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Pricing Strategies in Dual-channel Supply Chain with Discount and In-sales Service Consideration

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***Abstract*—Driven by increasing internet usage, Indonesia is experiencing a significant rise in e-commerce activities, with transactions projected to grow from 66 million to 99 million by 2029. This growth necessitates a hybrid approach combining online and offline sales channels to maximize market coverage. However, this dual-channel strategy poses challenges in pricing, as customer preferences heavily influence purchasing decisions. This study analyzes pricing strategies within a dual-channel supply chain (DCSC). It examines two main scenarios, centralized and decentralized systems, to determine optimal pricing strategies considering in-sales service and discount. The decentralized system employs a Stackelberg game model, where the manufacturer sets prices first, followed by the retailer. A clothing company is used as a practical case study to apply these mathematical formulations. The study highlights how parameter variations such as customer preferences, service, and unit costs influence price. Notably, the decentralized system often results in higher profitability than the centralized approach under specific conditions. Sensitivity analysis further reveals that while some parameters remain stable, customer preferences significantly affect pricing decisions. A preference for online shopping tends to favor a centralized strategy, indicating that coordinated pricing can mitigate channel cannibalization risks. The study underscores the complex interplay between pricing strategies, discounts, and in-sales services in dual-channel supply chains.**

***Keywords*—dual-channel supply chain, pricing, discount, in-sales service.**

I. Introduction

Today, the Internet has become necessary for most Indonesian people. According to research by the Indonesian Internet Service Provider, the number of Internet users in Indonesia reached 221 million in 2024, 79.5% of the total population [1]. The use of the Internet in daily activities occurs in many aspects, including fulfilling needs (buying and selling transactions). The rapid growth of internet usage is one of the underlying factors in developing online shopping (e-commerce) trends. Currently, 66 million internet users in Indonesia have done e-commerce transactions, which is expected to reach 99 million by 2029 [2]. The rapid growth of e-commerce has led many companies to explore new business avenues. These companies utilize face-to-face transactions (offline channels) and e-commerce (online channels) to meet customer demand. In addition to the significant growth potential, the desire to enhance competitiveness is a key factor driving the expansion of their business reach [3].

The demand fulfillment system carried out through several channels is called a dual-channel supply chain (DCSC) [4]. Since customers differ in channel preferences, multiple channels may cover potential market segments that could not be covered by a single channel and may increase market coverage. Channels in this supply chain are complementary to meet customer demand. This business scheme is increasingly prevalent in modern retail strategies. However, integrating online and offline channels presents unique challenges and opportunities for pricing strategy. Uniform pricing across channels can simplify operations but may not exploit the distinct advantages of each channel. In the DCSC system, price is the main factor influencing customers in choosing a channel [5]. Customers prefer the lower-priced channel; however, companies must do more than just lower prices as it will not increase profits [6]. When determining the price in a channel, one must consider the price in another channel. Online sales channels offer advantages over traditional ones, mainly operating costs. However, they also have drawbacks, such as inferior service and longer delivery times. As a result, there are notable differences when a product is sold online and in traditional channels. Typically, online products are priced lower than those sold through conventional channels [7]. This creates inevitable conflicts of interest between the two channels,

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making pricing challenging. Channels may compete, which results in channel cannibalization [8].

Differentiated pricing, where prices vary between online and offline channels, can enhance profitability by aligning with consumer preferences and channel-specific cost structures [9]. Factors such as lead time, return policy, discount, and channel service may be considered when differentiating prices [10][11][12]. Discounts serve as a strategic tool to stimulate demand and control inventory across different channels, potentially influencing consumer purchases to shift between online and offline platforms, thereby increasing market share. However, overuse of discounts can damage brand value and trigger price wars, especially in DCSC, where more than one channel co-exists [13]. In-sales service, including customer assistance and personalized recommendations, enhances the shopping experience and fosters customer loyalty. The pricing of these services requires balancing the cost of high-quality service provision with perceived customer value [14]. The relationship between pricing, discounts, and in-sales service is intricate. Discounts can increase the perceived value of in-sales services, while high-quality service can support higher prices. Companies must develop pricing strategies thoughtfully to prevent discounts from compromising service quality [15].

Recent empirical research has explored various aspects of DCSC. Channel conflict and coordination are broadly discussed [8][16][17]. Pricing strategies in DCSC have also been a prominent topic discussed in many recent studies [4][6][7][13]. Studies have also examined the impact of pricing and service quality on consumer channel choice [10][11][14]. Lastly, studies on DCSC also explored the effect of discounts on the channel's profitability [13][18][19].

This research on pricing strategies considering discounts and in-sales services within DCSC is crucial for understanding how businesses can optimize their multi-channel operations. As the retail landscape becomes increasingly complex, companies must adopt effective pricing strategies that prevent channel conflicts and align with consumer expectations [5][10][11]. By exploring the interplay between pricing, discounts, and service quality, this study aims to provide valuable insights into how companies can balance customer preferences with cost structures to enhance profitability.

II. Model Development

This study examines a business with a DCSC scheme. The structure of the DCSC is as follows:

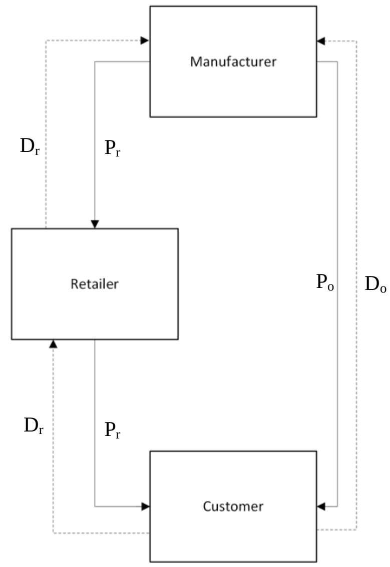

Figure. 1 DCSC Structure

Fig 1 shows the DCSC structure of the system studied. The business acts as a manufacturer and sells products to customers through an online channel (via e-commerce) with a price of P_o and an offline channel (via retailer) with a price of P_r. Prices set by the channels generate demand for both the online (D_o) and offline (D_r) channels. This study follows the demand functions from a study by Hamzaoui et al. [20]. This study proposed both offline and online demand functions which consider customer's channel preferences, expressed as follows:

$$D_o = \rho . a - \alpha_o . P_o + \beta . P_r \quad (1)$$

$$D_r = (1 - \rho). a - \alpha_r . P_r + \beta . P_o \quad (2)$$

Equations (1) and (2) show the demand function in a DCSC scheme [20]. ρ is the customer's preference on shopping via online ($0 < \rho < 1$), a is the maximum possible demand in both channels when the product is free, α_o and α_r are self-price sensitivity for online and offline channels, respectively, and β is the cross-price demand sensitivity.

In this study, several additional parameters and variables are considered. d_o and d_r are the discounts given in online and offline channels, respectively. γ is the demand sensitivity due to in-sales service, and w is the cost borne by the retailer for providing customers with in-sales services. Thus, (1) and (2) are modified into:

$$D_o = \rho . a - \alpha_o . (P_o - d_o) + \beta . (P_r - d_r) - \gamma . w \quad (3)$$

$$D_r = (1 - \rho). a - \alpha_r . (P_r - d_r) + \beta . (P_o - d_o) + \gamma . w \quad (4)$$

In (3) and (4) γ is used to convert the cost of in-sales service w into demand. The in-sales service provided in the offline channel will increase demand and decrease demand for the other channel (online). The discount is subtracted from the price given to the customers in both online and offline channels. If we let c as the unit cost of the product and profit be generated from the difference between price and cost multiplied by the

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customers' demand, therefore the profit for both channels can be expressed in (5) and (6) as follows:

$$G_o = (P_o - d_o - c)D_o \tag{5}$$
$$G_o = \rho a P_o - \alpha_o P_o^2 + 2\alpha_o P_o d_o + \beta P_r P_o - \beta d_r P_o - \gamma w P_o - \rho a d_o + \alpha_o d_o^2 - \beta P_r d_o + \beta d_r d_o + \gamma w d_o - \rho a c + \alpha_o P_o c - \alpha_o d_o c - \beta P_r c + \beta d_r c + \gamma w c$$

$$G_r = (P_r - d_r - c)D_r \tag{6}$$
$$G_r = aP_r - \rho a P_r - \alpha_r P_r^2 + 2\alpha_r P_r d_r + \beta P_r P_o - \beta d_o P_r - \gamma w P_r - a d_r - \rho a d_r + \alpha_r d_r^2 - \beta P_o d_r + \beta d_r d_o + \gamma w d_r - ac - \rho a c + \alpha_r P_r c - \alpha_r d_r c - \beta P_o c + \beta d_o c + \gamma w c$$

where G_o and G_r are total profits from online and offline channels respectively.

The notations used for modeling in this study are summarized in Table 2.

Table 2. Notations

Notation	Description
D_o	Demand in online channel
D_r	Demand in offline channel
P_o	Price in online channel
P_r	Price in offline channel
d_o	Discount in online channel
d_r	Discount in offline channel
ρ	Customer's preference
a	Maximum demand
α_o	Self-price sensitivity in online channel
α_r	Self-price sensitivity in offline channel
β	Cross-price demand sensitivity
γ	Demand elasticity from in-sales service
w	In-sales service cost
c	Unit cost
G_o	Profit of online channel
G_r	Profit of offline channel
G_{total}	Total profit of the supply chain

III. NUMERICAL EXPERIMENT

This study aims to maximize the profit gained by manufacturers by selling the product through online and offline channels with optimal prices and discounts. This is expressed mathematically as:

$$Max\ G_{total} = G_o + G_r \tag{7}$$
$$subject\ to$$
$$P_r \geq P_o \tag{8}$$
$$P_r - d_r \geq c \tag{9}$$
$$P_o - d_o \geq c \tag{10}$$
$$P_r, P_o, d_r, d_o \geq 0 \tag{11}$$

Equation (7) is the total profit the manufacturer gains or the supply chain profit. (8) is the price leadership following [7]. (9) and (10) ensure that the manufacturer gains profit from selling the product with the determined price and discount, while (11) ensures all variables are non-negative.

Two scenarios—centralized and decentralized—were developed to find the optimal solutions. In a centralized system, the manufacturer simultaneously determines online and offline prices. In a decentralized system, a Stackelberg game is used, where the manufacturer acts as the leader and the retailer as a follower.

A clothing business is chosen to conduct numerical experiments for this study. Models are coded using *fmincon* syntax from MATLAB to solve the proposed formulations. The following table presents the parameters' values used to solve the proposed models.

Table 1. Parameter Value

Parameter	Value
ρ	0.67
a	1,500
α_o	0.0006
α_r	0.0007
β	0.001
γ	0.01
w	5,000
c	50,000

A. Decentralized System

In the decentralized scenario, this study follows a Stackelberg game in which the manufacturer acts as a leader while the retailer acts as a follower. The manufacturer moves first and sets its price and discount, and then the retailer determines its price and discount in response to the manufacturer's decision. This scenario generates optimal solution P_o= 76,581; P_r= 468,990; d_o= 0; d_r= 0. These yield G_o= 27,201,704; G_r= 122,884,739; and G_{total}= 150,086,443.

Sensitivity analysis was conducted to observe how customer preference changes for shopping online (ρ), unit cost (c), and in-sales service cost (w) affect the price in each channel. Values between 0.1 and 0.9 were used to analyze changes in ρ, while w and c were analyzed using the Indonesian inflation rate of 1.84% based on the Bank Indonesia report. The results of this experiment are shown in Fig 2.

The experiment result in Fig 2 shows that optimal prices are greatly affected by changes in ρ. When customers prefer the online channel (higher ρ), they are willing to pay more for online shopping but will not accept a higher price in the offline channel. The result also indicates that prices in both channels are not sensitive to changes in the unit cost. Thus, the prices remain relatively constant. Lastly, changes in cost spent on providing in-sales service affect only the offline channel where the in-sales service occurs.

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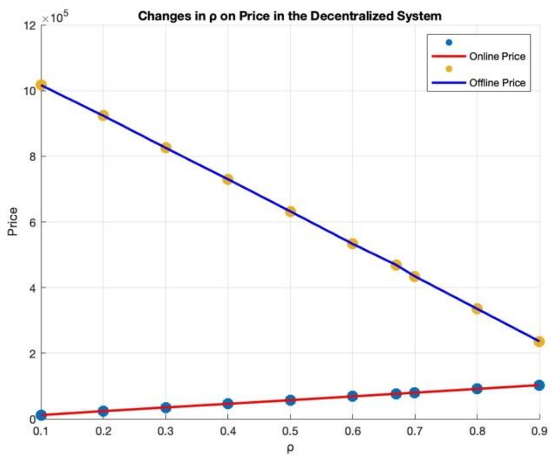
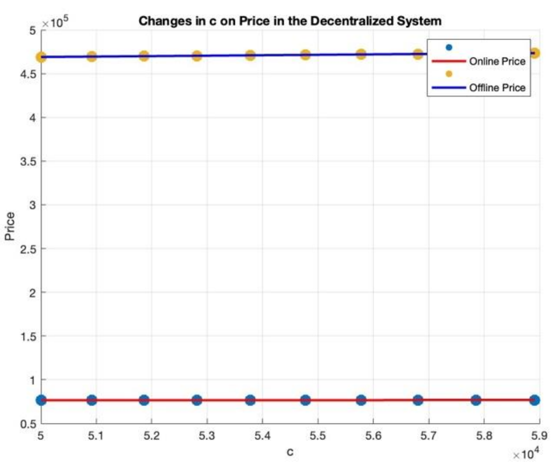
B. Centralized System

In this centralized scenario, the manufacturer determines the price and discount for online and offline channels. The prices are optimized to maximize the manufacturer's total profit. This scenario generates optimal solution P_o= 102,070; P_r= 281,030; d_o= 0; d_r= 0. These yield G_o= 104,044,129; G_o=; and G_{total}= 165,215,340. A sensitivity analysis was done for ρ, c, and w using the same value as the decentralized system. The results of this experiment are shown in Fig 3.

From Fig 3, we can conclude that when prices are determined simultaneously, neither parameter changes immensely alters the prices. Fluctuations in online prices indicate the occurrence of a discount. From the experiment, we can observe that the fluctuation only takes place when unit and in-sales service costs change. This shows that costs immensely influence discounts.





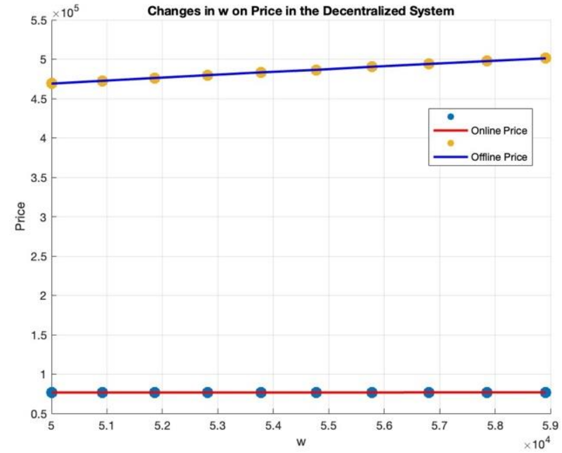
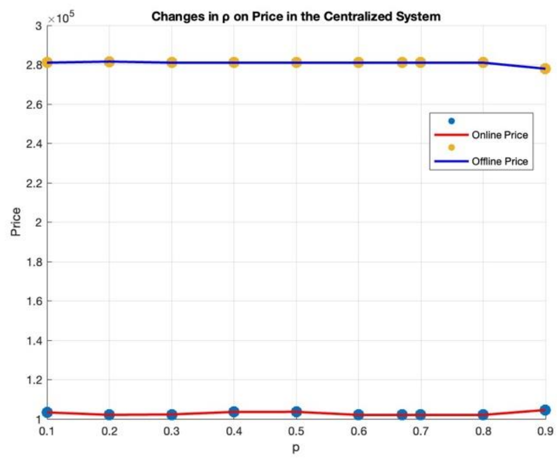
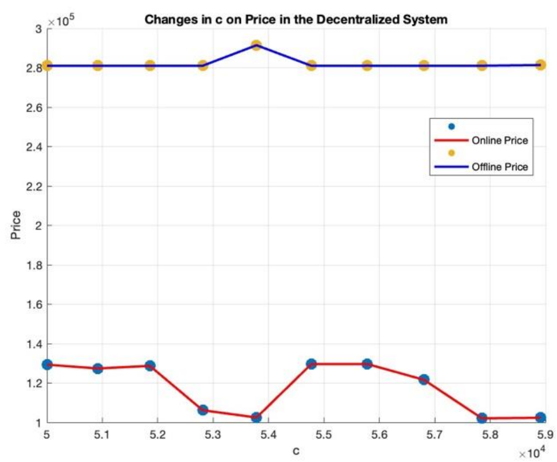


Figure 2. Sensitivity Analysis in the Decentralized System





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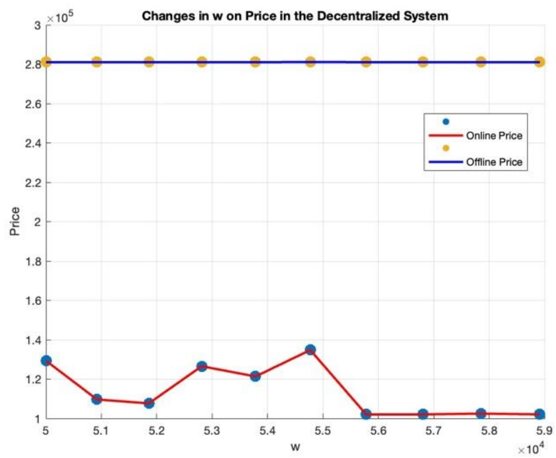


Figure 3. Sensitivity Analysis in the Centralized System

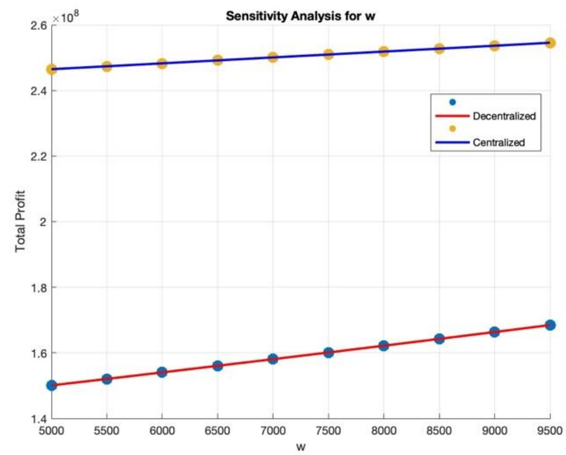
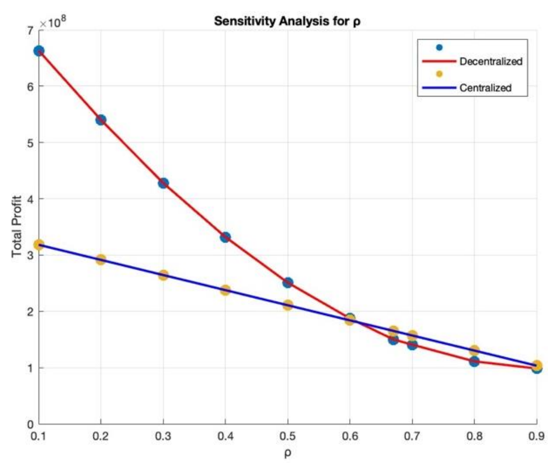
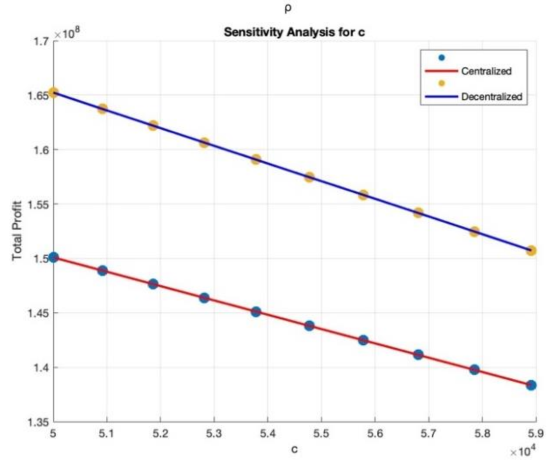


Figure 4. Scenario Comparison

IV. Result and Discussion

This study aims to observe how in-sales service and discounts affect the pricing strategy under two scenarios—centralized and decentralized. The result shows that, in this case, the decentralized system performs better than the centralized system as it generates more profit for the supply chain. However, the sensitivity analysis in Fig 4 shows that parameter changes shift the optimal solution.





The observed parameters are the preference for shopping online (ρ), unit cost (c), and in-sales service cost (w). From Fig 4, we can observe that the optimal solution remains for every change in the unit and in-sales service cost. This shows that the model developed in this study is not sensitive to c and w. From Fig 4, we can also conclude that a higher unit cost generates less profit while spending more on providing in-sales service generates more profit. However, changes in customer preference significantly affect the optimal decision. The optimal decision for ρ greater than 0.6 is to determine the price under the centralized system. When customers prefer the online channel, the better plan is to coordinate between the two channels to prevent the online channel from cannibalizing offline demand. The retailer gets less profit as an individual, but the supply chain will achieve maximum profit. On the other hand, lower ρ means more customers prefer the offline channel, allowing the retailer to determine its price in response to the manufacturer's online price.

V. Conclusion

The study introduces a mathematical model to optimize pricing and discount decisions across dual channels, addressing issues like in-sales service and discounts. It concludes that tailoring pricing strategies to align with consumer preferences can significantly boost profitability. Empirical analysis suggests that decentralized DCSC systems, where retailers adjust prices in response to manufacturers, tend to yield higher profits than centralized systems. Customer preferences for online or offline shopping heavily influence retail pricing decisions. This study shows that a centralized system is better for the supply chain when customer preference for online shopping is high. Conversely, a decentralized system is preferred when customers prefer to shop offline.

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