Int. J. Nonlinear Anal. Appl.
Volume 12, Special Issue, Winter and Spring 2021, 1477-1495
ISSN: 2008-6822 (electronic)
http://dx.doi.org/10.22075/IJNAA.2021.5793

Research on the influence of information technology investment on production cost management innovation in the retail industry under the 020 model

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(Communicated by Madjid Eshaghi Gordji)

Abstract

Nowadays, every sector strives to provide its customers an exceptional experience. With an online to offline retailing structure, higher profits may be made while still providing customers with dependable service. Offline and online techniques are also covered in this framework for improving production management. Online to offline (O2O) models are included here for various retail sales of particular items from the sector since information technology plays a vital role in retail production management. Industries must innovate or die if they want to remain competitive in the future marketplace. Because of this, innovation has become a popular term in the business world. Innovative product cost management technique that incorporates idea development, dissemination, and conversion. To get around this concept, one must use an approach that does not rely on distribution. The model's usefulness in Realtime is shown via numerical examples. Critical parameters are used in a sensitivity analysis. Graphical ramifications and special situations give further evidence of the current study's global optimization. Index Terms.

Keywords: Information technology, Retail industry, Online to offline, Innovation strategy

1. Introduction

A good example of the fourth industrial revolution is O2O. Reality and cyber-based innovation are combined in this technology to improve production management. Because of the advancement in technology, this phenomenon—of supplying online demand to offline markets—has become widespread.

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Received: August 2021 *Accepted:* Novamber 2021

It has recently expanded to include interiors, industries, workplaces, and even more occupations as a result of this. In accordance with the 2018 China O2O food facility service industry development study, the Chinese food service providing market had a value of 204.6 billion in 2017. In 2017, there were over 300 million online delivery users, a 15% increase over 2016. By the end of 2018, the population is expected to reach 350 million. Big data and artificial intelligence, for example, are used in the O2O model to provide real-time services via the platform to the end clients. In order to achieve and retain a sustainable competitive edge in a society, researchers feel that innovation is essential. An organization's stakeholders are said to get additional value through the adoption of innovative services or products. A critical role for innovation is assumed in every strategic firm. In this day and age of rapidly evolving information technology (IT), understanding organizational innovation has never been more important, and researchers consider it one of the most important topics when looking at the impact of IT on organizations. A contingency-based method, based on IT literature, is becoming more important to understand innovation in organizations.

Despite an increase in the number of studies on IT-based innovation and evidence that IT may provide a means for new services and products, the current literature remains cautious about the role of IT in organizational innovation. Studies debate if there is an unmistakable relationship between innovation and IT, but so far, they have come up with no conclusive answers. Many studies in this area indicate similar results concerning the relationship between IT innovation and business performance, including the finding that, in certain cases, there is no such relationship. The use of IT has benefited innovation, yet certain counter-intuitive in-built outcomes have limited the development of alternative theoretical frameworks for innovation research. Capacity has been seen as critical in this connection, for example. A resource viewpoint has been taken into account in other investigations. The level of hurdles and resistance identified at this time is due to a variety of factors, many of which may be traced back to corporate decisions unrelated to the current programme. This technique incorporates a smart retailing strategy to increase the importance of manufacturing cost control. People are also using smart gadgets like laptops, cellphones, and PCs for longer periods of time than in the past. In other words, researchers are trying to develop tactics based on or employed by people. Because of the widespread usage of smart devices, researchers are attempting to develop their own models by including various internet advertising strategies. Due to the reception of the internet and the frequent use of mobile internet, human intellectual and lifestyle were drastically altered. A considerable influence of the internet on retail profit optimization has been felt. Online-to-offline (O2O) delivery, as a specific kind of e-commerce, connects retailing with O2O. Based on manufacturing cost management, this approach provides a one-of-a-kind option for customers to designate their desired product offline and then get it online to use at a specific location. Customers in the O2O model have the option of taking their items offline or online. Customers will be able to choose their items online and have them delivered to their front door through offline mode under this framework. Obtaining investment and properly distributing staff at a reasonable price was the door step to the distribution model's distribution models. The main contribution of the suggested methodology in which the

- online to offline ($O2O$) model are included here for some selling specific products from the industry.
- Distribution-free methodology is utilized to improve the distribution model for the users.

Rest of the paper is structured as follows. Section II provides a quick overview of relevant literature. Section III explains the problem statement. Section IV contains a comprehensive explanation of the concept under consideration, while Section V examines the recommended approach. Finally, in Section VI, we come to a conclusion.

2. Related works

[14] an O2O retail supply chain is analyzed, with one provider serving as the hub. In the static example, the supply chain is managed by a revenue-sharing agreement. After the production plan is developed, disruptions affect the price sensitivity coefficient. Centralized supply chains only require suppliers to modify retail prices when disruptions fall within a specific range. As soon as there is a significant interruption, the supplier will have to modify both the retail pricing and manufacturing volumes accordingly. A decentralized decision-making process makes it impossible to coordinate the supply chain. So, the previous revenue-sharing agreement is useless in coordinating the new supply chain. The interrupted supply chain is coordinated via a new revenue-sharing contract. According to the findings, the enhanced contract is able to coordinate the original supply network with the disrupted supply chain, proving its resilience in the face of demand deviation. [9] this study's sustainable online-to-offline retailing approach suggests ways to improve customer service while also increasing profit. For the sake of providing the greatest service, the industry offers its goods both online and offline. When considering both online and offline systems, the selling price of items varies depending on the mode, and the demand for a given product is the sum of online and offline demand, which are linked to the product's pricing. To make things even better, the system calculates the actual lead time and backorder to determine the exact cost and profit of the system, which directly impacts how well it serves customers. To maximize the overall system profit, several investments are made. This model's problem can be solved using a non-distributional technique. The model's applicability in reality is shown using numerical examples. Critical parameters are used in a sensitivity analysis. The current study's global optimality has also been shown through special situations and graphical representations. [13] two strategies for the supply chain parties to use in order to lessen O2O competition and generate a Pareto outcome are manufacturer financial assistance in reward points for retailers and profit sharing. [2] analyze when a local B&M shop should use an O2O strategy and the circumstances under which each of the three operating modes is most effective. A shop should only use the O2O method if the market is either partly or totally covered and the business's delivery costs are reasonable. Based on the delivery cost threshold, we thoroughly describe the ideal mode of operation. When the shop provides consistent pricing to both online and B&M store clients, the self-building and mixed modes predominate over the platform mode. They also suggest a new structure of collaboration that may increase the earnings of both the platform and the local B&M shop. With the suggested framework for collaboration, platform mode will also have a significant advantage over mixed mode. [12] the O2O model uses Crawlzilla and R approaches to derive eleven indicators of overall satisfaction from customers. Consumers' overall opinion is reflected in the O2O model's social networks, which are built using social network analysis (SNA). This research (N = 768) demonstrates the general evaluation behavior patterns of customers in the O2O model by calculating network density, central potential, and edge between based on the modified social network and the extracted sub graph. [11] uses extensive information from more than 240,000 orders to determine the pricing strategy of three of the most popular on-demand food service platforms in China, and examines the influence of pricing strategy on platform performance. Some platforms use dynamic pricing techniques, while others use static pricing tactics, according to our research. They build a dyadic two-sided market theory based on the distinctive structure of the Chinese O2O on-demand food service industry and show that dynamic pricing methods outperform static pricing tactics. According to our hypothesis, platforms that use dynamic pricing techniques have much greater demand than platforms that use static tactics, as shown by our empirical investigation. [1] the evolution of location and pricing behavior of service providers, this paper proposes an O2O model based on profit-maximizing agents and utility-maximizing customers, both of whom are linked by

social networks, allowing them to spread the word about their service experiences through word of mouth (WOM). Customers' WOM may be overlooked if the service merchant standardizes its service management to provide a constant expectation. Firms with changeable service quality, on the other hand, should use aggressive price and location tactics when dealing with socialized clients. When it comes to O2O marketplaces, consumers' social learning makes it easier to provide a wide range of services, but it also causes unforeseen offline demand changes that put service providers' performance at risk. [15] Propose a matching approach for assignments that combines the optimization of matching and pricing techniques with the most efficient delivery routes to a variety of merchants on the basis of real-world data from Zallsoon, a well-known Chinese freight O2O platform, the suggested assignment matching technique may reduce pickup distance by 75–81.81 percent. In addition, the choice of price techniques may improve transportation costs by 60–93.33 percent in cities with different order patterns and marketing levels. [10] analyses a scenario in which a manufacturer sells via online and offline channels and provides a two-dimensional warranty policy, including a warranty-age and a warranty-usage package for sold items through online channel. Failures of all manufacturer's portfolio items are statistically dependent since various models share many components. Pricing and warranty policies may be optimized with a new model. Because warranty claim rates are stochastic, the value-at-risk technique is used to address the optimization issue. In addition, a copula is used to calculate the covariance between warranty claims made in connection with diverse items. [5] here the online retailer seeks optimal online sale prices and an optimal delivery schedule in an order cycle, and the offline retailer pursues a maximal rate of sharing profit due to the consignment from the online retailer by developing a stochastic Nash equilibrium model with incentive compatibility constraints. The equilibrium model is first turned into a set of restricted nonlinear equations using an expectation approach and optimality requirements. The model is then evaluated and the following practical insights are provided via a case study and sensitivity analysis. When used in BOPS mode, it is possible to create an equilibrium strategy for online and offline shops that includes the optimum online selling price, the ideal timetable for delivery and an adequate supply of profit allocations for both online and offline merchants. It's important to note that different model parameters like the operating cost and price sensitivity coefficient have different effects on the BOPS system's profitability and the equilibrium solution. (III) Delivery schedule optimization may increase customer surplus and reduce the offline retailer's portion of the online retailer's sale profit, even if the BOPS system's overall profit increases. It is essential to have inventory subsidies in BOPS mode if you want to increase the game model's applicability. [4] models the service providers as profit-maximizing agents and the consumers as utility-maximizing agents linked through social networks so that they may spread the news about their positive or negative service experiences via word of mouth (WOM). Customers' WOM may be overlooked if the service merchant standardizes its service management to provide a constant expectation. Firms with changeable service quality, on the other hand, should use aggressive price and location tactics when dealing with socialized clients. When it comes to O2O marketplaces, consumers' social learning makes it easier to provide a wide range of services, but it also causes unforeseen offline demand changes that put service providers' performance at risk. [3] In order to execute online retailing, a shop may either create all of its own online retail and delivery capabilities (self-building mode) or outsource order-taking to a third-party platform while offering clients a self-built delivery option (mixed mode). The circumstances under which each of the three modes is ideal are examined analytically when a local B&M shop should implement an O2O approach. A retailer should only use the O2O method if the market is either partly or totally covered, and the business's delivery costs are low enough to justify it. Based on the delivery cost threshold, we thoroughly describe the ideal mode of operation. When the shop provides consistent pricing to both online and B&M store clients, the self-building and mixed modes predominate over the platform mode. A new technique of collaboration that they suggest can help both the platform and the nearby B&M shop make more money. [6] presents a new framework for coordinating efforts in order to reduce channel rivalry and increase revenues for all stakeholders. It is first suggested and analyzed to use two different strategic methods (a manufacturer rebate to offline customers and a quantity discount).

3. Problem statement

As technology and digitization continue to accelerate, a sustainable O2O supply chain model was built in this present research. All supply chain improvements result in shorter lead times for meeting consumer demand. Advertisement expenses dropped, and the supply chain transitioned to a more sustainable one thanks to O2O channeling. Additionally, the system cost was decreased because of the implementation of a constant ordering cost and the calculation of a variable ordering cost under certain ongoing expenditures, making the model more financially viable. An increase in system stability as a result of continual investment increases O2O channeling service and makes the model more viable. This research studies the integrated decision planning for production reliability and productivity in high-tech capacity manufacturing. Developing inventory strategies based on demand fluctuation is also very useful for a company. The producer has an SSMD shipping policy, which stipulates that the goods must Furthermore, finding out how backordered is distributed is very difficult. Backorders were modeled using a normally distributed and a distribution-free technique. Defective rates are thought to follow a certain distribution, according to this theory. This results in a maximum overall system profit and optimal decision variable values, and it is shown that supply chain profits are maximized as a result. We take into account a demand function in which demand rises as technology levels rise. Consumer electronic goods such as mobile phones, laptops, high-tech items, smart watches, semiconductors, and electronic chips all have this sort of demand attached to them. The next stage in this study explores the impact of cost-effective product delivery to customers' doorsteps.

4. Proposed work

The schematic representation of the suggested methodology was depicted in figure 1.
The following assumptions may be used to create the model:

1. For a specific product type, this article examines a sustainable O2O retail channeling supply chain with just one store and one producer.

2. The manufacturer exclusively sold offline to the store, but the retailer sold both online and offline. Since online and offline demand is dependent on selling price, the supply chain's demand is determined by, $Db = F_{as}\alpha 1^1 + F_{bs}\alpha^2$ which makes the model more sustainable.

3. The offline pricing is always greater than the online price under the O2O model.

4. Reducing buying and shipping costs and improving the dependability of the manufacturing process are two new initiatives introduced.

5. Another aspect of service enhancement is the reduction of lead and shipping times. This approach considers a variety of crashing costs to shorten the lead time for several, mutually interdependent components. When it comes to crash costs per unit time up, we may say that the minimal length is equal to bp/ap. Assume that Lta is the minimum duration for components

1, 2, 3..., p and that $Lt0 = ny = 1bp$ is the minimum duration for Lta. Once this is established, the crashing cost R(Le) may be stated as follows:

$$R(Le) = up(Ltp - Le) + \sum py = 1(bq - aq)\ for\ p = 1, 2, \ldots, n$$

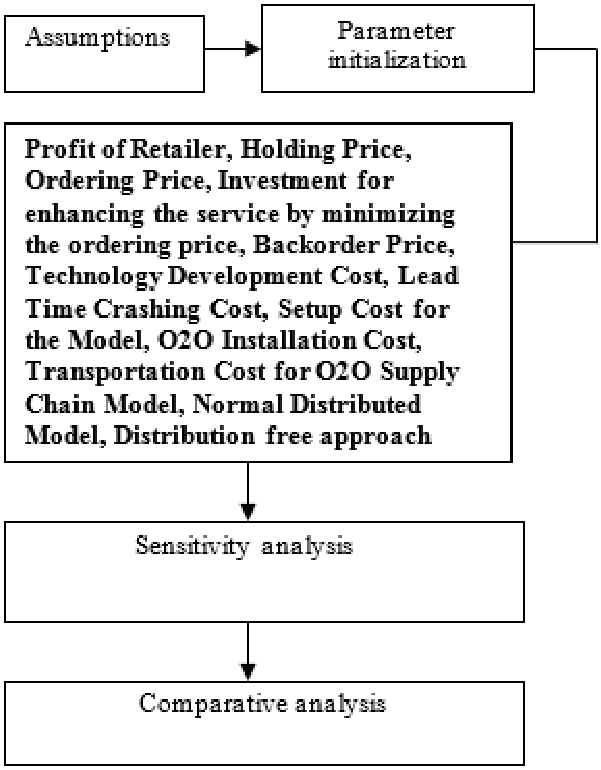

Figure 1: Proposed schematic representation

6. In this architecture, transportation is handled using a single-setup multi-delivery (SSMD) strategy. The items were made in a single batch by the manufacturer, and they were delivered in many deliveries. The primary rationale for implementing the SSMD policy is to improve the sustainability of the supply chain model in an O2O environment. The number of deliveries and transportation costs rose when several deliveries were employed. So, the retailer's holding costs have to be balanced against the increasing transportation expenses. To improve the sustainability of the model, variable and constant transportation costs, as well as carbon emission costs, were taken into account.

7. The reorder point was calculated using safety stock and the estimated demand plus the lead time.

8. The normally distributed backorder rate allows for fully backordered shortages, and distribution-free techniques are taken into account while forming two models. A dynamic way of living in today's social circumstances necessitates effective production management in the retail business. Online commerce, on the other hand, accentuates the brilliance of this concept. A seller and a customer are both mentioned in the model, which relates to an IT innovation. Production is based on the current market's innovation, quality, and service facility. The approach is nevertheless more genuine because of the online-to-offline capability that is included.

9. When assuming a mean and standard deviation, the demand has a normal distribution, as expected. The normally distributed backorder rate allows for fully backordered shortages, and distribution-free techniques are taken into account while forming two models.

Notation

To frame the model, following described notation are assumed and used in this model:
F_a- holding price of the inventory for retailer
$V-$ Each products volume
t- ordering point
B_b- rate of demand for retailer
L_e- lead period
μ- rate of backorder
P_b- ordering price for retailer
J_a- annual price of fraction for product investment
O_i- size of product
O_{c_o}- initial prices of product.

a. Profit of retailer

The customer is an important part of this strategy, which matches items in offline and online modes before the end user's hand. For the end-user, there are several strategies to increase profit, including providing service facilities, reducing ordering costs, and developing technology. The price shows how to take the end user into account.

b. Holding price (HP)

It has a significant impact on the price the customer pays. Even if the vendor-to-customer transfer of innovation is unlikely, it is critical to have a supply on hand. End user happiness and attractiveness need an investment approach like this. To show the holding price, below is a formula:

$$F_A[\frac{wv}{2} + a - B_b L_s + (1-r)F(Y-a)] \tag{1}$$

c. Ordering price (OP)

When the client gives the end user with facts about the requirement of the product, the quality of the product, and market demand, the ordering price comes into play. However, providers constantly offer the possibility to use a clever technique as their order methodology in this product management online-to-offline company model. Consequently, the cost to place an order will be as follows.

$$\frac{P_b(J_a V_1^{-a_1} + J_a V_2^{-a_2})}{W_s} = \frac{C_b(F_\alpha V_1 - \alpha_1 + F_\alpha V_1 - \alpha_1)}{V_s} \tag{2}$$

d. Investment for enhancing the service by minimizing the ordering price

The product service facility is improved, but the cost is kept to a minimum in this novel technique. Doing everything online without involving someone in the ordering process or collecting samples, for example. If possible, utilizing a practical approach to reduce the ordering price without increasing the price across numerous networks.

$$O_i = f\ ln\frac{O_{cv}}{P_b} \tag{3}$$

e. Backorder price (BP)

In today's retailing period, the price of backorders is the most important consideration. Because everyone's time is valuable these days, consumers place a high value on product innovation. It's likely that there will be very little time between product delivery and order in this circumstance. Backorders may be classified as either complete or partial depending on how long it takes to receive and fulfill the order. To prepare for backorders, the following pricing expression is taken into account.

$$\frac{(F_a V_1^{-a_1} + F_a V_2^{-a_2})}{W_s}(\mu_x + \mu_0(1-\tau)F(Y-a)) \tag{4}$$

f. Technology development cost (TDC)

A strong platform is required to stay afloat in today's highly competitive economy. It's useful for businesses that do both online and offline. Buyers may purchase items, market them, show stock, and recover the customer's order at a low cost, while also providing fast feedback, receiving feedback, and learning about the amount of improvement. This technological investment benefits both customers and suppliers considerably. For sustainable supply chain development, the O2O network plays a critical role, and it is essential to invest in the development of new technologies that will help make the system more sustainable. An example of such an investment is shown by the following statement:

$$TDC = I + T_D \frac{(F_a V_1^{-a_1} + F_a V_2^{-a_2})}{V_s} \tag{5}$$

g. Lead time crashing cost (LTCC)

Managing the green sustainable supply chain from online to offline now has critical mass. It's important to take into account things like lead times, buyer popularity, firm size, and time invested in the competitive market. A gift policy may be required to maintain a customer who has been waiting a long time for a delivery. Because of the mishap, the company not only has a full backorder, but it also has a loss in lead time and cost.

$$\frac{(F_a V_1^{-} \alpha_1 + F_a V_2^{-} \alpha_2)}{V_s} R(L_e) \tag{6}$$

Retailer cost can be illustrated by,

$$\begin{aligned}
TC_R(V_s, V, V_2, k, L_e, C_b) &= HC + OC + TDC + BC + LTCC \\
&= \left[h_s(\frac{V_s}{2} + r - D_b L_s + (1-\zeta)K(X-r)^+) \right] + 1 \\
&+ \frac{C_b(F_a V_1^{-} \alpha_1 + F_a V_2^{-} \alpha_2)}{V_s} + g\ ln \frac{O_{co}}{C_b} \\
&+ T_d \frac{(F_a V_1^{-} \alpha_1 + F_a V_2^{-} \alpha_2)}{V_s} \\
&+ \frac{(F_a V_1^{-} \alpha_1 + F_a V_1^{-} \alpha_1)}{V_s} \left(\pi_x + \pi_0(1-\zeta)E(X-r)^+ \right) \\
&+ \frac{(F_a V_1^{-} \alpha_1 + F_a V_1^{-} \alpha_1)}{V_s} R(L_e)
\end{aligned} \tag{7}$$

The profit revenue of the retailer can be illustrated by,

$$\begin{aligned} Profit_R(x, V_s, s_1, s_2, k, L_e, C_b) &= \big((V_1 - P_{ub}) + F_a s_1^- \alpha_1 + F_a V_1^- \alpha_1 + (V_1 - P_{ub}) F_b V_2^- \alpha_2\big) \\ &- TC_B(V_s, V_1, p_2, \sigma, L_e, C_b) \qquad (8) \\ &= \big((V_1 - P_{ub}) + F_a V_1^- \alpha_1 + F_a V_1^- \alpha_1 + (V_1 - P_{ub}) F_b V_2^- \alpha_2\big) \\ &- \left[h_B(\frac{V_s}{2} + r - DL_e + (1-\zeta)K(X-r)^+)\right] \\ &+ I + \frac{C_b(F_a V_1^- \alpha_1 + F_a V_2^- \alpha_2)}{V_s} + g\ ln\frac{O_{co}}{C_b} \\ &+ T_d \frac{(F_a V_1^- \alpha_1 + F_a V_1^- \alpha_1)}{V_s} \\ &+ \frac{(F_a V_1^- \alpha_2 + F_a V_1^- \alpha_2)}{mV_s}\big(\pi_x + \pi_0(1-\zeta)E(X-r)^+\big) \\ &+ \frac{(F_a V_1^- \alpha_2 + F_a V_1^- \alpha_2)}{xV_s} R(L_e) \qquad (9) \end{aligned}$$

h. Setup cost for the model

Equipment may be ready for multiple batches of goods by obtaining a production setup. Spending one's time may result in productivity throughout the course of the whole cycle and the subsequent period. It's a necessary cost to start and maintain a successful business. Based on the design, the production process moves quickly forward. The merchant should focus on a critical issue in addition to eco-friendly products. This is how much it will cost to set everything up:

$$\frac{(F_a s_1^- \alpha_2 + F_a s_1^- \alpha_2) A_s}{xV_s} R(L_e) \qquad (10)$$

i.O2O Installation cost

O2O installation is necessary to keep the O2O supply chain running efficiently. There is a predetermined fee for the O2O configuration installation. Internet host purchase and visualization expenses, as well as labor, all add up to the final web page design price. Costs associated with O2O setup have a significant influence on long-term viability of a system. The cost is established by,

$$\begin{aligned} O2O_{IC} &= C_{wd} + C_{ph} + C_{vw} + C_{lw} \\ &= \frac{(C_{wd} + C_{ph} + C_{vw} + C_{lw})(F_a s_1^- \alpha_2 + F_a s_1^- \alpha_2)}{xV_s} \qquad (11) \end{aligned}$$

j. Transportation cost for O2O supply chain model

To keep track of shipping costs, the O2O supply chain model must incorporate transportation costs,

$$xF_T + xV_T V_s \qquad (12)$$

k. Holding cost of the manufacturer

A big inventory and active supply chain management are necessitated by the holding cost. This is a positive development. All the unsold items are stored in this kind of investment.

$$\begin{aligned}\frac{[shaded-area]}{V_s/(F_a s_1^{-\alpha_1}+F_a s_2^{-\alpha_2})} &= \left[\frac{V_s}{2}+\frac{(x-2)V_s}{2}\left(1-\frac{(F_a s_1^{-\alpha_1}+F_b s_2^{-\alpha_2})}{(1-\beta)P_r}\right)\right]\\ &\left[\frac{V_s}{2}+\frac{(x-2)V_s}{2}\left(1-\frac{(F_a s_1^{-\alpha_1}+F_b s_2^{-\alpha_2})}{(1-\beta)P_r}\right)\right]H_c\\ &TC_M(x,V_s,s_1,s_z,P_\phi) \qquad (13)\end{aligned}$$

The profit function can be illustrated by,

$$\begin{aligned}&\frac{(F_a V_1^{-\alpha_1}+F_b V_2^{-\alpha_2})}{xV_s}(A_s+C_{wd}+C_{ph}+C_{vw}+C_{lw})\\ &\frac{V_s}{2}\left[1+(x-2)\left(1-\frac{(F_a V_1^{-\alpha_1}+F_b V_2^{-\alpha_2})}{(1-\beta)P_r}\right)\right]H_c\\ &\frac{xS_c(F_a V_1^{-\alpha_1}+F_b V_2^{-\alpha_2})}{2}+b\ ln\frac{P_{\phi 0}}{P_\phi} \qquad (14)\end{aligned}$$

The retailer and manufacturer profit function can be illustrated by,

$$\begin{aligned}&\frac{F_T(F_a V_1^{-\alpha_1}+F_b V_2^{-\alpha_2})}{xV_s}+V_T(F_a V_1^{-\alpha_1}+F_b V_2^{-\alpha_2})\\ &+\frac{(F_a V_1^{-\alpha_1}+F_b V_2^{-\alpha_2})F_{ccv}}{V_s}+V_{ccv}(F_a s_1^{-\alpha_1}+F_b V_2^{-\alpha_2})\\ &Profit_M(x,V_s,s_f,s_1,P_2,P_\phi)=\\ &((P_{ub}-P_{uv})F_a V_1^{-\alpha_1}+(P_{ub}-P_{uv})F_b V_2^{-\alpha_2})\\ &-TC_V(x,V_s,V_f,V_1,P_\phi) \qquad (15)\end{aligned}$$

The equation can be finally written in the form of,

$$\begin{aligned}&=((P_{ub}-P_{uv})F_a s_1^{-\alpha_1}+(P_{ub}-P_{uv})F_b s_2^{-\alpha_2})\\ &-\frac{F_T(F_a s_1^{-\alpha_1}+F_b s_2^{-\alpha_2})}{xV_s}(A_s+C_{wd}+C_{ph}+C_{vw}+C_{lw})\\ &+\frac{V_s}{2}\left[1+(x-2)\left(1-\frac{(F_a s_1^{-\alpha_1}+F_b s_2^{-\alpha_2})}{(1-\beta)P_r}\right)\right]H_c\\ &+\frac{xS_c(F_a s_1^{-\alpha_1}+F_b s_2^{-\alpha_2})V_s P_\phi}{2}+b\ ln\frac{P_{\phi 0}}{P_\phi}+\frac{F_T(F_a s_1^{-\alpha_1}+F_b s_2^{-\alpha_2})}{V_s} \qquad (16)\end{aligned}$$

The validation cost can be illustrated by,

$$V_T(F_a s_1^{-\alpha_1} + F_b s_2^{-\alpha_2}) + \frac{(F_a s_1^{-\alpha_1} + F_b s_2^{-\alpha_2})F_{ccv}}{V_s} V_{ccv}(F_a s_1^{-\alpha_1} + F_b s_2^{-\alpha_2})$$
$$\big((s_1 - P_{uv}) + F_a s_1^{-\alpha_1} + (s_2 - P_{uv}) + F_b s_2^{-\alpha_2}\big) - TC(x, k, V_s, L_e, s_1, s_2, P_\phi, C_b) \tag{17}$$

$$= \big((s_1 - P_{uv}) + F_a s_1^{-\alpha_1} + (s_2 - P_{uv}) + F_b s_2^{-\alpha_2}\big)$$
$$- [\left[h_B(\frac{V_s}{2} + r - D_b L_e + (1-\zeta)E(X-r)^+)\right] + I + \frac{C_b(F_a s_1^{-\alpha_1} + F_b s_2^{-\alpha_2})}{xV_s} + g\ ln\frac{O_{co}}{C_b}$$
$$+ T_d\frac{(F_a s_1^{-\alpha_1} + F_b s_2^{-\alpha_2})}{V_s} + \frac{(F_a s_1^{-\alpha_1} + F_b s_2^{-\alpha_2})}{V_s}\big(\pi_x + \pi_0(1-B)E(X-r)^+\big)$$
$$+ \frac{(F_a s_1^{-\alpha_1} + F_b s_2^{-\alpha_2})}{V_s}R(L_e)]\frac{(F_a s_1^{-\alpha_1} + F_b s_2^{-\alpha_2})}{xV_s}(A_s + C_{wd} + C_{ph} + C_{vw} + C_{lw}) \tag{18}$$

$$\frac{V_s}{2}\left[1 + (x-2)\left(1 - \frac{(F_a s_1^{-\alpha_1} + F_b s_2^{-\alpha_2})}{(1-\beta)P_r}\right)\right] H_c + b\ ln\frac{P_{\phi 0}}{P_\phi}$$
$$\frac{xS_c(F_a s_1^{-\alpha_1} + F_b s_2^{-\alpha_2})V_s P_\phi}{2} + \frac{F_T(F_a s_1^{-\alpha_1} + F_b s_2^{-\alpha_2})}{V_s} + V_T(F_a s_1^{-\alpha_1} + F_b V_2^{-\alpha_2})$$
$$\frac{(F_a s_1^{-\alpha_1} + F_b s_2^{-\alpha_2})}{V_s} + V_{ccv}(F_a s_1^{-\alpha_1} + F_b V_2^{-\alpha_2}) \tag{19}$$

l. Normal distributed model

According to the normal distribution model, the product quantity can be illustrated by,

$$E(X-r)^+ = \int_r^\infty (m-r)f(m)dm \tag{20}$$

$$E(X-r)^+ = \int_r^\infty (m-r)\frac{1}{\sqrt{2\pi\sigma}\sqrt{L_e}}e^{-\frac{1}{2}}\left(\frac{m - D_b L_e}{\sigma\sqrt{L_e}}\right)^2 dm \tag{21}$$

The probability density function can be illustrated by,

$$E(X-r)^+ = \sigma\sqrt{L_e}\int_k^\infty (z-k)\theta(z)dz \tag{22}$$

$$E(X-r)^+ = \sigma\sqrt{L_e}\psi(k) \tag{23}$$

The total estimated profit can be demonstrated us,

$$
\begin{aligned}
&Total\ Profit(x, k, V_s, L_e, s_1, s_2, P_\phi, C_b) \\
&= \left((s_1 - P_{uv}) + F_a s_1^{-\alpha_1} + (s_2 - P_{uv}) + F_b s_2^{-\alpha_2}\right) - TC(x, k, V_s, L_e, s_1, s_2, P_\phi, C_b) \quad (24)\\
&= \left((s_1 - P_{uv}) + F_a s_1^{-\alpha_1} + (s_2 - P_{uv}) + F_b s_2^{-\alpha_2}\right) - [[h_B(\frac{V_s}{2} + k\sigma\sqrt{L_e} \quad (25)\\
&+ (1-\zeta)\sigma\sqrt{L_e}\infty(k))] + I + \frac{C_b(F_a s_1^{-\alpha_1} + F_b s_2^{-\alpha_2})}{V_s} + g\ ln\frac{O_{co}}{C_b} \\
&+ T_d \frac{(F_a s_1^{-\alpha_1} + F_b s_2^{-\alpha_2})}{V_s} + \frac{(F_a s_1^{-\alpha_1} + F_b s_2^{-\alpha_2})}{V_s}\left(\pi_x + \pi_0(1-\beta)\sigma\sqrt{L_e}\infty(k)\right) \\
&+ \frac{(F_a s_1^{-\alpha_1} + F_b s_2^{-\alpha_2})}{V_s} R(L_e)] + \frac{(F_a s_1^{-\alpha_1} + F_b s_2^{-\alpha_2})}{x V_s}(A_s + C_{wd} + C_{ph} + C_{vw} + C_{lw}) \\
&+ \frac{V_s}{2}\left[1 + (x-2)\left(1 - \frac{(F_a s_1^{-\alpha_1} + F_b s_2^{-\alpha_2})}{(1-\beta)P_r}\right)\right] H_c + b\ ln\frac{P_{\phi 0}}{P_\phi} \\
&+ \frac{x S_c (F_a s_1^{-\alpha_1} + F_b s_2^{-\alpha_2}) V_s P_\phi}{2} + \frac{F_T(F_a s_1^{-\alpha_1} + F_b s_2^{-\alpha_2})}{V_s} + V_T(F_a s_1^{-\alpha_1} + F_b V_2^{-\alpha_2}) \\
&+ \frac{(F_a s_1^{-\alpha_1} + F_b s_2^{-\alpha_2})}{V_s} + V_{ccv}(F_a s_1^{-\alpha_1} + F_b V_2^{-\alpha_2}) \quad (26)
\end{aligned}
$$

m. Distribution free approach

The distribution of lead time is unclear in many real-world scenarios. As a consequence, the projected shortages per replenishment cycle $E(X - r)^+$ cannot be calculated and must instead be applied using the simplified min-max distribution-free technique. So, for each choice variable, the least favorable distribution function in F can be found, and the overall cost of the decision variables can be minimized. $MinF \in \Omega$ When P is 0, the maximum possible transmission power (TP) is $Min_{F\in\Omega}\ Max\ TP\ subject\ to\ 0 < P \leq P_0, 0 < O_c \leq O_{c0}$ The decision variables can be demonstrated us,

$$
\begin{aligned}
E(X - r)^+ &\geq \frac{1}{2}\sigma\sqrt{L_e}(\sqrt{1 + k^2 - k}) \quad (27)\\
F &\in \Omega \\
\zeta &\geq \frac{2\zeta}{1+\zeta}
\end{aligned}
$$

The proper distribution profit can be demonstrated us,

$$
\begin{aligned}
& Total\ Profit(x, k, V_s, L_e, s_1, s_2, P_\phi, C_b) \\
& = \left((s_1 - P_{uv}) + F_a s_1^{-\alpha_1} + (s_2 - P_{uv}) + F_b s_2^{-\alpha_2}\right) - TC(V_s, L, s_1, s_2, P_\phi, C_b) \\
& = \left((s_1 - P_{uv}) + F_a s_1^{-\alpha_1} + (s_2 - P_{uv}) + F_b s_2^{-\alpha_2}\right) - [[h_B(\frac{V_s}{2} + k\sigma\sqrt{L_e}] \\
& + I + \frac{C_b(F_a s_1^{-\alpha_1} + F_b s_2^{-\alpha_2})}{V_s} + g\ ln\frac{O_{co}}{C_b} + T_d\frac{(F_a s_1^{-\alpha_1} + F_b s_2^{-\alpha_2})}{V_s} \\
& + \frac{(F_a s_1^{-\alpha_1} + F_b s_2^{-\alpha_2})\pi_x}{V_s}\sigma\sqrt{L_e(\sqrt{1+k^2} - k)} + \frac{(F_a s_1^{-\alpha_1} + F_b s_2^{-\alpha_2})}{V_s}R(L_e) \\
& + \frac{1}{2}\left(\frac{(F_a s_1^{-\alpha_1} + F_b s_2^{-\alpha_2})}{V_s}\right)\left(\frac{1-\zeta}{1+\zeta}\right)\sigma\sqrt{L_e}(\sqrt{1+k^2} - k) \\
& + \frac{(F_a s_1^{-\alpha_1} + F_b s_2^{-\alpha_2})}{V_s}(A_s + C_{wd} + C_{ph} + C_{vw} + C_{lw}) \\
& + \frac{V_s}{2}\left[1 + (x-2)\left(1 - \frac{(F_a s_1^{-\alpha_1} + F_b s_2^{-\alpha_2})}{(1-\beta)P_r}\right)\right]H_c + b\ ln\frac{P_{\phi 0}}{P_\phi} \\
& + \frac{xS_c(F_a s_1^{-\alpha_1} + F_b s_2^{-\alpha_2})V_s P_\phi}{2} + \frac{F_T(F_a s_1^{-\alpha_1} + F_b s_2^{-\alpha_2})}{V_s} + V_T(F_a s_1^{-\alpha_1} + F_b V_2^{-\alpha_2}) \\
& + \frac{(F_a s_1^{-\alpha_1} + F_b s_2^{-\alpha_2})}{V_s} + V_{ccv}(F_a s_1^{-\alpha_1} + F_b V_2^{-\alpha_2}) \qquad (28)
\end{aligned}
$$

5. Performance analysis

The performance analysis of the suggested methodology was clearly depicted in this section [Figure 2],

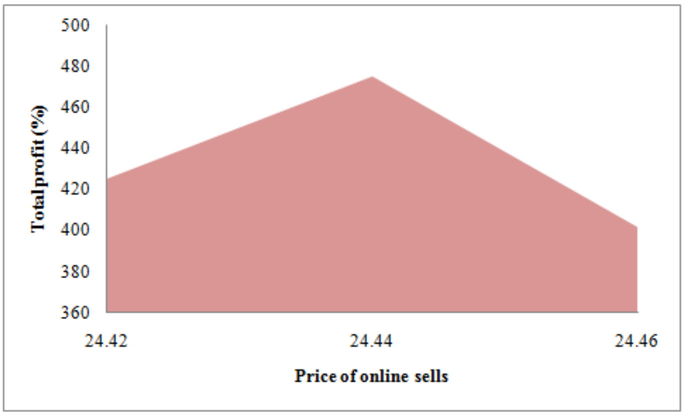

Figure 2: Price of online sells Vs. Total profit

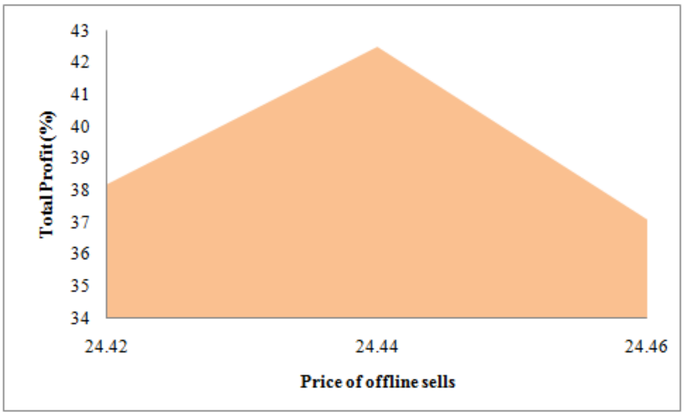

Figure 3: Price of offline sells Vs. Total profit

A distribution free function is used for normally distributed lead time, and the faulty rate is shown in Figure 3 as the concavity of the total profit function. Figure 3 shows that the worldwide optimal profit is $427.10 when the optimum online selling price is $24.46 per unit and the optimum offline selling price is $40.03.

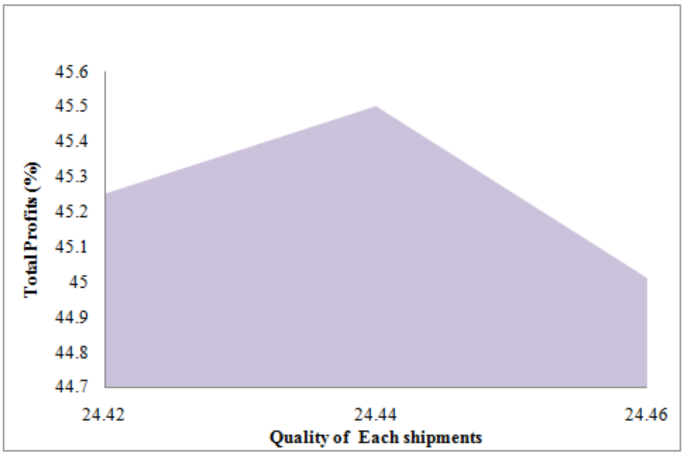

Figure 4: Quality of each shipment Vs. total profit

Figure 4 depicts the concavity of the total profit in relation to the online selling price and the number of shipments. Figure 3 shows that at a product selling price of $24.46 per unit and an optimal quantity in each shipment of $36 per unit, the overall system profit is at its highest.

Table 1: Distribution analysis

Parameters	Normal Distribution	Distribution Free Model
P (minimum duration lead time component ($p = 1, 2, ..., n$))	3.3	3.3
V_s(Volume of each shipment (unit))	37.24	37.09
$v_1(product'sonlineselling - price(\$/unit))$	25.38	25.48
v_2(product's offline selling-price (\$/unit))	40.89	41.04
C_b(Ordering cost for retailer (\$/unit))	0.00042	0.00042
T_c(Cycle time, $T_c = Q_1/D_b = xV_{s/D_b}(time)$)	4.2	4.2
B_p(Demand rate of retailer, $B_p = F_a s_1^{-1} + F_b s_2^{-2}$ (units))	13.48	12.27
ζ(Backorder rate)	38.78	38.88
F_T(Fixed transportation cost (\$/shipment))	427.56	428.13

Table 2: Normal Vs. free distribution model

Parameters	Normal Distribution	Distribution Free Model
P (minimum duration lead time component ($p = 1, 2, ..., n$))	3.3	3.3
V_s(Volume of each shipment (unit))	22.19	22.15
s_1(product's online selling-price (\$/unit))	14.68	14.72
s_2(product's offline selling-price (\$/unit))	18.40	18.45
C_b(Ordering cost for retailer (\$/unit))	0.0007	0.0007
T_c(Cycle time, $T_c = Q_1/D_b = xV_{s/D_b}(time)$)	5	4
D_b(Demand rate of retailer, $D_b = F_a s_1^{-1} + F_b s_2^{-2}$ (units))	6.24	11.26
ζ(Backorder rate)	17.20	17.25
F_T(Fixed transportation cost (\$/shipment))	337.42	360.79

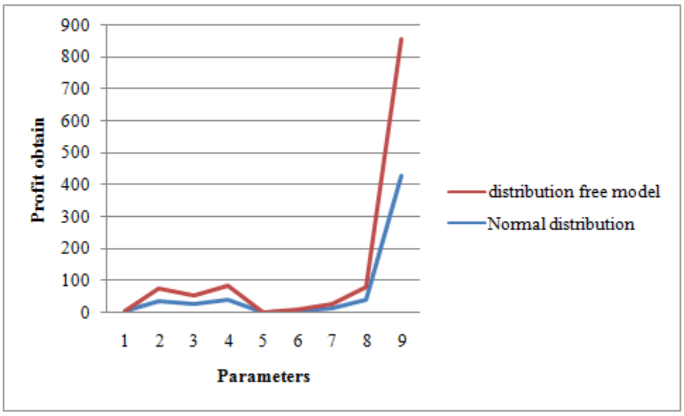

Figure 5: Distribution model analysis As of from the table 1,2 and figure 5 when compared to the ordinary distribution approach the distribution free approach earns high profit.

Table 3: Sensitivity analysis

Parameters	Changes (in%)	TP (in %)
P (minimum duration lead time component ($p = 1, 2, ..., n$))	-55	-39.05
	-20	-19.55
	+20	+19.55
	+55	+39.05
V_s(Volume of each shipment (unit))	-55	+3.08
	-20	+1.57
	+20	-1.57
	+55	-3.08
s_1(product's online selling-price (\$/unit))	-55	+0.35
	-20	+ 0.18
	+20	- 0.18
	+55	-0.35
s_2(product's offline selling-price (\$/unit))	-55	+4.72
	-20	+2.38
	+20	-2.38
	+55	-4.72
C_b(Ordering cost for retailer (\$/unit))	-55	+0.32
	-20	+0.18
	+20	-0.18
	+55	-0.32
T_c(Cycle time, $T_c = Q_1/D_b = xV_{s/D_b}(time)$)	-55	+1.72
	-20	+0.88
	+20	-0.88
	+55	-1.72
D_b(Demand rate of retailer, $D_b = F_a s_1^{-1} + F_b s_2^{-2}$ (units))	-55	+4.08
	-20	+1.72
	+20	-1.36
	+55	-2.39
ζ(Backorder rate)	-55	+41.65
	-20	+13.58
	+20	-8.14
	+55	-13.58
F_T(Fixed transportation cost (\$/shipment))	-55	+4.18
	-20	+2.08
	+20	-2.08
	+55	-4.18

This section calculates the impact of changing key parameters by (55 percent, 20 percent, -20 percent, -55 percent) on overall profit. Online sales have a very sensitive pricing elasticity characteristic. The entire system profit is directly proportional to the elasticity parameter's value, therefore even a minor adjustment has a big influence. A sustainable supply chain was greatly impacted by production rate. Production rate is critical in this O2O supply chain concept. There is an inverse relationship between production rate and the profit of a system, meaning that cutting output improves profit. It's important to consider the retailer's holding costs, the retailer's initial ordering

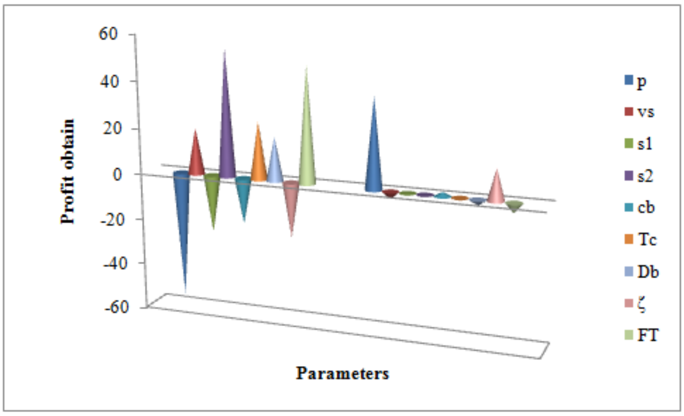

Figure 6: Analysis of the sensitivity

costs, and the fault rate of the manufacturer. All of these factors are negatively related to the overall system profit. Because of this, cutting expenses is usually advantageous for any company. The process quality-related scaling parameter has a small sensitivity. Lowering this value is advantageous to the industry. The manufacturer's production costs are, as usual, quite volatile. The cost savings that come from cutting output are always welcome in the manufacturing business. Technology development costs, as well as all other supply chain cost characteristics, make absolutely no sense. If those expenses are changed by 55%, the whole system profit changes by less than 5%. To prove the efficiency of the suggested methodology it can be compared with the some existing methodology [6], [7], [8] and [9].

Figure 7 (a, b) compares the results to those found in the current literature that shows the results graphically. The suggested methodology earns high profit when compared to other existing methodology. The overall analysis shows that the producer makes more money with an O2O model than with a combination mechanism, while the retailer makes less money with a combination mechanism than with an O2O model. According to Figure 7, the whole supply chain makes more money when using combination mechanisms rather than an O2O model, which puts all supply chain participants when using the profit-sharing mechanism. These findings support the hypothesis of a combination mechanism against an O2O model in this case. For the most part, the mechanism of combination helps supply chain actors make more money and is thus a more effective way to reduce O2O rivalry than the rebate given to offline customers by manufacturers. With growing acceptance of products for online sales however, the profit difference between a combination mechanism and a manufacturer rebate (that is the competitive advantage of a combination mechanism) decreases throughout the whole supply chain. Since products are more suitable for online sales, O2O rivalry gets stronger. As a consequence, the combination mechanism reduces the overall supply chain's coordinating power. Since the online acceptability of a product affects the value and performance of a combination mechanism in an O2O competition, managers must thoroughly evaluate products disseminated via competitive channels.

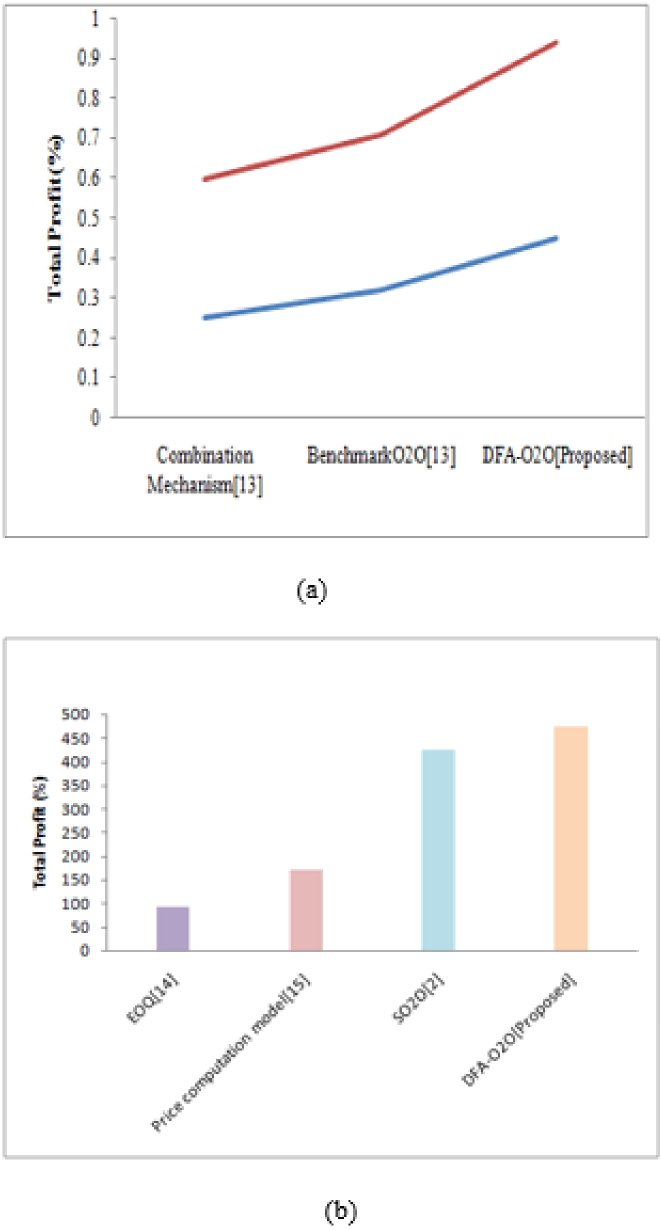

Figure 7: Profit analysis

6. Conclusion

This research established a sustainable O2O supply chain model that takes price-dependent demand into account. In this approach, various prices and varied needs for the same product are taken into account, where one product sells via two separate chan1nels online and offline due to significant expansion in the e-commerce business plan. Due to additional advertising expenditures, retail store display costs, and labor charges, the product's offline pricing is naturally somewhat higher than its online price. In spite of the slightly higher price in the offline channel, some clients choose to visit the shop because of the excellent quality of service. This study takes into account the impact of back-orders and lead times as well. Using normally distributed lead time demand and distribution-free techniques for lead time, several unusual situations were reported. Because of this numerical finding, the supply chain's profitability is now optimized for a normally distributed lead time distribution.

We optimized the overall system profit as well as the optimum selling prices for two separate channels, batch shipping size, safety stock, lead time and ordering costs. We also looked at the likelihood of moving from an in-control to an out-of-control condition. The study's set output rate is another drawback. Another drawback of this design is the manufacturer's fixed setup costs. The goods were bought online, but it was delivered to clients offline through the internet channel. Some electronic equipment, such robots or drones, are capable of this kind of transportation, which represents an exciting new study path. If the offline merchant pays for various incentives or presents to entice clients and improve system profit, this model may be further expanded. This model may be investigated by looking at the quality of the product or at the changing rate of production.

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