OF COMBINATIVE VALUE CREATION

Consumer psychology and internal factors are thought to have a profound impact on consumer buying behavior, and research is being conducted to elucidate this. Analysis of consumer buying behavior has long been an area of emphasis in the field of marketing. A typical example is customer buying behavior analysis performed by applying data mining techniques to customer profile data and purchase history data collected using point of sale (POS) systems. Furthermore, diversification of consumer preferences in recent years has given rise to the need for deeper analysis of the psychological and internal states of consumers up to the point of product purchase. In response, research analyzing consumer behavior using Bayesian networks with conditional probabilities expressed using vectors and nodes is emerging to address the issue of human uncertainty. [5]

Much research of this type is limited to the selection of a single product from among similar options. However, when humans make decisions, they select what they think to be the

optimal decision-making method in each case and decide according to that method. For this reason, the decision-making method used when selecting a single product may differ from selection of a combination of multiple products. Accordingly, it may be possible to obtain new knowledge by exploring consumers' internal states when they create high-value combinations. Whether conscious of them or not, consumers face many occurrences of combinative value creation in everyday life; familiar examples include (1) dinner menu preparation, (2) shopping on a limited budget, (3) room interior arrangement, (4) fashion coordination, and (5) travel planning.

Dinner menu preparation is an illustrative example of combinative value creation. Various processes are involved in the creation of the combination of items that make up a menu. Since a menu basically consists of a food staple, a main dish, side dishes, and soup, one conceivable decision-making method is to first decide the main dish, then decide a food staple and a soup that go well with the main dish, and finally achieve balance with side dishes. However, the decision-making order may differ from person to person. The selection method may also differ significantly according to which of many possible elements the decision-maker emphasizes; for example, taste, nutritional balance, calories, or volume. Furthermore, when restrictions such as a requirement to use carrots, a requirement to avoid eggs, or a certain maximum calorie limit apply, such restrictions are likely to cause significant changes in the thought process.

The case of shopping for multiple products on a limited budget can be considered the most basic of combinative value creation problems. One such situation is the purchase of a set of room interior items within a certain budget. If a person purchases the products individually, judging them piece by piece, it is highly probable that the result will be a combination lacking in harmony, even if the individual items are good. To avoid such circumstances, it is necessary to take balance into consideration when creating combinations. Although the buyer focuses on function and quality when selecting a product, he or she must also focus on the relative property of the product's compatibility with other items. Consideration from that perspective results in the creation of products that demonstrate effectiveness in combination even if they are uninteresting in and of themselves. Such shopping situations can also be considered problems of skillful allocation of budget, a limited resource. By considering the issue in this way, we can find a new frame of reference: proportionality of monetary amount. These matters are likely important elements in the consideration of high-value combinations.

In product selection, it is natural that preferences vary from individual to individual. Accordingly, the products people purchase differ even when the merchandise selection and purpose is the same. Nevertheless, analysis of concrete case examples of purchased products and thought processes during shopping may reveal key points in product selection, tendencies in ways of thinking, and other factors. The revelation of such factors will yield benefits for sellers and consumers alike. If sellers are able to effectively show products in combination using displays, point of purchase (POP) materials and the like, they will be able to make consumers aware of new value in their products. Moreover, if a new product combination recommendation method and system can be established, sellers will likely be able to satisfy an important consumer expectation: people's desire for highly satisfying products in light of their current possessions.

3. APPLICATION OF THE GREEDY METHOD APPLIED TO A KNAPSACK PROBLEM

Operations research (OR) is a problem solving science that is widely used for rational, scientific approaches to decision-making. Various OR studies have been conducted on everything from issues connected to organizational operation to extremely personal problems. [6][7]. Combination optimization can be thought to fall in the OR category.

Here, we consider a knapsack problem, a typical combination optimization problem, with respect to the case of the creation of high-value combinations within a given budget. The following is an example of a knapsack problem.

Question: The table below indicates a product group for which the satisfaction level and price of each product is known. What product combination should be created to maximize satisfaction level on a budget of 300 yen?

Table 1: A Knapsack Problem Example

Product	**Satisfaction level**	**Price**
Chocolate	5	100
Rice crackers	7	130
Marshmallows	4	80
Hard candy	2	50
Gummy candy	3	70
Potato chips	6	110
Cheese	1	30

Even if we do not know a specific method of solving this problem, in cases such as this where the number of products is low, we should be able to arrive at the optimal solution by experimenting with several combinations and comparing the results. However, as the number of products increases, enumeration becomes difficult, and a strategy becomes necessary. Accordingly we attempt to solve the problem using the greedy method, a typical approximate solution method for combination optimization problems. With the greedy method, combinations are created by selecting products in descending order of the value obtained by dividing satisfaction level by price. Realistic consideration of this value should make it possible to ascertain cost performance (CP). Calculating the CP of each product and rearranging the products in descending order of CP value results in the following table.

Table 2: Example Calculation Process

Product	Satisfaction level	Price	CP	Order
Potato chips	6	110	0.055	1
Rice crackers	7	130	0.054	2
Chocolate	5	100	0.050	3
Marshmallows	4	80	0.050	4
Gummy candy	3	70	0.043	5
Hard candy	2	50	0.040	6
Cheese	1	30	0.033	7

Solving the above problem using the greedy method involves the following flow, yielding a solution with a satisfaction level of 15 for 290 yen.

(1) Buy potato chips. (2) Buy rice crackers. (3) There is not enough money left to buy chocolate, marshmallows or gummy candies. (4) Buy hard candy.

This is not a unique solution: other solutions also exist. Furthermore, in cases where multiple purchasing of the same product is allowed, the purchase of two units of potato chips and one unit of marshmallows yields a solution with a satisfaction level of 16 for 300 yen.

When we actually purchase combinations of products, we do not mechanically select products in descending order of CP as is done in the greedy method. Such a selection method results in bad overall combinations even when individual items are good. This is very different from value creation. It is also likely impossible to consider minutely detailed CPs for all products. Nevertheless, when shopping in everyday life consumers want to purchase the best possible products as cheaply as possible. With respect to "price" and "satisfaction level," this solution method can be considered close to the way ordinary consumers think. This approach ought to yield certain suggestions useful in considering combinative buying behavior. Accordingly, in the present study we conduct an experiment with conditions similar to those of this example.

4. CASE STUDY

4.1. Experimental Method

Experimental subjects are told, "Please buy snacks for an excursion using 300 yen. We will give you the snacks that you choose." After they finished shopping, we had the subjects provide data on the products purchased and their thoughts during shopping using free responses. Since variation in both quality and quantity is likely to occur in open-ended statements, we also performed in-depth probing and externalization in interviews conducted on the basis of the written responses.

The subjects in this experiment were ten men and women in their 20s (Subjects A to J). The experiment was conducted at a convenience store and a university co-op having ample

product options. Moreover, although no time restriction was imposed on shopping, the mean shopping time was about 15 minutes. In addition, definitions of the words "excursion" and "snacks" were not provided to the subjects, and the purchasing of beverages was prohibited.

Specific Survey Items

- Product name, snack category, volume of contents, and price satisfaction level (on a scale of 1 to 5 points)
- The order in which products were handled (placed in the shopping basket), total price, and overall level of satisfaction with the purchases (scale of 1 to 10 points)
- Thoughts during shopping (open-ended statements, time-sequenced from the start of shopping to the finish)
- Open-ended statements of post-purchase impressions and points for reflection

4.2. Results

4.2.1. Insights from Thought Process Descriptions

The experiment revealed that the subjects selected products using various criteria: personal preference as well as volume of contents and calories. We learned that within the experimental context, many subjects were strongly aware of whether the products were sweet or salty and how each product's price fit with the remaining budget as they shopped. We also learned that no subject created a combination all at once and that every subject created combinations by repeatedly changing his or her way of thinking such as deciding on the next product while mulling over the products in hand. Below we provide an example of the thought process of one subject during shopping.

- Thought Process Citation

Because the subject likes chocolate, he placed Product A, which he had eaten before and found tasty, in the basket. At that time, he hesitated in choosing between Product A and Product B. He also eliminated chocolate priced over 180 yen as candidates for selection. Next, he put Product C, another of his favorites, in the basket because he wanted something salty rather than another sweet item.

From the standpoint of budget, he thought about adding a small item to the purchases. Although he had never tried it, he selected Product D since it seemed tasty. Next, he selected Product E to bring the total close to 300 yen. This decision had a strong price adjustment implication.

4.2.2. Subject Classification

We attempted to classify subjects focusing on three factors that many subjects reported as having been in mind during shopping: "sweet or salty," "product price," and "order in which products were handled", and were able to divide the subjects into two broad patterns. In the following discussion of these patterns we included the level of satisfaction with each product, which was expected to be important in the data analysis.

• Subject Pattern 1

Table 3: Subject A

Order	Name	Sweet or Salty	Price	Satisfaction Level
1	Snack item	Salty	145	4
2	Chocolate	Sweet	103	4
3	Chocolate	Sweet	32	3
4	Less-processed snack	Salty	10	1
5	Cheese	Salty	10	1

Table 4: Subject F

Order	Name	Sweet or Salty	Price	Satisfaction Level
1	Snack item	Salty	124	4
2	Gummy candy	Sweet	105	5
3	Chocolate	Sweet	42	1
4	Snack item	Salty	11	1
5	Snack item	Salty	11	1

The data above show the choices of two people who exhibited a pattern common to five of the ten subjects. The subjects in this group tended to conform to the following flow while shopping.

(1) Select a main salty (or sweet) snack.

(2) Select a second, complementary main sweet (or salty) snack.

(3) Fill out the selection with a strong consciousness of the remaining budget.

As shown by the data in Tables 3 and 4, when the subjects first selected a salty snack, they made that selection as a pivot point and next selected a sweet snack (and vice versa). After that, the subjects consistently selected products to bring the total price close to 300 yen, demonstrating stronger consciousness of the remaining budget than of the level of satisfaction with products. The subjects in this group can be said to emphasize the value of maximal use of the "flavor balance" and "budget" constraints.

• Subject Pattern 2

Table 5: Subject E

Order	Name	Sweet or Salty	Price	Satisfaction Level
1	Chocolate	Sweet	105	5
2	Hard candy	Sweet	100	3
3	Less-processed snack	Salty	82	3

Table 6: Subject J

Order	Name	Sweet or Salty	Price	Satisfaction Level
1	Snack item	Salty	42	4
2	Snack item	Salty	32	3
3	Cookies	Sweet	105	4
4	Hard candy	Sweet	105	4

The data above show the choices of two people who exhibited the second pattern, which was common to the remaining five of the ten subjects. The subjects in this group tended to conform to the following flow while shopping.

(1) Select two or three items that they want to eat.

(2) Refine the product selection while considering the overall situation.

As shown by the data in Tables 5 and 6, unlike Pattern 1 subjects, these subjects first select some products they desired without considering factors such as "sweet or salty." They subsequently refine the product selection to attain balance in factors such as "sweet or salty" or "size." Another significant difference from Pattern 1 subjects is that all Pattern 2 subjects selected only products that had high satisfaction levels.

4.2.3. Comparison of Subject Groups

As described above, subjects were grouped on the basis of their decision-making processes. A comparison of the two subject groups is shown in Table 7. The price total supports both groups reported thought processes: Group 1 subjects' purchase totals were closer to their budget limit than Group 2 subjects' totals.

Both groups reported a high sense of satisfaction, with no difference in overall satisfaction level. From this we can conclude that the subjects of both groups quickly created high-value combinations satisfactory to the individuals without using difficult algorithms. From the equality in satisfaction level we can also likely conclude that even though the thought processes during shopping differed, neither process is clearly superior.

Table 7: Subject Group Comparison

	Price Total	Overall Satisfaction Level
Group (1) Five-person mean	298	8.6
Group (2) Five-person mean	286	8.6

4.3. Implications

The experimental results and thought processes reported reveal that decision-making methods switch sequentially due to factors such as the first product affecting the judgment criteria for selection of the second product. i.e., when people select products from a broad search domain, selection of one product affects the search domain for the next product, and the search domain narrows. In this way, it was found that human beings efficiently arrive at highly satisfactory combinations even when faced with problems involving many combinations that are difficult to solve using a computer.

The decision-making process at the time of product selection also revealed some patterns. Subjects focused on product attributes and characteristics such as "sweet or spicy/salty" as well as product price and satisfaction level. Future research needs to consider the patterns observed here and consider, in detail, individual subject differences.

It is natural that some individual differences exist in the decision-making process. Nevertheless, we can conclude that the discovery of two distinct patterns as a general outline of the heuristics individuals employ when creating high-value combinations is of major significance.

5. CONCLUSION

In this research, we examined the decision-making process for deciding on combinations of multiple products as an example of combinative value creation in everyday life. Specifically, as a familiar example we discussed buying behavior in the purchase of 300 yen worth of snacks. As a result, by examining combinative value we were able to discover heuristics leading to efficient, highly satisfactory decision-making.

There are several implications for future research. First of all, larger sample sizes should be considered. Moreover, accompanying shoppers and examining "behaviors" rather than focusing on "thoughts" only will likely lead to new discoveries. This study is a step toward development of a combination recommendation system to promote consumers' creation of high-value combinations. We envision a system that will automatically select other products and recommend combinations once a product has been selected. Even after such a support system is developed and evaluated, continuing exploration of how people think and act in everyday life will be important.

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