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Potential for Sustainable Marketing that Provides Value to both Customers and Supply Chain - Analysis of EC Site Sales Record Data -

Jundai Koketsu [*], Makoto Kimura [*],
Aya Ishigaki [*]

Abstract

Marketing aims to provide new value to customers and maximize it. However, for a rapid increase in the burden on the supply chain rapidly owing to the maximization of customer value is not healthy. This study proposes a sustainable marketing approach that can provide value to both customers and the supply chain. The results reveal the possibility of reducing the aforementioned burden while increasing sales, which is the value provided to customers, more than conventional marketing.

Keywords: Sustainable marketing, Discount sale, Prospect theory, Supply chain

1 Introduction

The significance of marketing changes as times change [1]. In the era of mass production and consumption, the objective of marketing was to make the existence of a product known to as many people as possible. In an era when the world is full of products, the goal of marketing has been to predict the goods and services that customers want. As the Internet and information terminals have become widespread and the world is overflowing with information, the objective of marketing has shifted to providing new value to customers. The American Marketing Association [2] defines marketing as "the activity, set of institutions, and processes for creating, communicating, delivering, and exchanging offerings that have value for customers, clients, partners, and society at large." Marketing is no longer only targeted at customers who buy products, but also considers the partners involved in the manufacture of the product and society as a whole. For example, marketing that uses products and services that are low-cost, high-quality, and of great value to the customer, but places a burden on subcontractors or suppliers, or is associated with forced labor or child labor, would be eliminated. Considering social trends, marketing that pursues short-term profits will decrease, and so-called sustainable marketing, which can return fair and long-term benefits to supply chain partners, society as a whole, and all stakeholders while satisfying customers and securing profits for the company, will become the mainstream [3].

In recent years, one of the bottlenecks in the supply chain has been transportation and logistics. Although the problems of international logistics that have emerged as a result of globalization and infectious disease outbreaks are also important [4], this study contributes to solving the

[*] Tokyo University of Science, Tokyo, Japan

problems of domestic logistics using trucks and other vehicles. In developed countries and those with rapidly developing economies, a shortage of transportation capacity is gradually becoming apparent [5]. One of the causes is that the number of truck drivers and other workers involved in transportation has not increased in response to the rapid increase in transportation capacity demanded by the spread of e-commerce [6]. Governments and companies are aiming to increase the number of drivers by increasing wages and improving the working environment [7]. Academia has also attempted to indirectly reduce the required transportation capacity by proposing efficient truck delivery route planning, facility location planning, and warehouse layout optimization [8][9][10]. However, direct reductions in required transportation capacity, that is, attempts to fundamentally reduce customer demand or quality of service, are rarely considered. For example, suspending the "next-day delivery service" some e-commerce companies offer would certainly create more transportation capacity, but it is unlikely to be implemented. In a highly competitive industry, poor service leads to defeat [11]. However, while the way products and services are offered should not be made worse, changes are worth considering. For example, as typified by Wal-Mart, Everyday Low Price (EDLP) marketing, which aims to always offer products at low prices, will certainly reduce demand fluctuations and lower the required transportation capacity compared to High-Low (HiLo) marketing, which offers products at low prices with conditions. If sales volume and revenues also increase, EDLP marketing is closer to sustainable marketing.

This study presents suggestions aimed at changing the way marketing is conducted (see Figure 1). Marketing is the link between the supply chain and the customer and stimulates customer demand and supply chain operations. However, traditional marketing focuses on the customer, with little consideration for the supply chain burdens generated by the demand. Therefore, we argue that a shift from conventional to sustainable marketing that provides value to both customers and the supply chain can contribute to the realization of a more equitable and sustainable society.

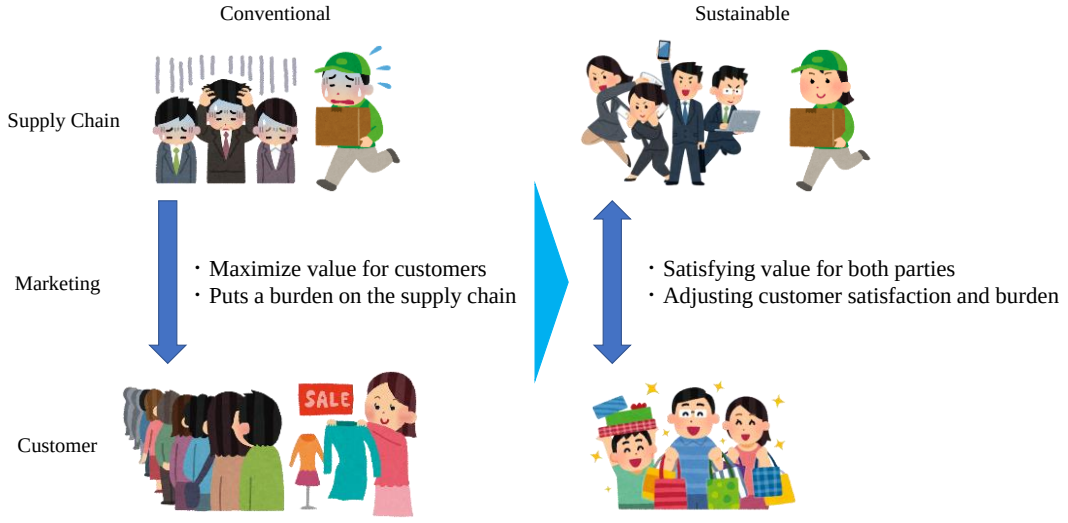

Figure 1: What is sustainable marketing?

Based on the idea that an increase in sales volume and revenue is an increase in value for the customer and a decrease in demand fluctuation is an increase in value for the supply chain, this study proposes an example of marketing that increases sales volume and revenue while decreasing demand fluctuation. Specifically, using sales record data from an e-commerce site, we

design a purchasing model for customers who purchase according to the value function of prospect theory, compare the results of HiLo marketing, EDLP marketing, and the proposed sustainable marketing, and demonstrate the superiority of the latter. By doing so, we contribute to the realization of a sustainable society by encouraging more companies to shift to and consider marketing that not only maximizes customer satisfaction and sales volume, but also takes the situations of other stakeholders into account.

2 Materials

We utilized EC site sales record data provided by the 2022 Data Analysis Competition sponsored by the Joint Association Study Group of Management Science. The study covered from January 1, 2019 to December 27, 2020 (2 years, 104 weeks). One factor to be considered during the period under study is that infectious diseases began to spread in Japan around 58 weeks. The sales data reveal three pieces of information: the week in which the sale took place, price range of the product, and three levels of the product's genre. The target customers were 100,000 randomly selected customers in the 20-35, 35-50, 50-65, and 65-80 age groups, for a total of 400,000. The three types of customer information are gender, age, and region of residence in Japan. The data are summarized in Table 1.

Table 1: Data overview and examples

Item	Contents/Example
week	1~104
user_gender	Male/Female
user_age	(20,35],(35,50],(50,65],(65,80]
user_region	Hokkaido, Tohoku, Kanto, Chubu, Kinki, Chugoku, Shikoku, Kyushu, Okinawa
goods_price	(0,1000],(1000,2000],(2000,3000],…,(10000,20000],(20000,30000],…
goods_genre	Shoes >> Women's Shoes >> Sneakers

The EC site offers a variety of discount sales. We focus only on Sale A, a large-scale sale that takes place four times a year, and Sale B, a medium-scale sale that takes place about 15 times a year. The sales record data used in this study do not include the discount rate at the time of the sale, so the characteristics of sales and discount rates are assumed by checking the EC sites directly [12]. In Sale A, a very small number of featured goods have a discount rate of more than 50%, and many other goods have a discount rate of 10~20%, so we assume that the price discount rate for Sale A is 20%.Assume that the price discount rate for Sale B is 5% because Sale B is a sale in which the maximum discount rate is 10% with the purchase price of the product. We assume that the price discount rate for Sale A is 20% and the price discount rate for Sale B is 5%.

We focus on the largest genre of products (Shoes in Table 1). A total of 34 product genres are covered in this study, excluding those with an average weekly sales quantity of less than 100. The number of goods sold per week for each genre and the timing of the discount sales are illustrated in Figure 2. Sale A is indicated in yellow and Sale B is in blue.

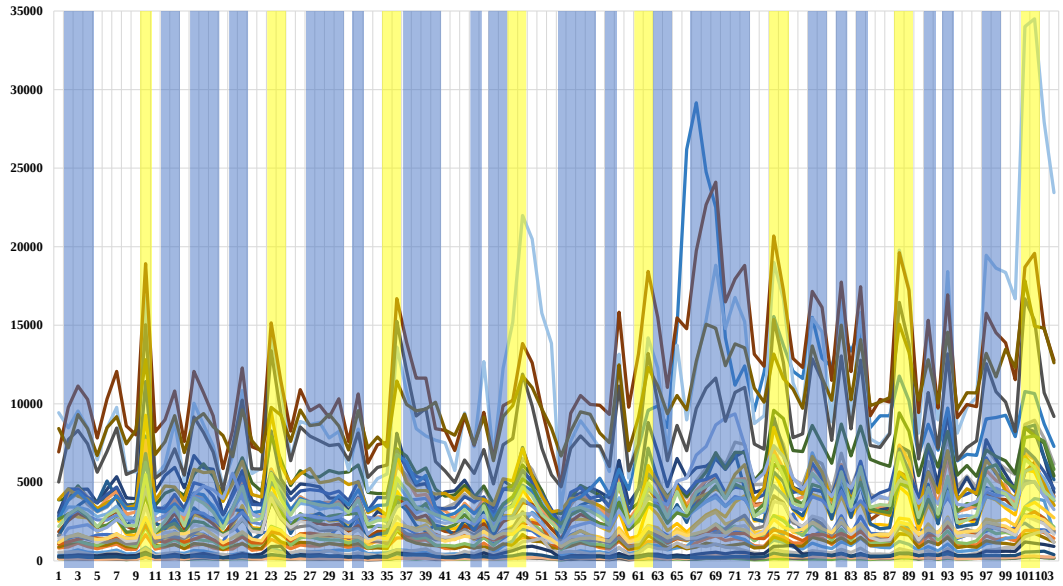

Figure 2: Week of the sale and sales volume of each genre

3 Method

This study compares the effectiveness of HiLo marketing, EDLP marketing, and sustainable marketing. Since it is difficult to implement and compare each strategy in actual stores, we designed a purchasing model based on the data provided. By applying each type of marketing to the purchasing model, the effects are simulated and results compared.

3.1 Purchase Model Design with Utility

This section describes the purchasing model and the considerations made in designing the model.

The EC site conducts HiLo marketing. To design a purchasing model, it is necessary to determine the impact of the discount sale. According to Figure 2, many genres are strongly affected by discount sales. The impact of Sale A and Sale B also appears to vary across genres. Therefore, it is necessary to derive the impact of the sales on each genre. In addition, some genres exhibit changing trends in demand before and after outbreaks of infectious disease.

The purchasing model assumes that "customers do not purchase more than two goods in each genre per week." Customers repeat the binomial selection of whether to buy for each genre, and this process is repeated for 400,000 users (see Figure 3).

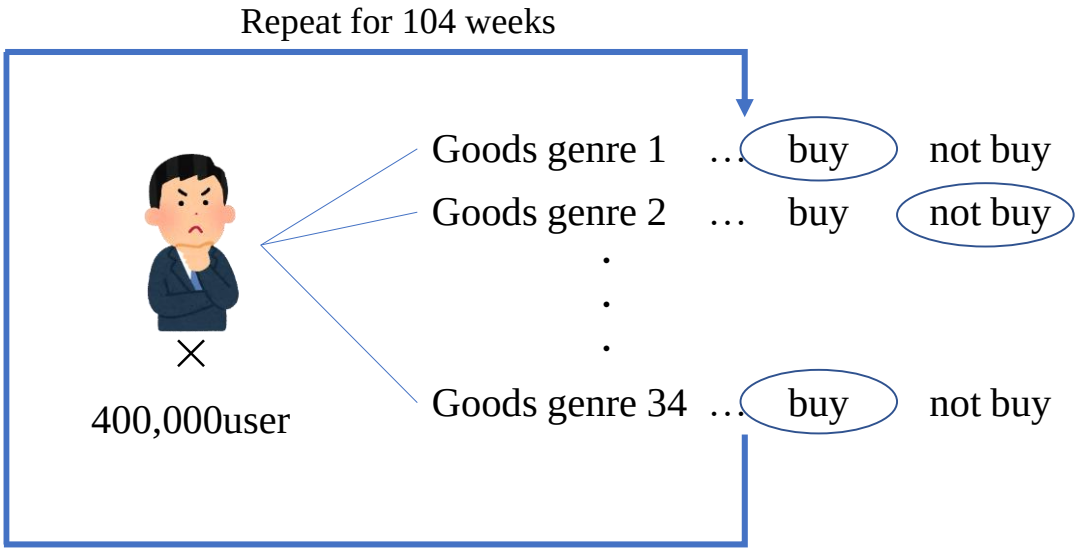

Figure 3: Purchase model overview

We use a binomial logit model to represent the discrete choice problem of whether to buy for each genre, with the presence or absence of discount sales and the prevalence of infectious diseases as explanatory variables. Let U_{ij1} be the utility that a customer gains by acquiring goods belonging to genre i in week j, and U_{ij0} be the utility they gain by not buying them. The explanatory variables are a binary variable S_A of 1 and -1 indicating the presence or absence of Sale A, a binary variable S_B of 1 and -1 indicating the presence or absence of Sale B, and a binary variable C of 1 and -1 indicating the prevalence of infectious diseases. The utility U_{ijk} is shown below with the error term as ε_k.

$$U_{ij0} = \beta_{i00} + S_A\beta_{i01} + S_B\beta_{i02} + C\beta_{i03} + \varepsilon_0 \quad (1)$$

$$U_{ij1} = \beta_{i10} + S_A\beta_{i11} + S_B\beta_{i12} + C\beta_{i13} + \varepsilon_1 \quad (2)$$

Goods are purchased when the utility gained by acquiring them exceeds that gained by not purchasing them. Expressing $\beta_{i1l} - \beta_{i0l}$ as β_{il}, a customer purchases goods when the utility U_{ij} they obtain by purchasing the goods satisfies the following condition.

$$U_{ij1} - U_{ij0} = U_{ij} = \beta_{i0} + S_A\beta_{i1} + S_B\beta_{i2} + C\beta_{i3} + \varepsilon > 0 \quad (3)$$

Both error terms are assumed to follow a standard logistic distribution. Let the binary variable $Y_{ij} = 1$ for the purchase of goods belonging to genre i in week j. The probability that a customer buys goods belonging to genre i in week j is as follows.

$$\text{Probability}[Y_{ij} = 1] = \text{Probability}[U_{ij} > 0] = \frac{\exp(\beta_{i0} + S_A\beta_{i1} + S_B\beta_{i2} + C\beta_{i3})}{1 + \exp(\beta_{i0} + S_A\beta_{i1} + S_B\beta_{i2} + C\beta_{i3})} \quad (4)$$

By deriving the parameter β_{il} using the maximum likelihood method, the purchase probability can be determined based on the available data.

3.2 Prospect Theory with Benefit

The utility-based purchasing model in the previous section can only represent the effects of two HiLo marketing activities, Sale A and Sale B. We next compare the effects of sales with different discount rates from Sales A and B, and the effects of EDLP marketing. This section proposes a method for using the value function of prospect theory as a benefit-based purchasing model and explains how to link it to a utility-based purchasing model.

Prospect theory is an important theory in behavioral economics that states that humans do not always make rational decisions, such as disliking losses over gains of the same amount [13]. Prospect theory is mainly composed of two components: a value function and a probability weighting function; this study focuses on the value function.

The value function of prospect theory and how the net benefits obtained from the purchase of goods at a discounted sale are captured is illustrated in Figure 4. B is the net benefit, p is the price of the goods, v is the objective value, and d is the rate of price discount. The variables that follow the value function of prospect theory are δ, which expresses the degree to which the increase or decrease in benefits becomes slower as gains and losses increase, and λ, which expresses the degree to which losses are disliked more than gains. We consider the benefits of purchasing goods as follows

$$B = (v - p)^{\delta} \tag{5}$$

The benefits of purchasing goods with a permanent price discount, so-called EDLP marketing, are as follows:

$$B = (v - (1 - d)p)^{\delta} \tag{6}$$

In the case of a temporary discount sale, the customer loses out on the sale discount if they do not purchase during the sale. The benefits of making purchases during discount sales in HiLo marketing are as follows.

$$B = (v - p)^{\delta} + \lambda(dp)^{\delta} \tag{7}$$

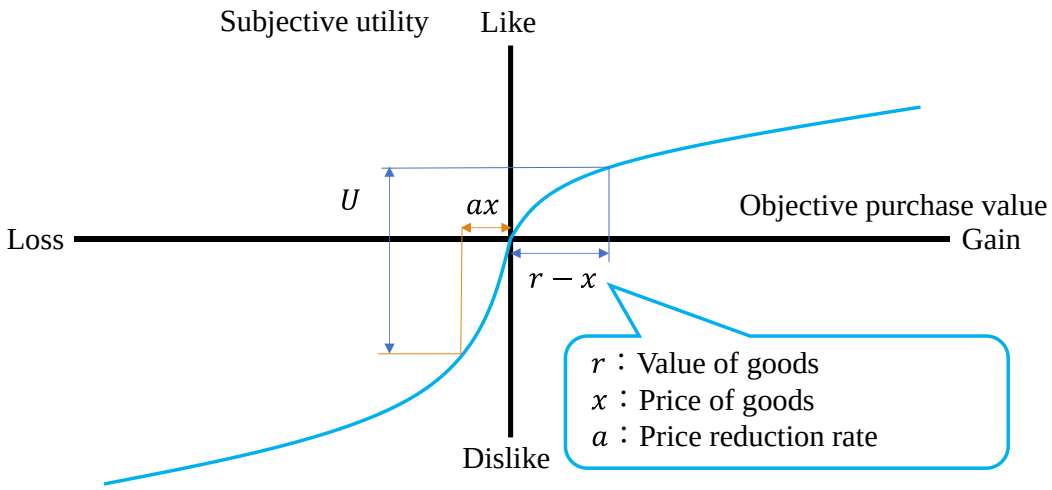

Figure 4: Purchase model overview

The purchasing model designed in section 3.1 is based on utility. Although there is an indirect relationship between utility and benefit, a direct conversion method is a subject of research and is difficult to achieve. Therefore, we use the purchase probability derived from utility by the logit model to connect benefits and utility in a pseudo manner. Let $Prob$ be the probability of buying goods belonging to genre i in normal times, $Prob_{iA}$ be the probability of buying goods in the week when Sale A with a 20% price discount is implemented. Equations (5)-(7) are associated with the purchase probability derived by Equation (4) as follows.

$$(v_i - p_i)^\delta = B_i \tag{8}$$

$$(v_i - p_i)^\delta + \lambda(0.8p_i)^\delta = \frac{Prob_{iA}}{Prob} B_i \tag{9}$$

We assume that the price p_i of a product is the median value of the product's genre, and the net benefit B_i from purchasing the product under normal circumstances, the objective value r_i of the product, for each genre is derived from Equations (8) and (9), respectively. The values of δ, the factor of diminishing sensitivity, and λ, the loss aversion factor, are taken from the literature [13].

By applying each value, $Prob_{EDLP}$, the probability that a customer buys a product belonging to genre i in week j in EDLP marketing, is obtained from the following equation to reproduce the effect of EDLP marketing:

$$(v_i - (1-d)p_i)^\delta = \frac{Prob_{EDLP}}{Prob} B_i \tag{10}$$

3.3 Sustainable Marketing

Assuming that the customer's desire for purchasing activity follows the value function of prospect theory, HiLo marketing can make the customer believe that "if you don't buy now, you will lose money," so the increase in utility for the discount rate is high. However, there is a large difference in sales volume between periods when the sale is held and when it is not held, which may place a high burden on transporters and the supply chain. On the other hand, EDLP marketing always offers lower prices, making it difficult to generate differences in sales volume. However, the increase in utility relative to the discount rate is not very large. This section describes sustainable marketing that encourages regular purchases while making customers believe they are missing out if they do not buy.

The proposed sustainable marketing consists of two major elements. The first is an increase in the discount rate owing to regular purchases and employs the following three rules:

i. If the customer does not make one purchase in four weeks, the discount rate is set to 0 from the next week.

ii. If one purchase is made in a four-week period, the discount rate is maintained for the following week.

iii. If a customer makes two or more purchases in a four-week period, the discount rate for the following week is increased.

Let d_m be the current discount rate of customer m, u be the incremental value of the discount rate, and u_{limit} be the upper limit of the discount rate. The benefit that a customer obtains by purchasing a product belonging to genre i is as follows:

If you have not yet made a single purchase in four weeks:

$$(v_i - (1 - a_m)p_i)^\delta + \lambda(a_m p_i)^\delta \tag{11}$$

If you have not purchased only once in four weeks and $a_m < u_{limit}$:

$$(v_i - (1 - a_m)p_i)^\delta + \lambda(up_i)^\delta \tag{12}$$

If you purchase more than twice in four weeks:

$$(v_i - (1 - a_m)p_i)^\delta \tag{13}$$

This element encourages regular purchases by separating the discount rate every four weeks, while making customers with high discount rates believe that they would miss out if they did not buy. However, once the customer's discount rate a_m is low, it becomes almost ineffective. Therefore, another element of the proposed sustainable marketing is the implementation of sales at appropriate intervals with the aim of increasing customer discounts.

The problem with discount sales in HiLo marketing is that they need to be conducted many times because once the discount sale is over, the price returns to its original level and does not encourage purchases. Sales in sustainable marketing significantly increase the customer discount rate for one purchase during sales. Customers continue to purchase regularly even after the sale is over to avoid losing the discount rate because it increases. We believe that by conducting sales at appropriate times when the number of customers with zero discount rates increases, it is possible to increase customers' willingness to purchase while developing new customers.

Let u' be the incremental value of the discount rate during the sale. Then, the benefit that a customer obtains by purchasing a product belonging to genre i during the sale is as follows:

$$(v_i - (1 - a_m)p_i)^\delta + \lambda_i(\min((a_m + u'), u_{limit})p_i)^\delta \tag{14}$$

4 Results and Discussion

4.1 Purchasing Model

The actual sales data and results of the purchasing model are presented in Figure 5. The vertical axis represents sales volume, and the horizontal axis indicates weeks. The red line is the actual sales data and the blue line is the results of the purchasing model. With the explanatory variables for Sale A and Sale B, as well as the explanatory variables indicating before and after the outbreak of infectious disease, the purchasing model was able to capture the characteristics of the data.

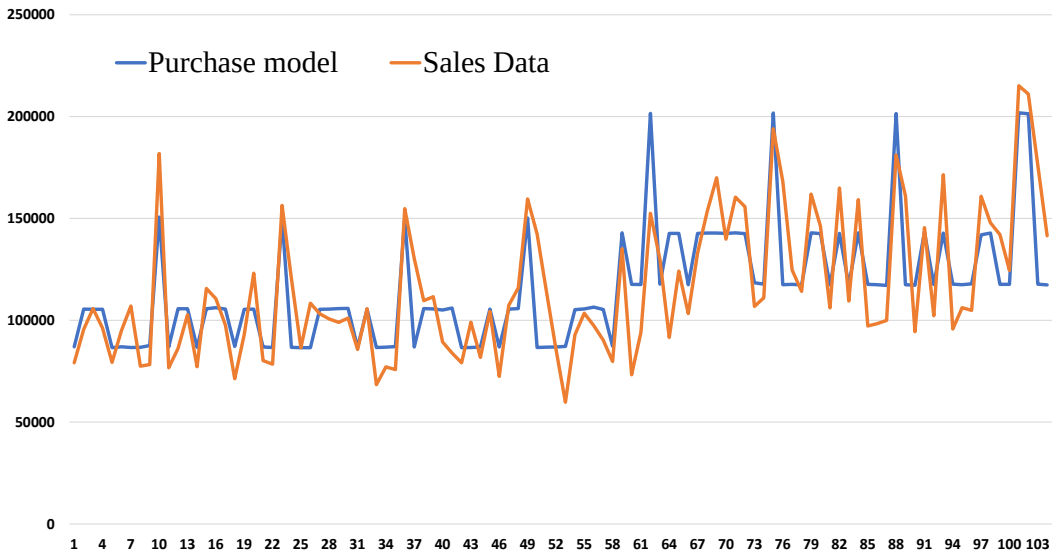

Figure 5: Purchase model overview

4.2 Marketing Effectiveness Comparison

The results of fitting each marketing strategy to the purchasing model are illustrated in Figure 6. The vertical axis indicates sales volume, and the horizontal axis indicates weeks. The red line represents the purchasing model with HiLo marketing, the black line is the results applied to the EDLP marketing purchasing model, and the blue line indicates the results of applying sustainable marketing to the purchasing model. EDLP marketing always offers a 10% discount. For sustainable marketing, the incremental discount rate $u = 0.01$, the upper limit of the discount rate is $u_{limit} = 0.1$, the incremental discount rate during a sale $u' = 0.05$, and the sale is conducted for one week every 16 weeks. The cumulative sales volume, cumulative sales, and coefficient of variation of sales for each marketing strategy is reported in Table 2. Red figures indicate the best values for each evaluation item.

Table 2: Results of each marketing strategy

	Total Sales (Volume)	Total Sales (Revenue)	Coefficient of Variation
HiLo	12,733,520 (100%)	100%	0.252
EDLP	11,697,324 (96%)	91%	**0.169**
Sustainable	**12,983,198 (101%)**	**102%**	0.182

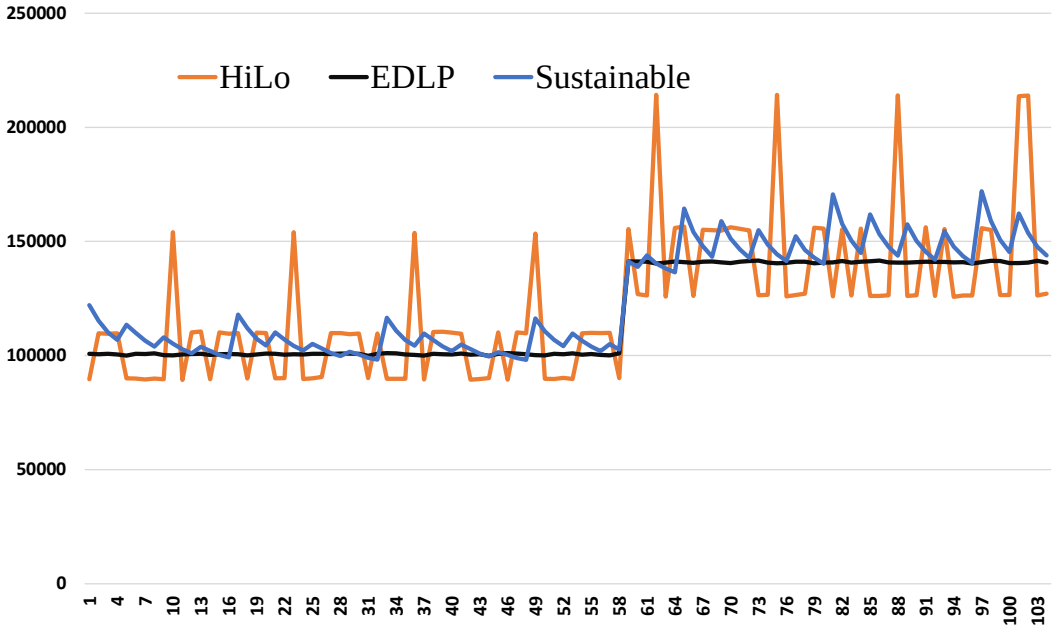

Figure 6: Sales transition of each marketing

When focusing on the HiLo marketing strategy, we consider that it has the largest coefficient of variation and that the burden on the supply chain, especially logistics, is quite large. The coefficient of variation for the EDLP strategy is about half the value of that for the HiLo marketing strategy, which is the smallest among the three marketing strategies and reduces the load on logistics. However, regarding sales volume and revenue, the EDLP strategy derives the worst results. Therefore, EDLP is effective in cases where logistics costs rise sharply and the load on the supply chain needs to be reduced as much as possible. Regarding the sustainable marketing strategy, it has the best sales volume and revenue, and its coefficient of variation is below that of the HiLo marketing strategy and close to that of the EDLP marketing strategy. The sustainable marketing strategy increased revenue, the degree of value provided to customers, and decreased the coefficient of variation, the degree of value provided to the supply chain.

5 Conclusion and Future Research

We propose marketing strategies that provide value to both customers and the supply chain as sustainable marketing and investigate its impact via a purchasing model based on the value function of prospect theory. A purchasing model was designed using sales data from an EC site using HiLo marketing to investigate the effects of sustainable marketing, and the results revealed that the coefficient of variation of sales volume was reduced while sales were increased.

Several issues remain to be addressed. First, the conversion method between utility and benefit should be modified. This study converts utility into benefit through the purchase probability derived by the logit model and reproduces the change associated with the change in price associated with a discount sale. To design a more accurate purchasing model, it is necessary to derive the amount of willingness-to-pay, for example, from a questionnaire survey on the difference in

product purchase. Next, the parameters of prospect theory should be adjusted. Owing to the data, our analysis focused on products rather than individual customers. However, it is not possible to accurately reproduce the effects of marketing without taking individual customer characteristics, such as the degree of favoritism toward the sale, into account. Target customers should be established and the impact of marketing on whom and how it affects them should be measured.

Although there are many challenges, we propose the concept of sustainable marketing for both customers and the supply chain, and suggest that sustainable marketing can be implemented.

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