International Journal of Mathematics and Statistics Invention (IJMSI)
E-ISSN: 2321 – 4767 P-ISSN: 2321 - 4759
www.ijmsi.org Volume 12 Issue 6 || Nov.-Dec. 2024 || PP: 06-11

Optimal Inventory Policy for Lowering the Cost of Decentralized Framework Via Side-Chain Transaction

Rohit Kumar Verma
Associate Professor, Department of Mathematics,
Bharti Vishwavidyalaya, Durg, C.G., India

Mamita
Research Scholar Ph.D. Department of Mathematics,
Bharti Vishwavidyalaya, Durg, C.G. India

ABSTRACT: *The global supply lines of incredible defenselessness have been exposed by COVID-19. Item accessibility becomes a critical consideration in such extreme cases. This research examines oblique transference, a crucial inventory management technique under decentralized frameworks that may be crucial in handling stock outs during unexpected emergencies. In addition to responding quickly to stock outs, horizontal transshipments are also very environmentally friendly because they significantly lower generation and transportation-related pollutants. In a decentralized setting, this study considers optimal horizontal transshipment and replenishment decisions. We construct a multi-stage stochastic model that accounts for client exchanging behavior and request instability. We demonstrate that the optimal transshipment decision follows a double-threshold structure, much like in the centralized setting. Two estimating mechanisms the arranged component (NP) and the individual mechanism (IP) are used to determine the optimal renewal quantities. The impact of sidelong transshipment on supply chain fetched decrease is illustrated numerically.*

KEYWORDS: *Production network the board; horizontal parcel; manageability; irregular exchanging etc.*

Date of Submission: 12-11-2024 Date of acceptance: 22-11-2024

I. INTRODUCTION

The flare-up of Covid infection 2019 (Corona virus) may change the worldwide stockpile chainsfor all time. On one hand, a few conventional organizations have been totally closed down due to regulation strategies and exchange limitations. For instance, food security alarms emerge after the lockdown of around 33% of the total populace [1, 2] and ocean transport is likewise upset [3]. Despite the fact that there have been many advances on anticipating Corona virus [4-6], no fix or antibody is accessible at this point. The supportability of worldwide stock chains will in any case be under danger in the event that request can't recuperate in an opportune style. Then again, the prosperous "new retailing" has enormously helped for China's situation. Purchasers make orders online from online retailers and afterward get one, in this manner staying away from pointless actual connections, which assists with keeping up with the maintainability of the food production network during the pandemic. Besides, different web-based stages are accessible to keep up with undisrupted administration and telecom organizations give free projects to entertainment. To finish up, the help of current data innovation, like large information, man-made brainpower, and so on, is fundamental for conventional organizations to get by, as new innovation isn't just more efficient, yet in addition stronger under outrageous conditions.

The sharp differentiation above rouses us to reexamine about how to construct an economical store network in instance of startling emergencies later on. In a survey of feasible store network the board in little and medium endeavors [7, 8], business, natural and social aspects are utilized, nonetheless, they are conflicting measures fundamentally [9, 10], which needs unpretentious equilibrium to accomplish most extreme social government assistance. In a precise survey of practical production network the board in worldwide stock chains [11, 12], different arrangements and administration modes are refined, yet a few unforeseen shocks, like exchange rubbing and pandemic, are not thought of. This is additionally the test confronting key inventory network the board, as in [13, 14]. As we would see it, during the pandemic, the smooth progression of materials ought to be the main goal. As stock out is a typical peculiarity that decreases retailers' benefits, yet in addition harms items' image pictures, the supportability of the entire inventory network, and, surprisingly, the existences of medical care laborers and customary individuals all over the planet. That is one primary explanation that we focus closer on fundamental stock administration right now, regardless of it being an extremely customary measure to keep up with store network supportability. Other than that, great stock administration assists with lessening not just transportation cost, yet in addition obtainment cost, because of more exact interest and supply coordination. According to the viewpoint of reasonable acquisition or green public acquirement [15], cost decrease by stock administration helps address a central question of monetary requirement by and by, as examined by Brammer and Walker [3]. There have been a significant number of learns about stock the executives, of which one stream is parallel parcel. Parallel parcels inside a stock framework are stock developments between areas of a similar echelon. With further developed following precision, horizontal parcel between different stores acquires its fame, on the grounds that each store can likewise work as a distribution center to address the clients' issues, in the event of lack at different stores. These days, it is normal to see sidelong parcels between different stores [16]. It is quicker to answer buyers contrasted with crisis orders .It saves energy from superfluous creation, particularly for transitory merchandise. It lessens the potential contamination, because of significant distance transportation from the focal stockroom. In this paper we study the ideal parcel choices and stock recharging choices under a decentralized setting [18]. We audit some connected writing on sidelong parcel in the following area [19, 20].

1.1 Essential Model Settings

This paper thinks about two nearby business sectors, with two stores i and j(i, j∈{1,2}) selling similar items. We center around a transitory item and consequently a solitary period. We use Di to address the autonomous, stochastic, nearby interest looked by Store i, for i = 1, 2. Furthermore, $G_i(d_i)$ and $g_i(d_i)$ are utilized to address the aggregate circulation capability and the likelihood thickness capability of neighborhood request Di, individually. The common occasions streams are as per the following.

1. To begin with, each store decides the recharging level. Q_i and Q_j before acknowledgment of interest.
2. Second, the nearby requests are acknowledged individually, with the acknowledgment of di and dj, without misfortune of over-simplification, say Store j has abundance stock, while Store j runs unavailable, i.e., $Q_i > d_i$ and $Q_j < d_j$.
3. Third, Store j demands parcel from Store i.
4. Fourth, excess Store i decide the parcel amount q_{ij} to be transported to Store j previously the perception of likely interest from neglected clients.
5. Fifth, unsatisfied clients of Store j change to Store i.
6. 6th, the two stores gather income

At the point when request acknowledge are seen in the subsequent stage, the neglected client has three options: hang tight at Store j for renewal, change to local Store i, and quit any pretense of purchasing. This is the wellspring of differentiated exchanging clients, which will be talked about further.

With regards to demands for parcel, we allude to $\psi_j \in [0, 1]$ as Store j's "demand rate", which addresses the level of the first neglected request at Store j. In this paper, we expect to be that j is a known consistent for the retailer and how much the parcel request can be gotten by $\psi_j\ d_j - Q_j$.

After getting the parcel demand, Store I should decide q_{ij}: the parcel amount from Store i to Store j. The upper bound on not set in stone by the two stores' overflow and deficiency levels. Right off the bat, q_{ij} can't surpass Store i's overflow Qi - di. Also, q_{ij} can't surpass the mentioned request: ψ (dj - Qj). Along these lines, ψ_j $(d_j - Q_j)$. So, $0 \le q_{ij} \le q_{ij} \equiv \min \{Q_i - d_i, \psi_j (d_j - Q_j)$. It is important that Store j will confront another questionable interest on the grounds that, while the parcel demand is tended to right now, client exchanging request isn't noticed at this point. Store I needs to adjust between concealed future open doors and the ongoing opportunity to lessen the extra stock. This arrangement of occasions makes one more justification for the excess store to some degree satisfies the parcel interest: saving stock for the exchanged interest streaming to Store i.

The parcel stage is then trailed by the exchanging stage. Additionally, Ω_j is utilized as Store j's "switch rate", and ω_j is the acknowledgment of ω_j, which addresses the level of the eventually neglected request at Store j that is changed to Store I. We expect that ω_j is an irregular variable inside [0, 1], what's more, $Fj(\omega_j)$, $fj(\omega_j)$ are alluded to as the cdf and pdf of ω_j individually. Note that how much the eventually neglected request at Store j is $d_j - Q_j - q_{ij}$. How much the exchanged interest is, subsequently, $\Omega_j (d_j - Q_j - q_{ij})$. It merits contrasting the first neglected request and at last neglected request.

As at first neglected request can be parted into three streams, the eventually neglected request can likewise be separated into two streams: the first neglected request and dismissed parcel interest. In a unified framework, the whole organization causes every one of the expenses and gathers all the income, while in a decentralized framework, the stores settle on their own choices to boost their person benefits, with each bearing their own expenses and colleting their own income. At the point when the excess store sends a parcel to the lack store, we expect the excess store bears the expense of parcel furthermore; the lack store takes care of every unit of parcel, as in the investigation.

We use p_{ij} to signify the value Store j pays Store i for every unit of parcel and expect to be that $r_j > p_{ij} > \tau_{ij} + s_i$. We consider two different components at picking parcel costs. One is the singular value (IP) system, where parcel not entirely set in stone by the stores exclusively ahead of time, and the other is the arranged value (NP) component where the two stores arrange a couple of (pij, pji). Prior to noticing their neighborhood interest, the two stores autonomously set their recharging levels. After the parcel amount is chosen, the lack store pays the excess store pij per unit for parcel, yet the unit parcel cost is paid by the excess store. Notwithstanding occasion depictions, a few vital financial boundaries are presented, as recorded . The expense of securing one unit of stock is ci at Store I; every unit sold by Store I gets an income of ri when it is offered to either neighborhood interest or exchanged request; ij is transporting cost for every unit stock from Store I to Store j, and is brought about by the dealer, i.e., Store I; the rescue esteem at Store I toward the finish of the period si; loss of kindness cost for the neglected request is thought to be zero.

1.2 Ideal Parcel Amount

In the concentrated frameworks, the chief, normally, notices request acknowledge at the two stores. At the point when the stores are each all alone, the interest acknowledgment and renewal level at a singular store might be the store's confidential data. Our methodology is to expect that the deficiency sum and the excess sum are public data. This supposition assists with identifiability, while giving the stores a degree of security. Without loss of consensus, we let Store I be the excess endlessly store j the lack store when determining the ideal parcel strategy. Signify by d Store I's ideal, contingent benefit when $d_i < Q_i$ and $d_j > Q_j$. Store I pays c_iQ_i to renew its stock, procures an income of r_id_i from fulfilling neighborhood interest, an edge of $(p_{ij} - \tau_{ij})q_{ij}$ from parcel, a normal income of $\mathbf{r_i E_{\Omega_j} \min}(L_i, \Omega_j L_j)$, where $\mathbf{L_i \equiv Q_i - d_i - q_{ij}}$ addressing the stock level ready for the impending exchanging request, what's more, $\boldsymbol{L_j \equiv d_j - Q_j - q_{ij}}$ addressing a definitive neglected request from lack store, a normal rescue worth of $\boldsymbol{s_i E_{\Omega_j} \max(L_i - \Omega_j L_j, 0)}$ from possible extras. Obviously, Store I might want to pick $\mathbf{q_{ij} \leq q_{ij}} \equiv \min(Q_i - d_i, \ \Psi_j(d_j - Q_j))$ carefully, so that q_{ij} results in d. Assembling those components.

With q_{ij}^d addressing Store I's ideal parcel amount in the decentralized setting, we formalize our outcomes in Recommendation 1.

Suppose $d_i < Q_i$ and $d_j > Q_j$, $Z_i = \frac{Qi-di}{Dj-qj}$, the optimal transshipment policy is as follows., the optimal transshipment policy is as follows.

1. If $p_{ij} \leq \tau_{ij} + s_i + (r_i - s_i)E\Omega_j$, then $q^d \equiv 0$.
2. In any case, there are two edges: z_i^d and z_i^{-ijd} that $z_i^d < z_i^{-d} = (1 - z_i^d)\Psi_j + z_i^d$

& $\int_0^{z_i^d} (1 - \omega j) dF_j(\omega j) \leq \frac{ri-pij+\tau ij}{ri-si}$

Suggestion 1 demonstrates that the ideal parcel strategy in the decentralized setting follows the design of the ideal parcel strategy in the brought together setting. The principal difference lies in the limits. Newsvendor-like basic proportions are applied in the two arrangements to portray the limits, while rj is utilized in the brought together setting for the computation of its basic proportion. The parcel value pij is utilized in the decentralized setting. This checks out in light of the fact that the parcel amount still up in the air by Store I in the decentralized setting, and Store I thinks often more about pij (i.e., what Store i acquires for every unit of parcel sent) than about rj (i.e., what Store j procures for every unit of parcel got). Expanding upon this understanding, we lay out Culmination 1.

Result 1. For some random arrangement of

For any given set of Q_i, Q_j, d_i, d_j , $q^d \leq q^c$ and $q^c - q^d$ decreases in p_{ij}. If $p_{ij} = r_j$, then

$q^d = q^c$. Where q^c is the ideal traference under centralized system.

when the excess store will choose, all alone, the parcel amount, its parcel cost matters. The higher the cost p_{ij},, the more appealing parcel is to Store I and the higher the ideal parcel amount $q_{ij}^c = q_{ij}^d$ Since Store i can't charge a parcel cost p_{ij} that is higher than r_j (i.e., Store j's income from selling a unit), the ideal parcel amount in the concentrated setting sets an upper bound on the ideal parcel amount in the decentralized setting. Interestingly observe that it is ideal for the excess store to ship all overflow stock to the deficiency store, if important, and allude to the strategy as "complete pooling". Besides, in the model concentrated. The excess store's ideal parcel amount is free of its parcel cost or whether the setting is brought together or on the other hand decentralized.

1.3 Ideal Recharging Amount

The induction of the excess store's ideal parcel amount permits us to additionally investigate the store's renewal choices. While running autonomously, the two stores decide their own renewal levels freely and secretly. In any case, each store's definitive benefit relies upon the other's renewal level. Let $\pi_i^d(Q_i, Q_j, p_{ij}, p_{ji})$ address Store I's normal benefit given a couple of renewal levels and a couple of parcel costs. Note here that, while Store I notices its own renewal level and both parcel costs, Store j's recharging level remaining parts obscure to Store I. To find a reasonable arrangement, we search for balance renewal levels: y_i^d what's more, y_{ij}^d. Hypothesis 1 describes the free stores' harmony recharging levels under the individual value instrument and the arranged value system, separately.

Under the singular Cost instrument, the harmony parcel costs are (p_{12}, p_{21}) = (r_2, r_1), and the harmony recharging levels (y_1^{-d}, y_2^{-d}) can still up in the air Under the IP component, the harmony parcel cost charged by the excess store is equivalent to the unit income at the lack store. Thus, the satisfied parcel does not acquire any extra increase for the deficiency store. This makes the stores more leaned to keep away from deficiency, and thus brings about higher recharging levels at balance in the decentralized setting than in the unified setting. Under the NP component, we can show that the amount of the balance recharging levels expansions in the parcel cost. Nonetheless, it is indistinct how the amount of the balance recharging levels analyzes to the amount of the ideal renewal levels in the unified setting. The difficulties are like those recorded [10]

II. New Result

Brought together frameworks work better compared to decentralized situation, given inflexible presumptions, one of which is the ideal coordination between stores. In this paper, we exhibit that sidelong parcel likewise functions admirably in saving the all out cost of the store network in decentralized frameworks. Accordingly, we center around the absolute store network cost decrease, despite the fact that there is no coordination from a virtual head or parent organization. To accomplish this objective, we give two benchmarks where the stores pursue free choices.

Now, by choosing the order amount y_t, a store manager can utilise state variables to maximize the store's projected and discontinued stream of present and future earnings with state variables

$$x_t = (k_t, p_t, \ln Q_t) \text{ and } \varepsilon_t = \left(\varepsilon_t(0), \varepsilon_t(1), \dots, \varepsilon_t(J)\right)$$

and the value function $V(x_t, \varepsilon_t) = \max_{y_t \in Y}\{\pi(y_t, x_t) + \sigma_\varepsilon \varepsilon(y_t) + \beta E(V(x_{t+1}, \varepsilon_{t+1})|y_t, X_t)\}$, where $0 < \beta < 1$. The integrated value function

$$V_\sigma(x_t) = \frac{1}{\sigma_\varepsilon}\int V(x_t, \varepsilon_t) d\varepsilon_t$$

and the associated integrated equation are now available.

$$V_\sigma(x_t) = \ln\left\{\sum_{y\in Y} \exp\left(\frac{\pi(y, x_t)}{\sigma_\varepsilon} + \beta E(V_\sigma(x_{t+1})|\, y, X_t)\right)\right\}$$

The parameters of the expected profit function $\pi(y_t, x_t)$ are linear. In other words, $\frac{\pi(y_t, x_t)}{\sigma_\varepsilon} = h(y_t, x_t)'\gamma$, where γ is the structural parameter vector. The vector $h(y_t, x_t)$ is the following vector of functions of the state variables: $\gamma = \left(\frac{1}{\sigma_\varepsilon}, \frac{\gamma^h}{\sigma_\varepsilon}, \frac{\gamma^z}{\sigma_\varepsilon}, \frac{\gamma^f}{\sigma_\varepsilon}, \frac{\gamma^c}{\sigma_\varepsilon}\right)'$

$$h(y_t, x_t)' = (LIp_t E(\min(d_t, k_t)|x_t), -k_t, E(1(d_t > k_t)|x_t) - 1(y_t > 0), -y_t)$$

Now, the vector form of another integrated equation is $V_\sigma = \ln\{\sum_{y\in Y} \exp(H(y)\gamma + \beta F_x(y) V_\sigma)\}$

and the logit form $P(y, x_t) = \frac{\exp\left(h(y, x_t)'\gamma + \beta E(V_\sigma(x_{t+1})|\, y, X_t)\right)}{\sum_{j=0}^{J} \exp\left(h(j, x_t)'\gamma + \beta E(V_\sigma(x_{t+1})|\, j, X_t)\right)}$

For any $y \in Y$, the policy improvement mapping in the logit model has the vector form $\sum_{j=0}^{J} \exp(H(j)\gamma + \beta F_x(j) V)$,

therefore $P(y) = \lambda(y, V) = \frac{\exp(H(y)\gamma + \beta F_x(y) V)}{\sum_{j=0}^{J} \exp(H(j)\gamma + \beta F_x(j) V)}$ The form of the valuation mapping is as follows:

$$V = v(P) = \frac{\sum_{y=0}^{J} P(y)(H(y)\gamma + euler - \ln P(y)))}{I - \beta \sum_{y=0}^{J} P(y).F_x(y)}$$

The first is the absolute expense from the two free stores without parcel and each embracing newsvendor model. The subsequent one is the absolute expense from the two free stores while completely fulfilling parcel demands from deficiency stores. It catches the total pooling situation with full participation. To make significant examinations, we register the ideal stock levels and benefits under three situations. The initial two spotlight on individual benefit, while the third amplifies the complete inventory benefits. Mathematical outcomes show amazing evenness, or at least, when store one expects to boost its own benefit, it will renew the greatest conceivable stock inside the given upper bound, while store two recharges the lower bound, as well as the other way around. This seems ok given the settings of decentralized frameworks with irregular exchanging and fractional solicitation, on the grounds that every one of the two stores endeavors to acquire the whole benefit from the production network. To quantify the complete expense saved by the sidelong parcel choices, we figure the extent of complete benefit from our model to those of the previously mentioned benchmarks, considering that absolute benefit is something contrary to add up to cost and add up to cost is negative. The examinations are made between our model against newsvendor models and full parcel models without irregular exchanging, separately, comparing to the initial two situations, and individually relating to the third situation. We standardize the benchmark cases to 100 percent; subsequently more than 100 percent shows an increment and improvement, while less than 100 percent demonstrates a reduction and less than ideal circumstance. For stock correlations, similar instruments hold, then again, actually a number more prominent than 100 percent demonstrates sub optimality because of expanded conveying cost. The other money related boundaries utilized in our analysis are portrayed underneath, and exceptional medicines are applied to keep away from inconsequential circumstances.

We expect a consistently circulated nearby interest of [0, 200] for the two stores, and symmetric money related boundaries with $r_1 = r_2 = 100$, $p_{12} = p_{21} = 95$, $\tau_{12} = \tau_{21} = 80$, $c_1 = c_2 = 10$, $s_1 = s_2 = 3$.
Fractional solicitation rate I begins from 0.1 with a stage length of 0.1 to 1, for I = 1, 2. The arbitrary switch rate φi agrees to uniform dispersion, having a place with (0, 0.1), (0, 0.2), (0, 0.3), (0, 0.4), (0, 0.5), (0, 0.6).

This paper initially examines the circumstances where the two stores hold something similar demand rates and exchanging rates, and afterward all the solicitation rate coordinates and exchanging rate matches are contemplated.

III. Conclusions

As developing consideration is paid to natural and social manageability, the conventional meaning of maintainability has been changed. In any case, the unforeseen Corona virus pandemic has struck the worldwide supply chains decisively, making extraordinary harm a huge number of lives, because of the absence of clinical securities or the deficiency of food. Globalization has joined the world to be a unified framework, which has extraordinarily progressed with close participation. In any case, Corona virus uncovered the worldwide stock chain to incredible weakness and show us a thing or two to keep a specific degree of freedom. Enlivened by both practice. This paper concentrates on the horizontal parcel and renewal choices under decentralized framework, where the two stores settle on autonomous choices. The setting is normal practically speaking, as incorporated frameworks don't necessarily in all cases function admirably, because of understood costs from coordination disappointment, frameworks efficiency, and the maintainability of the production network. Decentralized frameworks might be mediocre compared to incorporated frameworks hypothetically, however may perform better under outrageous conditions due to the natural supporting capability, explicitly, balancing effects in boosting the benefit in our model. This paper infers the interesting and ideal parcel amounts and works out the most extreme benefit, accepting uniform appropriation for the arbitrary factors. Mathematical tests show the positive connection between ideal benefit and solicitation rate, and the negative connection between ideal benefit and exchanging rate. In opposition to the natural conviction that retailers ought to divert down the solicitation from contenders, the outcome advances empowering close participation, i.e., higher solicitation rate to build the additional worth to the inventory network.

REFERENCES

[1]. R. Anupindi; Y. Bassok; E. Zemel (2020): A General Framework for the Study of Decentralized Distribution Systems, pp. 349–368.

[2]. J. Bian; Y. Liao; Y. Wang; F. Tao (2019): Dynamic balancing of inventory in supply chains. European Journal of Operational Research, Vol. 159, pp. 296 -317.

[3]. S. Brammer and H. Walker (2015): Modeling emergency supply exibility in a two-echelon inventory system. Management Science, Vol. 45 No. 10, pp. 1416 -1431.

[4]. V. J. Clemente-Suárez; V. Hormeño-Holgado; M. Jiménez; J. C. Benitez-Agudelo (2017): Optimal division of inventory between depot and bases, vol. 64, no. 1, pp. 3–18.

[5]. W. Cheng; A. Appolloni; A. D'Amato; Q. Zhu: (2018): Decentralized inventory control in a two-level distribution system, European Journal of Operational Research, pp. 1084–1098.

[6]. C. M. Galanakis (2020): Modeling replenishment and transshipmentdecisions in periodic review multi location inventory systems, Journal of the Operational Research Society, Vol. 58 No. 7, pp. 948 -956.

[7]. I. Heiland; K. H. Ulltveit-Moe (2020): An Unintended Crisis in Sea Transportation due to COVID-19 Restrictions.in COVID-19 and Trade Policy pp. 151–163.

[8]. X. Huang (2013): A Review on Policies and Supply Chain Relationships under Inventory Transshipment, pp. 21–42.

[9]. E. Koberg; A. Longoni (2019): A systematic review of sustainable supply chain management in global supply chains, pp-1084–1098.

[10]. S. Kot (2018): Sustainable supply chain management in small and medium enterprises, pp-350-450.

[11]. J. Li; Y. Liao; V. Shi; X. Chen (2007): Modeling replenishment and transshipment decisions in periodic review multi location inventory systems." Journal of the Operational Research Society."Vol. 58 No. 7, pp. 948 -956.

[12]. W. Martin; J. B. Glauber (2019): The use of simple calibrations of individual locations in making transshipment decisions in a multi-location inventory network, pp. 230-250.

[13]. B. Pirouz; S. S. Haghshenas; P. Piro (2022): A simulation study of lateral transshipments in a single supplier multiple buyers supply chain network, International Journal of Production Economics, Vol. 81-82, pp. 103 -114.

[14]. C. Paterson; G. Kiesmüller; R. Teunter; K. Glazebrook (2019): Inventory models with lateral transshipments: A review, Eur. Junral . pp. 125–136.

[15]. C. Paterson; G. Kiesmüller; R. Teunter and K. Glazebrook (2019): Inventory models with lateral transshipments: A review. Eur. J. Oper. Res. pp-125–136.

[16]. Z. Rezaee (2019): Supply chain management and business sustainability synergy, A theoretical and integrated perspective, pp-275.

[17]. Z. Rezaee (2020): Supply chain management and business sustainability synergy: A theoretical and integrated perspective, pp-275-230.
[18]. N. Rudi; S. Kapur; D. F. Pyke (2021): A Two-Location Inventory Model with Transshipment and Local Decision Making, pp-1668–1680.
[19]. S. Sanchez-Caballero (2019): A multi-echelon integrated JIT inventory model using the time buyer and emergency borrowing policies to deal with random delivery lead times, International Journal of Production Research, Vol. 41 No. 13, pp. 2911 – 2931.
[20]. W. Zhang; X. Zhang and M. Zhang (2020): In-season transshipments among competitive retailers, Serv. Op. 14, Pp-290–300.