RT&A, No 4 (71)
Volume 17, December 2022

Designing of Inventory Management for Determining the Optimal Number of Objects at the Inventory Grouping Based on ABC Analysis

K. Srinivasa Rao[1], R. Venu Gopal [2,] Adilakshmi Siripurapu [3]

•

Dept. of Operations, GITAM school of Business, GITAM (Deemed to be University), Visakhapatnam, AP, India[1]

Dept. of Marketing, GITAM school of Business, GITAM (Deemed to be University), Visakhapatnam, AP, India[2]

Dept. of Basic Science and Humanities, Vignan's Institute of Information Technology (A), Duvvada, Visakhapatnam, AP, India[3]

skolli2@gitam.edu[1]
vreddi@gitam.edu[2]
slakshmijagarapu@gmail.com[3]

Abstract

The most appropriate procedures in the inventory organization area are inventory arrangements based on ABC investigation, a well-known technique for establishing the objects in a different collection, giving their status and principles. This research Bi- A mathematical goal to advance the inventory group founded on the ABC. The Planned model instantly improves the amenity level, the amount of inventory grouping, and the number of due things. An Arithmetical model is available in this study to categorize inventory objects, considering significant revenue and rate decrease catalogues. The model aims to maximize the net gain of available items. Economic and inventory constraints are also taken into account. The Benders decay and Lagrange reduction procedures respond to classical arithmetical stands. The outcomes of the two answers are then equated. TOPSIS and numerical examinations estimate the planned answers and choose the best. Later, numerous sensitivity studies on the classic were completed, which assists inventory control executives in regulating the outcome of inventory administration rates configured for optimum verdict production and element grouping. The Arithmetical diagram was run for ten different arithmetic instances, and the results of the two suggested explanations were statistically equated using a t-test. As a result, the TOPSIS technique was appropriate; the Lagrangean approach was chosen as the more fabulous technique.

Keywords: ABC analysis, Bi-Goal optimization, inventory control, decomposition procedures, TOPSIS

1. Introduction

Given the intense business competition in today's manufacturing world, it is vital to repay the kindness to inventory control and appropriate regulation of altogether sorts of administrations, particularly industrial singles. Many establishments' entire investment has been completed up of their inventories in recent centuries. In established and emerging nations, investment properties of altogether periods are tall. The ABC study is the utmost frequently utilized technique for preparation

RT&A, No 4 (71)
Volume 17, December 2022

and supervising the inventory [1]. The cataloging of stocks founded on the ABC investigation allows the establishments to classify their stocks into expressive collections.

Overall, the ABC technique trails the Pareto law, implying thatlone30% of catalogs make 70% of the overall revenue, and the remaining 70% of records yield 30% of revenue [2]. Session A has the invention by the maximum worth, and session C has the product with the bottom worth [3]. The stated ABC technique has specific difficulties, like the absence of suitable strategies to regulate the service level, supervising the relative amongst facility levels and group results, and deserting to deliberate the economic restriction in all steps [4]. These difficulties make investigators project an established ABC technique.

This arrangement is emphasized, particularly for the association in evolving and established countries, as a significant proportion of their venture is grounded on catalogs. This article plans a multiple-criteria decision analysis (MCDA) ABC investigation to exploit the entire clear revenue at different planes for a construction business below the economic restriction. Other approaches exist in current centuries to categorize ABC multiple-criteria decision analysis (MCDA). In this esteem, it may mention the analytic hierarchy process (AHP), non-natural intelligence methods, arithmetical study, information envelopment investigation (IEI) [5], emotional Euclidean detachment, standard measure matrix classical, collection investigation classical, meta-heuristic procedures, optimization measures, ABC-FUZZY organization method. However, they have been utilized in the current study and even compared. This arrangement typically too serves inventory and procedure executives to optimize several objects instantaneously, counting(a) the amount of catalog grouping, (b) their facility stages, and (c) the distribution of individual pieces toward a piece collection below a partial economical.

2. Literature review

2.1. ABC study for the inventory controller of stock

In 1915, Ford Harris from the Westinghouse Foundation gave an unpretentious formulation for inventory control [5]. Then, this autonomous formula was verified by some investigators [6, 7]. The old-style ABC technique categorizes the objects founded on sole standards (i.e., rate), and numerous lessons are absorbed in multi-criteria cataloging [8- 11]. Ng and Ramanathan [12] also [13] deliberated the multiple-criteria decision analysis (MCDA) ABC technique toward regulating the account by calculating the average price of each component, yearly in getting worth, then head period. [14] too offered multiple-criteria decision analysis (MCDA) ABC technique then applied the combined standards medium.

Supplementary investigators study the grouping of the ABC- investigation procedure by different thoughts toward the account organization's progress. As an initial move, additional rational then inclusive pointers for account organization were planned. Furthermore, Douissa and Jabeur [15] designed an original ABC investigation classical and utilized it characterized by compensation. Accumulation procedure toward organizing the account objects. The outcome established that the organization of things shaped the lowermost inventory rate related to additional models.

Moreover, Yu [16] connected the group techniques founded on old-style numerous prejudiced analyses (MDA). Based on their consequences, AI procedures were specific in the account group, and the SVM was more precise among the AI procedures. Furthermore, Gong et al. [17] utilized an involuntary knowledge technique (IKT), which involves the TOPSIS method for analyzing the slash of individual account items. Similarly, Mehdizadeh [18] planned a combined ABC analysis technique for circulation systems of auto replacement fragments with the reflection of the account controller procedure. The planned ABC investigation additional the economic morals to strains then classifies the replacement fragments found and arranged their effects scheduled supplier presentation. Gong et al. [19] utilized the disappointment method result and criticalness investigation (DMRCI) to plan a multiple-criteria decision analysis (MCDA) ABC investigation system for replacement fragment manufacturing. They found a massive development in ABC investigation and a substantial decrease in chief mechanisms percentage. Most of the studies cited the ABC investigation.

2.2. Lagrange and benders procedures in the evaluation

Optimization sums consist of various matrix constructions arranged in the plan of medium chunks and their association [20]. The procedures that apply this problematic medium construction are frequently additional effective and find the correct response to the sum at the suitable period. Overall, the structure of optimization sums often contains compound restrictions or compound variables. These restrictions and variables typically replicate the communal usage of sum chunks on one or other infrequent bases. Then additional arrangements are utilized to such sums. Indirectly explaining sum using decomposition methods, it is compulsory to recognize the sum construction. Many investigators have used those analytical procedures, some of which are presented below.

Adaptable get-together lines often occur in businesses fabricating extensive goods. Numerous workforces are allocated toward a similar position toward accomplishing multiple errands on identical merchandise instantaneously. The effective Arithmetical formulas obtainable can only resolve a few minor examples, while greater ones are resolved by empirical approaches that organize non-require assurance optimality. Wang et al. [21]'s article introduced an original short-interest LP construction by substantial equilibrium disruption restrictions.

2.3. Investigation gap

Inventories are a dynamic component for altogether establishments in today's manufacturing world. In fresh periods, establishments have met thousands of unlike kinds of accounts, then account managing and making has stayed the focus of planning's in this esteem. Appropriate account controller arrangements have developed a substantial contest for altogether establishments, which is essential for Investigation in this zone. The absence of proper inventory control schemes generates numerous glitches for administrations. Initially, they face inventory-related rates for fields, collection, and famines.

3. Explanation of the Arithmetical classical

The Arithmetical problem is founded on dominant stock and w constituencies. There is supposed to be only one significant stock and numerous divisions with special requests and scar city rates in this model.

Table 1: *Summary of the literature review*

Reference	Segment A					Segment B		
ABC investigation						Decomposition procedures		
	Goal function		Criteria		Solution techniques	Lagra nge	Benders	Compariso n
	Single	Multi	Single	Multi				
Hadi-Vencheh [19]	Yes	No	No	Yes	Extended version of NG-model	No	No	No
Massart [16]	Yes	No	Yes	No	-	No	No	No
Flores and Whybark [17]	No	No	No	Yes	A simple mechanical procedure	No	No	No
Kaabi *et al*. [5]	No	No	No	Yes	Automatic learning technique	No	No	No
Douissa & Jabeur [13]	Yes	No	No	Yes	PROFT technique	No	No	No
Liu *et al*. [7]	Yes	No	No	No	Clustering examination	No	No	No
Hajbabaie [8]	No	No	No	No	-	No	No	No
Mardan *et al*. [4]	No	No	No	No	-	No	Yes	No
Jaglarz *et al*. [9]	No	No	No	No	-	Yes	No	No
Li *et al*. [11]	No							
Zetina *et al*. [25]	No							-
Sudhakar *et al*. [23]	-							
Wang *et al*. [21]	No	No	No	No		Yes	No	Yes
Li and Jia [10]	No	No	No	No	-	No	Yes	No

Where

i = Established inventory objects

j =Established inventory grouping

t = Establishedtime

Strictures

$d_{(i,t)}$ =Average of monthly calls for SKU I in time$t$

σ_i =Typical deviation of the once-a-month direction of SKU i
$h_{(i,t)}$ = Headperiod of SKU i
$\pi_{(i,t\,)=}$ Un civilized revenue per component of SKUI in time t
$e_{(i,t\,)=}$ Inventory field price per component of SKU I in time t
θ_j = Variable above control rate for inventory objects j
M = Amount of inventory objects (SKUs)
D = Existing in expensive
β_j = Facility level related to inventory objects j
Z_J = Z – value related to the facility level β of inventoryobjects j
$O_{(i,t\,)}$ = Set direct rate for SKU i from the central stock to traders in time t
$CL_{(I,j,t)}$ = Set rate of shortage for SKU I at inventory group j in time t

Decision variables
$V_{(i,t)}$ = The inventory level of SKU $i$in the dominant stock in time t
$La_{(i,j,t)}$ = The total of lack SKU$i$at inventory group $j$in time t
$X_{(i,j,t)}$ = If SKU$i$is allocated to group j in time t,one and otherwise 0
$Y_{(i,t)}$ = If inventory group $j$is specific in time$t$, one and otherwise 0

$$\delta_{(i,j,t)} = d_{(i,t)}h_{(i,t)} + z_j\sigma_i\sqrt{h_{(i,t)}} \tag{1}$$

$$MaxZ = \sum_i\sum_j\sum_t \pi_{(i,t\,)}d_{(i,t)}\beta_j\, X_{(i,j,t)} - \sum_j\sum_t \theta_j Y_{(i,t)} - \sum_i\sum_j\sum_t CL_{(i,j,t)}\, La_{(i,j,t)} \tag{2}$$

Subject to:

$$\sum_j X_{(i,j,t)} \leq 1 \tag{3}$$

$$\sum_j X_{(i,j,t)} \leq MY_{(i,t)} \tag{4}$$

$$V_{(i,t)} + \sum_j La_{(i,j,t)} = \sum_j d_{(i,t)}h_{(i,t)}X_{(i,j,t)} + \sum_j z_j\sigma_i\sqrt{h_{(i,t)}}\; X_{(i,j,t)} + V_{(i,t)-1} + \sum_j La_{(i,j,t)-1} \tag{5}$$

$$\sum_i e_{(i,t\,)}V_{(i,t)} \leq D\forall t \tag{6}$$

$$\sum_i V_{(i,t)}, La_{(i,j,t)} \geq 0 \tag{7}$$

$$X_{(i,j,t)}, Y_{(i,t)} \in [0,1] \tag{8}$$

4. Planned decomposition procedures Head time of SKU

In several Arithmetical replicas, with the problematic magnitude, the computational difficulty of the perfect also grows exponentially so that the particular answers cannot be intended in a sensible date [23, 7]. Subsequently, investigators have planned several systems that use a specific method to pursue estimated and near-optimal answers. These approaches are usually separated into two group's experiential and meta-heuristic procedures. Disintegration events are among the experiential techniques that aim to shorten compound Arithmetical models to attain an estimated response in a reasonable time. Frequent requests for these procedures have commanded their application in many optimization difficulties. Educations through Yolmeh and Saif [24], Wang et al. [25], Naderi et al. [26], and Aydin and Ta¸skin [27] are instances of the request for these procedures toward hard restraint complications.

This segment presents the explanations for the planned classical. In this respect, situations are completed to Lagrange and Bender's disintegration procedures. Then, they are associated with choosing the most satisfactory answer to the model. As stated, disintegration explanations are envisioned to shorten the Arithmetical model planned in this Investigation. These explanations are familiarized in the subsequent subdivisions.

4.1. Lagrange reduction procedure

The Lagrange reduction process is one of the advanced approaches that employ the Lagrange proposition to explain composite Arithmetical representations to find an estimated solution in a reasonable amount of time. This method has been used to solve a variety of optimization problems. Diabat et al. [16], Kang and Kim [28], and Ahmadi-Javid and Hoseinpour [29] are examples of applications of the Lagrange approach to such challenges.

$Min\ c^T x$

Subject to

$Ax \leq b, x \in X$

$Min\ c^T x + \mu^T (Ax - b)$

Subject to $x \in X$

$$MaxZ + u\left(-\sum_i \sum_t V_{(i,t)} - \sum_i \sum_j \sum_t La_{(i,j,t)} + \sum_i \sum_j \sum_t d_{(i,t)} h_{(i,t)} X_{(i,j,t)} + \sum_i \sum_j \sum_t z_j \sigma_i \sqrt{h_{(i,t)}}\ X_{(i,j,t)} + \sum_i \sum_t V_{(i,j)-1} - \sum_i \sum_j \sum_t La_{(i,j,t)-1}\right)$$

$$u^{c+1} = max\left[0, \left\{u^c + \pi^c . \left(-\sum_i \sum_t V_{(i,t)} - \sum_i \sum_j \sum_t La_{(i,j,t)} + \sum_i \sum_j \sum_t d_{(i,t)} h_{(i,t)} X_{(i,j,t)} + \sum_i \sum_j \sum_t z_j \sigma_i \sqrt{h_{(i,t)}}\ X_{(i,j,t)} + \sum_i \sum_t V_{(i,j)-1} - \sum_i \sum_j \sum_t La_{(i,j,t)-1}\right)\right\}\right]$$

$$\pi^c = \frac{v^c (BUB^c - LB^c)}{\left(-\sum_i \sum_t V_{(i,t)} - \sum_i \sum_j \sum_t La_{(i,j,t)} + \sum_i \sum_j \sum_t d_{(i,t)} h_{(i,t)} X_{(i,j,t)} + \sum_i \sum_j \sum_t z_j \sigma_i \sqrt{h_{(i,t)}}\ X_{(i,j,t)} + \sum_i \sum_t V_{(i,j)-1} - \sum_i \sum_j \sum_t La_{(i,j,t)-1}\right)^2}$$

4.2. Bender's decomposition algorithm

Benders [30] planned the Benders decomposition algorithm to resolve compound number complications.

$$Min\ Z = -\sum_i \sum_j \sum_t \pi_{(i,t)} d_{(i,t)} \beta_j X_{(i,j,t)} + \sum_j \sum_t \theta_j Y_{(i,t)} + \sum_i \sum_j \sum_t CL_{(i,j,t)} La_{(i,j,t)} \quad (9)$$

Subject to: $1 \geq \sum_j X_{(i,j,t)}\ \forall\ i, t$ (10)

$$0 \geq -MY_{(i,t)} \sum_i X_{(i,j,t)}\ \forall\ j, t \quad (11)$$

$$\sum_j d_{(i,t)} h_{(i,t)} X_{(i,j,t)} + \sum_j z_j \sigma_i \sqrt{h_{(i,t)}}\ X_{(i,j,t)} + V_{(i,t)-1} + \sum_j La_{(i,j,t)-1} - V_{(i,t)} + \sum_j La_{(i,j,t)} = 0 \quad (12)$$

$$\sum_j e_{(i,t)} V_{(i,t)} \geq -D\ \forall\ i, t \quad (13)$$

5. Comparison of decomposition procedures

This section decides whether to approve the anticipated approach for resolving the current Arithmetical model to manage the optimal amount of inventory grouping in stock. There are two decomposition processes available: Lagrangean and Benders. The classical is then resolved, and the effects are equal. The Arithmetical classic for each technique is applied in 10 different arithmetical illustrations in the direct repetition and comparison of these two intended ways. The results of this procedure are then equated in all mathematical instances using t-tests using the arithmetical presumption investigation. The TOPSIS method is also used to determine the optimal approach. It is worth noting that with the GAMS software version 24.1.3 and CPLEX problem solver, all arithmetical samples are used to resolve the intended Arithmetical classic.

5.1. Numerical instances

In this section, the indicators are defined first to approximate the anticipated Arithmetical construction and technique of solution. As a result, two indices are determined. They include the value of the Goal purposes premeditated by the model with each planned technique and the time spent. In addition, the planned technique is equated to generating some mathematical drawings.

Table 2: *The consequences of the application of the classical by dissimilar mathematical instances*

Arithmetical instances	Bender's decomposition		Lagrangean reduction	
	OBJ(RS)	Time(s)	OBJ(RS)	Time(s)
1	3.49040D+7	2.14	3.468116D+7	9.51
2	2.62670D+7	3.03	2.624825D+7	6.23
3	4.22314D+7	7.67	3.601867D+7	9.64
4	4.41611D+7	47.88	4.413372D+7	12,12
5	1.00500D+7	3.04	1.003803D+7	7.07
6	3.23075D+7	19.67	3.228605D+7	8.53
7	1.31380D+7	4.43	1.312534D+7	4.28
8	2.83043D+7	8.31	2.827428D+7	8.64
9	3.33035D+7	7.32	3.327178D+7	9.06
10	3.41170D+7	9.17	3.410455D+7	90
Average	3.08563D+7	12.27	3.020718D+7	8.31

5.2. Statistical examination of the outcomes

Some t-tests are utilized to investigate the outcomes of the 2 planned approaches of resolving the Arithmetical model and equating them. Specified the 95% confidence equal, the numerical evaluation of the resources of the outcomes of the 2proposedapproaches is achieved for individually of the definite estimation directories. In individual assessment, the supposition of nothing (H0) is equivalent to the unkindness of the consequences of the 2 planned techniques, and the conflicting hypothesis (H1) pursues to contest this supposition. This theory examination is stretched for counted directories; these resources at 95% self-possession level; nearby is no expressive change among the answers of the two planned explanations concerning the Goal role worth power. Similarly, the insignificant hypothesis concerning the CPU Period power of the classical is recognized since its P-value is more advanced than 0.05, which incomes there is no considerable modification among the replies of the 2planned key methods about the CPU Period index.

Table 3: *The outcome of numerical examination for the OBJ function*

OBJ function	N	Mean	St. Dev	SE Mean	P-Value
Bender's breakdown	10	309562500	110663870	24020014	0.783
Lagrangean reduction	10	302071820	103420821	22044473	

Table 4: *The outcome of numerical examination for the CPU period*

OBJ function	N	Mean	St.Dev	SE Mean	P-Value
Bender's breakdown	10	12.3	15.7	4.2	0.368
Lagrangean reduction	10	8.31	1.01	0.56	

Table 5: *Summary of the old-style ABC examination*

Class	Proportion of objects	The ratio of things worth	Facilities level (%)	The worth of each type ($)
A	8.45 7.34	65.82 54.71	93 82	102038493853.37 102028382742.26
B	19 18	24.33 13.22	90 80	37722210667 26611100556
C	61.44	8.24	70	141578166681
Total	90	90	90	144018521201.26

Table 6: *The preparation has got the best facility level and inventory grouping answers*

The group with service level (%)	No. of SKUs (%)	Inventory spending ($)	Gross revenue ($)	ROI
99	15(13.72)	524664040.4	231800800	3.33
95	4(3.52)	606106844.3	226030700	2.63
90	6(5.38)	681011602.0	2167043000	2.08
87	2(1.67)	744766781.0	2073800000	1.67
80	3(2.60)	821125077.1	1980535000	1.31
75	3(2.60)	1041313306	1747400000	1.56
70	5(4.45)	659732677.2	1584206000	1.30
60	15(13.71)	783055104.4	1351071000	1.62
50	9(8.15)	823782025.1	1118037000	1.25
40	8(7.23)	906 697 438.5	885801300	0.98
30	7(6.30)	620761028	652666500	1,05
	19(17.41)	0	0	-

5.3. Regulate the best algorithm using the TOPSIS method

Founded on the outcomes of the mathematical instances and the statistical judgments, it is not conceivable to determine an explanation technique greater than the others in both circumstances. Therefore, the Technique for Direct of Favorite by Comparison to Ideal Solution (TOPSIS) method selects the most proper technique. The word TOPSIS means partiality founded on resemblance to the perfect key. The model recognized by Hwang and Yoon [21] is a unique method for ranking possibilities.

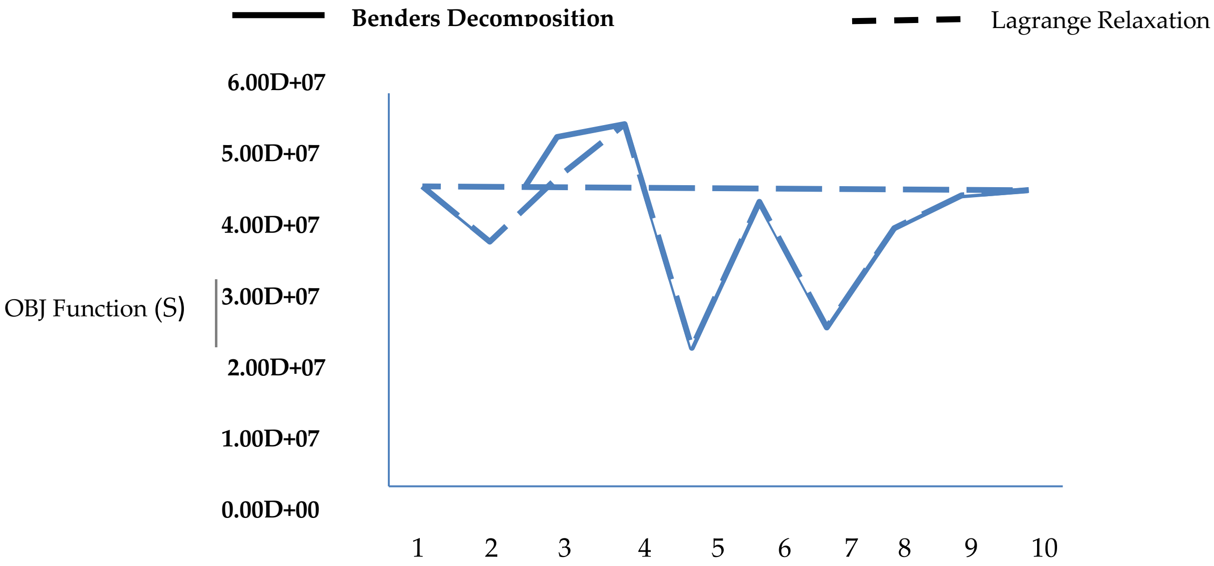

Figure1: *Numerical example*

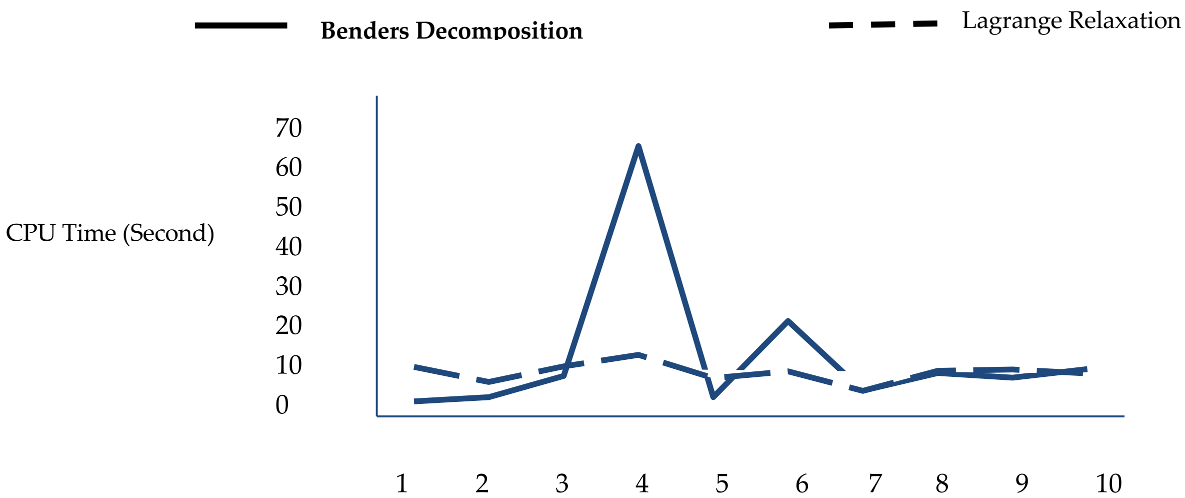

Figure2: *Numerical example*

6. Conclusion

Currently, inventory management and controller constructions are major issues presented by developing administrations. This research identified an optimization Diagram to categorize inventory groups, regulate their facility stages instantly, and assign objects to those assemblies. This strategy improves the inventory group founded on the ABC examination by integrating automatic and optimal replies. The Diagram designed in this education differs from existing optimization Diagrams in two ways. Initially, the model observes and exploits the company's income rather than minimizing inventory rates. It also optimizes the trade-off between inventory rates and payments and allocates inventory-to-inventory items. The Arithmetical Diagram used in this article was to maximize the residual income from stock items.

The interpretation occupied boundaries such as low cost and a lack of inventory. Disintegration events and their proportionate scrutiny are other elements that distinguish this Investigation from other papers on the subject. Two indices, counting the Goal purpose value and CPU while approaching the anticipated solution, approach tenaciously. The Arithmetical diagram was then running for ten distinct arithmetic occurrences, and the results of the two suggested explanations were statistically equated using a t-test. In terms of superiority and response time, the responses were fairly close. Choose one of these. As a result, the TOPSIS technique was appropriate, whereas the Lagrangean technique was chosen as the more spectacular technique.

References

[1] Chen Y, Li KW, Kilgour DM, Hipel KW (2008) A case-based distance model for multiple criteria ABC analysis. Compute Oper Res 35(3):776–796

[2] Pareto, V. (1971). Manual of political economy, 1909. English translation by Kelley AM, New York.

[3] Armstrong DJ (1985) Sharpening inventory management. Harv Bus Rev 63(6):42–58.

[4] Teunter RH, Babai MZ, Syntetos AA (2010) ABC classification: service levels and inventory rates. Prod Oper Manag 19(3):343–352

[5] T.J. Coelli, D.S.P. Rao, C.J. O'Donnell, and G.E. Battese, An Introduction to Efficiency and Productivity Analysis. Springer Science & Business Media (2005).

[6] O. Abdolazimi, M.S. Esfandarani, M. Salehi and D. Shishebori, Robust design of a multi-Goal closed-loop supply chain by integrating on-time delivery rate and environmental aspects case study of a Tire Factory. *J. Cleaner Prod.* 264(2020) 121566.

[7] M.L. Fisher, The Lagrangean relaxation technique for solving integer programming problems. *Manage. Sci.* 50(2004) 1861- 1871.

[8] O. Abdolazimi, M.S. Esfandarani, and A. Abraham, Design of a closed supply chain regarding the social and environmental impacts under uncertainty (2020).

[9] P. Jaglarz, P. Bory lo, A. Szymanski, and P. Cho LDA, Enhanced Lagrange decomposition for multi-Goal scalable TE in SDN *Comput. Netw.* 167(2020) 106992.

[10] J. Li, X. Zeng, C. Liu, and X. Zhou, A parallel Lagrange algorithm for direct acceptance and scheduling in cluster supply chains. *Knowl. -Based Syst.* 143(2018) 271- 283.

[11] J. Liu, X. Liao, W. Zhao, and N. Yang, A classification technique based on the outranking model for multiple criteria ABC analysis. *Omega* 61(2016) 19- 34.

[12] A. Hadi-Vencheh, An improvement to multiple criteria ABC inventory classification. *Eur. J. Oper. Res.* 201(2010) 962- 965.

[13] H. Kaabi, K. Jabeur, and L. Enneifar Learning criteria weights with TOPSIS technique and continuous VNS for multi-criteria inventory classification. *Electron. Notes Discrete Math.* 47(2015) 197- 204.

[14] M.A. Cohen and R. Ernst, Multi-item classification and generic inventory stock contr. *Prod. Inventory Manage. J.* 29(1988) 6.

[15] AK Chakravarty, Multi-item inventory aggregation into the grouping. *J. Oper. Res. Soc.* 32(1981) 19- 26.

[16] P. Massart, The tight constant in the Dvoretzky-Kiefer-Wolfowitz inequality. *Ann. Probab.* 18(1990) 1269- 1283.

[17] A. Diabat, O. Batta¨ıa, and D. Nazzal, An improved Lagrangean relaxation-based heuristic for a joint location-inventory problem. *Compute. Oper. Res.* 61(2015) 170- 178

[18] B.E. Flores and D.C. Whybark, Implementing multiple criteria ABC analysis. *J. Oper. Manage.* 7(1987) 79 - 85.

[19] M.R. Douissa and K. Jabeur, A new model for multi-criteria ABC inventory classification: ROAFTN technique. In: KES (2016) 550 - 559.

[20] O. Abdolazimi and A. Abraham, Designing a multi-Goal supply chain model for the oil industry in conditions of uncertainty and solving it by meta-heuristic procedures (2020).

[21] G. Wang, W. Ben-Ameur and A. Ouorou, A Lagrange decomposition-based branch and bound algorithm for the optimal mapping of cloud virtual machines. *Eur. J. Oper. Res.* 276 (2019) 28 – 39

[22] J. Li, X. Zeng, C. Liu, and X. Zhou, A parallel Lagrange algorithm for direct acceptance and scheduling in cluster supply chains. *Knowl. -Based Syst.* 143(2018) 271- 283.

[23] N.V.Kovaˇcki, P.M. Vidovi'c and A.T. Sari's, Scalable algorithm for the dynamic reconfiguration of the distribution network using the Lagrange relaxation technique. Int. J. Electr. Power Energy Syst. 94 (2018) 188 - 202.

[24] A. Yolmeh and U. Saif, Closed-loop supply chain network design integrated with assembly and disassembly line balancing under uncertainty: an enhanced decomposition technique. *Int. J. Prod. Res.* 59(2021) 2690 - 2707.

[25] J. Wang, Q. Wan and M. Yu, Green supply chain network design considering chain-to-chain competition on price and carbon emission. *Comput. Ind. Eng.* 145 (2020) 106503.

[26] B. Naderi, K. Govindan, and H. Soleimani, A Benders decomposition technique for a simple case supply chain network design with capacity acquisition and transporter planning: wheat distribution network. Ann. Oper. Res. 291 (2020) 685 - 705.

[27] M.A. Aydin and Z.C. Ta¸skin, Decentralized decomposition procedures for peer-to-peer linear optimization. *RAMIRO: OR* 54(2020) 1835 – 1861

[28] J.H. Kang and YD. Kim, Inventory control in a two-level supply chain with risk pooling effect. *Int. J. Prod. Econ.* 135(2012) 116 - 124.

[29] A. Ahmadi-Javid and P. Hoseinpour, A location-inventory-pricing model in a supply chain distribution network with price-sensitive demands and inventory-capacity constraints. *Transp. Res. Part E: Logistics Transp. Rev.* 82(2015) 238 - 255.

[30] JF Benders, Partitioning procedures for solving mixed-variables programming problems. *Comput. Manage. Sci.* **2** (2005) 3 - 19.