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Abstracts

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Conference Secretary

- Hyokyung Jung (Korea Institute of Industrial Engineers) constructed. There cycling rate and costs for each part are estimated by Recyclability Evaluation Method (REM) provided by Hitachi Ltd. Also, the CO2 saving rate is calculated by a Life Cycle Inventory (LCI) database by the input-output tables. Next, the environmentally friendly and economical disassembly parts selection is formulated by Goal Programming under the disassembly precedence relationships, which has 3 objective functions: minimizing recycling costs, maximizing recycling rate and maximizing CO2 saving rate. Finally, a case study is experimented and discussed for an optimal and Pareto optimal solutions

B1: Manufacturing Systems (2)

- 10 October 13:30~14:45 / Place: Coral Hall (18F)
- Chair: Mohd Norzaimi Che Ani
  (Universiti Kuala Lumpur, Malaysia)

* Corresponding Author

■ B1.1

Common Due-date Assignment and Scheduling on a Single Machine with Sequence-dependent Setups and Discretely Controllable Processing Times

Akmal Ulugov, Jeong-Hoon Shin, and Dong-Ho Lee*
Department of Industrial Engineering, Hanyang University, Seoul, Republic of Korea
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This study considers single machine common due-date assignment and scheduling with controllable processing times, which is the problem of determining the common due-date, the processing times and the sequence of jobs to be processed on a single machine. The processing time of each job is considered in the discrete form in that it is determined by selecting one of its discretely available processing times. Also, the sequence-dependent setup, in which setup times depend on the type of job just completed and the job to be processed, is also considered. A mixed integer programming model is proposed for the problem with the objective of minimizing the sum of earliness, tardiness, due-date assignment and job processing costs, where the job processing costs may be different for different available processing times. Then, due to the complexity of the problem, the two-stage heuristic algorithms are proposed in which an initial solution is obtained by the position weights and then it is improved by the pairwise interchange method together with determining the processing times. Computational experiments were done on various randomly generated test instances and the results are reported.

■ B1.2

Hybrid Algorithms for Order Acceptance and Scheduling

Gen-Han Wu[1,*], Hung-Wei Chen[2], and Wang-Xian Li[2]
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For some seasonal products, many orders often come in a short time. As a result, a make-to-order plant needs to select the adequate orders from the order inquiries and schedule the accepted orders in limited production capacity. In this study, the integrating problem of order acceptance and parallel machine scheduling is studied. A mixed integer programming model is proposed to minimize the total tardiness. We arrange its encoding system as the orders' sequence based on the real numbers to fit the basic concept of particle swarm optimization. Initial solutions are randomly obtained and several improvement metaheuristic strategies based on particle swarm optimization, harmony search, and variable neighborhood search are introduced. Comparative numerical results have shown that the proposed algorithms can obtain very good performance.

■ B1.3

Modeling Part Replenishment System for Factory-in-factory Concept

Mohd Norzaimi Che Ani[1], Mohd Khomeini Solihin Shafei[1], Shahrul Kamarudin[2], and Ishak Abdul Azid[1*]
[1] Universiti Kuala Lumpur, Malaysia
[2] Universiti Teknologi Petronas, Malaysia
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This paper presents a study on a newly constructed factory-in-factory concept adopted by an automotive assembly factory, focusing on the part replenishment system. Poor design of the part replenishment system will cause the production idling due to part shortage. This situation will affect the production performance and at the same time will increase the lead time. The normal part replenishment system is infeasible in this case because parts in factory-in-factory are handled multi-paths. Furthermore, the cycle time of the part replenishment is largely imbalance. Two possible part replenishment systems are proposed to solve the problem of production idling and both systems are investigated through computer simulations enhanced with WITNESS simulation. The two factors influencing the overall system which are allocation of workers and the impact of changing path to the performances of the production are investigated. The main purpose to evaluate the possible methods of part replenishment system is to determine the optimum solution of the production idling. The finding shows that there are clear indications of the effects of the number of workers and the paths for the performances of the system have a significant impacts influencing the production idling. Based on the evaluation, the result shows one of the proposed solutions gives the optimum solution and the production performance has drastically increased. The proposed solution has also improved the effectiveness of the supply chain management.

■ B1.4

A Sustainable Manufacturing System with Minimum Quantity Lubrication and Carbon Footprint

Muhammad Omair and Biswajit Sarkar*
Department of Industrial & Management Engineering, Hanyang University, Ansan, Gyeonggi-do 426 791, Republic of Korea
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The industrial sector faces many challenges over period of time from cost minimization to quality improvement, lean, green, and recently sustainable manufacturing. This paper proposes a manufacturing model with multiple objectives to minimize total cost of manufacturing, energy consumption and carbon footprint with the effect of variable production quantity to provide sustainable manufacturing. Total cost of manufacturing includes fixed cost and variable costs with the addition of cost of minimum quantity lubrication (MQL), solar energy and imperfect quality items. MQL system is an ecofriendly and sustainable to minimize cost of machining, mitigate burden on environment and improve worker safety. In addition, solar energy is renewable and sustainable source of energy ultimately producing positive impact on environment. This study also considers the situation where imperfect quality items are produced and are reworked at certain known rate. A numerical example is presented to depict the practical application of the proposed model.

B2: Operations Management (2)

- 10 October 13:30~14:45 / Place: Dong-hae Hall (18F)
- Chair: Lijing Zhu
  (China University of Petroleum, China)

* Corresponding Author

■ B2.1

Determination of Interval Order Policy at Distributor and Retailers Using Innovative Heuristic Method to Minimize Inventory Total Cost (Application Case at Distributor X in Indonesia)

Rainisa Maini Heryanto*, Santoso, and Elizabeth Ivana Kristianto
Bachelor Program in Industrial Engineering, Maranatha Christian University, Bandung, West Java, Indonesia
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A supply chain system usually consists of entities such as manufacturer, distributor, retailer, and customer. Integration in a supply chain system is an important factor to increase competitiveness between each other. This research will be discussed how to integrate between single distributor and ten retailers of eight products and to find a minimum inventory total cost. Currently, distributor and each retailer have its own order policy and give an impact that inventory total cost is expensive. The innovative heuristic method which used to integrate order policy between distributor and retailers for multi item is a model of Praharsi, et al (2014). The initial step in this research is calculating the cost elements such as ordering cost and holding cost, then calculating inventory total cost with current method and innovative heuristic method. The result of this research is interval order policy at distributor and each retailer. This method is given a minimum inventory total cost at distributor and each retailer.

■ B2.2

Designing an Optimal Inventory Replenishment Strategy in a Combined MTS-MTO Supply Chain

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We consider a combined MTS-MTO supply chain in which an MTO manufacturer replenishes component inventory from contract suppliers on a MTS basis. Two types of component replenishment strategies are evaluated; multiple suppliers with a fixed order quantity and a single supplier with volume flexibility. We formulate the problem using a discrete Markov Decision Process and propose a solution procedure for each strategy. Numerical analysis provides interesting findings. First, the design of an optimal replenishment strategy is dependent not only on the lead-time but also on the traffic intensity at the MTO manufacturer. Second, the optimal policy for ordering inventory is of the control limit type.

■ B2.3

Applying Ant Colony Algorithm to Inventory and Open Vehicle Routing Problem for Multiple Depots and Multiple Retailers' Distribution System

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This research apply the meta-heuristic of ant colony optimization to an established set of Inventory Open Vehicle Routing Problem (IOVRP) to the multiple depots and multiple retailers' distribution system. The objectives of this research is to develop practical replenishment decisions by using IOVRP concept and to compare the solutions of IOVRP to Inventory Routing Problem (IRP). The sensitivity analysis of related factors which are inventory holding cost, ordering cost and vehicle capacity, is performed. The result shows that the IOVRP gives better solution than that of IRP about 24.66%. Based on the analysis of variance, the algorithm of IOVRP is advantage over IRP when the delivery is performed by small vehicle capacity with low ordering cost and high holding cost.

■ B2.4

Analysis of a Traceability System for Perishable Food Supply Chains

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This study analyzes an RFID-enabled traceability system for perishable food supply chains, which consist of an upstream supplier and a downstream retailer. The supplier delivers the RFID embedded perishable food to the retailer. The deployment of RFID enables constant monitoring of the parameters that are critical to the quality and the safety of food (such as temperature, humidity and time period) and therefore provides real-time food quality data. Based on the quality of food when it arrives at the retailer, the supplier sets the wholesale price and the retailer determines price markdowns, accordingly. We develop a decision-making mechanism for a perishable food supply chain when demand depends on the price, the quality, and the safety of perishable food. The optimal decisions of the participants are derived in both centralized and decentralized systems. We further propose an incentive scheme to coordinate the decentralized system. Numerical analysis is conducted to provide managerial insights in terms of RFID deployment in the perishable food supply chain.

■ B2.5

Fuzzy Production Quantity Model with Backorders

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Considering the fuzzy set theory in modeling of inventory problem, it may possible and reasonable to discuss fuzzy production inventory models. In

Determination of Interval Order Policy at Distributor and Retailers using Innovative Heuristic Method to Minimize Inventory Total Cost (Application Case at Distributor X in Indonesia)

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Abstract: A supply chain system usually consists of entities such as manufacturer, distributor, retailer, and customer. Integration in a supply chain system is an important factor to increase competitiveness between each other. This research will be discussed how to integrate between single distributor and ten retailers of eight products and to find a minimum inventory total cost. Currently, distributor and each retailer have its own order policy and give an impact that inventory total cost is expensive. The innovative heuristic method which used to integrate order policy between distributor and retailers for multi item is a model of Praharsi, et al (2014). The initial step in this research is calculating the cost elements such as ordering cost and holding cost, then calculating inventory total cost with current method and innovative heuristic method. The result of this research is interval order policy at distributor and each retailer. This method is given a minimum inventory total cost at distributor and each retailer.

Keywords: integration, innovative heuristic, interval order policy, inventory total cost

1. INTRODUCTION

Supply chain management is a method or integrative approach for managing product flow, information, and money integratively involve entities from upstream to downstream which consist of supplier, manufacturer, distribution network, and logistic service (Pujawan, 2010). Manufacturer produces product, distributor distributes product from manufacturer to retailer, prepares and delivers product base on retailer order. Distributor will order product to manufacturer for keeping stock at warehouse so that well inventory control is really needed. Sometimes, each entity at supply chain has its own role for producing or ordering product.

This research concerns to apply one method to integrate two entities in supply chain system between distributor and retailers. There is single distributor and ten retailers of eight products and no integration policy between them. The supply chain system of that case is shown in Figure 1. Currently, distributor and each retailer have its own policy to order product. Distributor has a fix quantity order to manufacturer and every retailer has a fix period order to distributor.

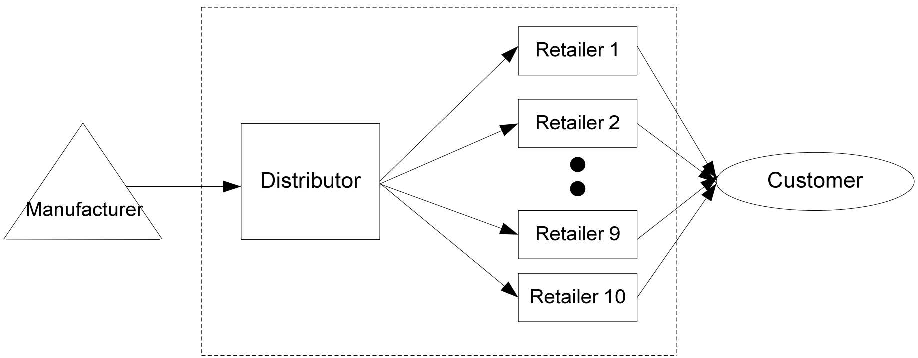

Figure 1. Supply Chain System

The difference order policy between every entity or disintegrate between them give an impact to the inventory total cost. The expensive inventory total cost will cause low competitiveness between retailer and low advantage at distributor and retailer. This research tries to integrate order policy between distributor and retailers for multi item products to minimize inventory total cost in every chain and to increase advantage and competitiveness among retailers.

2. METHODOLOGY

This research uses innovative heuristic method base on model of Praharsi, et al (2014). The model is development model from any earlier research which major explain about joint replenishment. The characteristic of this model is consists of single warehouse and n retailers and for multi item. The aim of this method is determining interval order policy which has minimize inventory total cost.

The initial step for using this method is calculating the cost element such as ordering cost and holding cost. The following algorithm of innovative heuristic is shown in Figure 2.

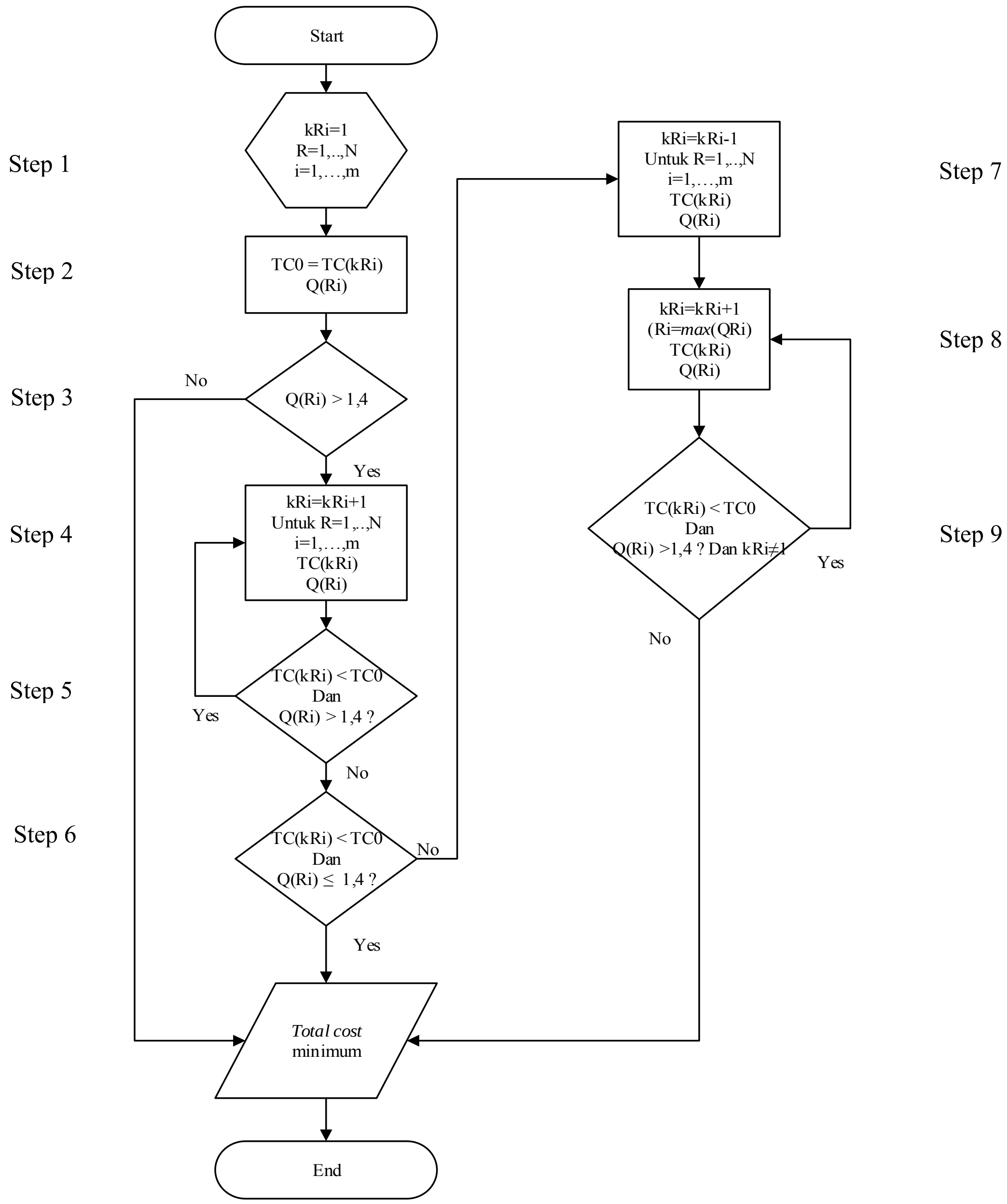

Figure 2. Innovative Heuristic Algorithm (Praharsi, et al, 2014)

a. Step 1
   Set all k_{Ri} value to 1 for each retailer and each product.
b. Step 2
   Calculate initial inventory total cost and calculate Q_{Ri} value based on first step.

c. Step 3
   Check Q_{Ri} value. The expectation Q_{Ri} value is less than or equal 1.4. It's mean that total inventory cost is the smallest. If Q_{Ri} value is more than 1.4, then continue to the step 4. The value of 1.4 is based on model of Nilsson, et al (2007) which describes the lowest error from major replenishment cost.
d. Step 4
   Add k_{Ri} value = k_{Ri} + 1 if Q_{Ri} value more than 1.4 and then calculate new inventory total cost and Q_{Ri} value.
e. Step 5
   Check Q_{Ri} value and new inventory total cost. The Q_{Ri} value is less than or equal 1.4 and the new inventory total cost must be less than initial inventory total cost, so that continue to step 6. If not and then go back to step 4.
f. Step 6
   Check Q_{Ri} value and new inventory total cost must be less than initial inventory total cost. If this condition is fulfilled, so that inventory total cost is the smallest. If not then go to step 7.
g. Step 7
   Less k_{Ri} value = k_{Ri} - 1 if k_{Ri} value more than 1 and then calculate new inventory total cost and Q_{Ri} value.
h. Step 8
   Add k_{Ri} value = k_{Ri} + 1 for the highest or maximize Q_{Ri} value and then calculate new inventory total cost and Q_{Ri} value.
i. Step 9
   Check Q_{Ri} value and new inventory total cost. The Q_{Ri} value is less than or equal 1.4 and the new inventory total cost must be less than initial inventory total cost. It's mean that total inventory cost is the smallest. If not then go to step 8 till Q_{Ri} value less than or equal to 1.4 and new inventory total cost less than initial inventory total cost.

2.1 Model Component

2.1.1Assumption

The assumptions for this method and this case are described below:
1. Demand rate for each retailer and each product is constant value.
2. Retailer uses EOQ (Economic Order Quantity) to order to distributor.
3. Backorder isn't allowed.

2.1.2 Performance Criteria and Decision Variable

Performance criteria used in this research is minimizing total inventory cost. The total inventory cost consists of ordering cost and holding cost.

The decision variable in this research using innovative heuristic is distributor order interval and inventory total cost. Order interval at retailer is multiple from order frequency at distributor. If t_0 more than or equal than t_R so that the frequency value at retailer $f_R \in (1, 2, 3, \ldots)$. If t_0 less than t_R so that the frequency value at retailer $f_R \in \left(\frac{1}{2}, \frac{1}{3}, \frac{1}{4}, \ldots\right)$

3. MATHEMATICS

3.1 Mathematics Notation

Index Notation:
i = index for product (i = 1, 2, …, 8)
R = index for retailer (R = 1, 2, …, 10)

Decision Variable:
t_0 = ordering interval at distributor (month)
$TC_{(kRi)}$ = inventory total cost (IDR/month)

Parameter notation:

w_0 = major ordering cost at distributor (IDR/order)
w_i = ordering cost for product i at distributor (IDR/order)
H_i = holding cost for product i at distributor (IDR/month)
D_{Ri} = demand for retailer R and product i (box)
f_0 = ordering frequency at distributor (order/month)
f_R = ordering frequency at retailer R (order/month)
S_R = major ordering cost at retailer R (IDR/order)
S_{Ri} = ordering cost at retailer R and product i (IDR/order)
t_{Ri} = interval order time at retailer R and product i (month)
t_R = ordering interval at retailer R (month)
h_{Ri} = holding cost at retailer R for product i (IDR/month)
Q_{Ri} = ratio between holding cost and order cost at retailer R for product i
k_{Ri} = integer value = 1 as comparison

3.2 Component Cost at Distributor

Ordering Cost
Ordering cost at distributor consists of major ordering cost (fixed ordering cost) and minor ordering cost (variable ordering cost) with formulation:

$$\text{Total ordering cost} = \frac{w_0}{t_0} + \sum_{i=1}^{8} \frac{w_i}{t_0} \tag{1}$$

Holding Cost
Distributor will have holding cost if $t_0 > t_R$ or $f_R > f_0$ with formulation:

$$\text{Total holding cost} = \sum_{R=1}^{10} \sum_{i=1}^{8} \frac{H_i\, D_{Ri}\, t_R\, (f_R - 1)}{2} \quad \text{for } f_R > 1 \tag{2}$$

3.3 Component Cost at Retailer

Ordering Cost
Ordering cost at all retailers consists of major ordering cost (fixed ordering cost) and minor ordering cost (variable ordering cost) for each product with formulation:

$$\text{Total ordering cost} = \sum_{R=1}^{10} \frac{S_R}{t_R} + \sum_{R=1}^{10} \sum_{i=1}^{8} \frac{S_{Ri}}{t_{Ri}} \quad \text{where } t_R\, f_R = t_0 \text{ and } t_{Ri} = k_{Ri}\, t_R \tag{3}$$

Holding Cost
Holding cost at all retailers with formulation:

$$\text{Total holding cost} = \sum_{R=1}^{10} \sum_{i=1}^{8} \frac{h_{Ri}\, D_{Ri}\, t_{Ri}}{2} \tag{4}$$

3.4 Inventory Total Cost

Inventory total cost using innovative heuristic can be formulated:

$$\text{Inventory total cost} = \frac{w_0}{t_0} + \sum_{i=1}^{8} \frac{w_i}{t_0} + \sum_{R=1}^{10} \sum_{i=1}^{8} \frac{H_i\, D_{Ri}\, t_R\, (f_R - 1)}{2} + \sum_{R=1}^{10} \frac{S_R}{t_R} + \sum_{R=1}^{10} \sum_{i=1}^{8} \frac{S_{Ri}}{t_{Ri}} + \sum_{R=1}^{10} \sum_{i=1}^{8} \frac{h_{Ri}\, D_{Ri}\, t_{Ri}}{2} \tag{5}$$

Substitute: $t_R\, f_R = t_0$ and $t_{Ri} = k_{Ri}\, t_R$, then:

$$\text{Inventory total cost} = \frac{w_0}{t_0} + \sum_{i=1}^{8} \frac{w_i}{t_0} + \sum_{R=1}^{10} \sum_{i=1}^{8} \frac{H_i\, D_{Ri}\, t_0\, (1 - \frac{1}{f_R})}{2} + \sum_{R=1}^{10} \frac{f_R S_R}{t_0} + \sum_{R=1}^{10} \sum_{i=1}^{8} \frac{f_R\, S_{Ri}}{k_{Ri}\, t_0} + \sum_{R=1}^{10} \sum_{i=1}^{8} \frac{h_{Ri}\, D_{Ri}\, k_{Ri}\, t_0}{2 f_R} \tag{6}$$

The inventory total cost formulation is calculated by finding t_0 value as ordering interval at distributor. t_0 value is reached if $\frac{dTC}{dt_0} = 0$ so t_0 can be formulated:

$$t_0 * = \sqrt{\frac{2\left[w_0 + \sum_{i=1}^{8} w_i + \sum_{R=1}^{10} f_R\, S_R + \sum_{R=1}^{10} \sum_{i=1}^{8} \frac{f_R\, S_{Ri}}{k_{Ri}}\right]}{\left[\sum_{R=1}^{10} \sum_{i=1}^{8} H_i\, D_{Ri} \left(1 - \frac{1}{f_R}\right) + \sum_{R=1}^{10} \sum_{i=1}^{8} \frac{h_{Ri}\, D_{Ri}\, k_{Ri}}{f_R}\right]}} \tag{7}$$

Substitute (7) to (6) so that the optimal inventory total cost can be formulated:

$$TC * = \sqrt{2\left[w_0 + \sum_{i=1}^{8} w_i + \sum_{R=1}^{10} f_R\, S_R + \sum_{R=1}^{10} \sum_{i=1}^{8} \frac{f_R\, S_{Ri}}{k_{Ri}}\right]\left[\sum_{R=1}^{10} \sum_{i=1}^{8} H_i\, D_{Ri} \left(1 - \frac{1}{f_R}\right) + \sum_{R=1}^{10} \sum_{i=1}^{8} \frac{h_{Ri}\, D_{Ri}\, k_{Ri}}{f_R}\right]} \tag{8}$$

3.5 Ratio Between Ordering Cost and Holding Cost

The ratio between ordering cost and holding cost or Q_{Ri} value is formulated:

$$Q_{Ri} = \frac{\frac{f_R\, S_{Ri}}{k_{Ri}\, t_0}}{\frac{h_{Ri}\, D_{Ri}\, k_{Ri}\, t_0}{2 f_R}} = \frac{2 f_R\, S_{Ri}}{h_{Ri}\, D_{Ri}\, k^2{}_{Ri}\, t^2{}_0} \tag{9}$$

4. RESULT AND DISCUSSION

In this research, the innovative heuristic method will apply at distributor X which has 10 retailers and 8 products. Based on calculating result, Distributor X has major ordering cost (w_0) about 194,327 IDR/order, minor ordering cost for each product (w_i) about 785/IDR/order, and holding cost for each product (H_i) about 1,517 IDR/month. The initial data from each retailer can be shown at Table 1.

Table 1. Ordering Cost at Retailer

Retailer (R)	**Major Ordering Cost (S_R) (IDR/order)**	**Minor Ordering Cost (S_{Ri}) (IDR/order)**							
		i = 1	2	3	4	5	6	7	8
1	120,349	1,063	1,063	1,063	1,063	1,063	1,063	1,063	1,063
2	122,779	1,474	1,474	1,474	1,474	1,474	1,474	1,474	1,474
3	121,911	1,040	1,040	1,040	1,040	1,040	1,040	1,040	1,040
4	125,466	1,510	1,510	1,510	1,510	1,510	1,510	1,510	1,510
5	122,432	1,040	1,040	1,040	1,040	1,040	1,040	1,040	1,040
6	118,849	998	998	998	998	998	998	998	998
7	122,432	1,040	1,040	1,040	1,040	1,040	1,040	1,040	1,040
8	120,411	1,040	1,040	1,040	1,040	1,040	1,040	1,040	1,040
9	120,609	1,063	1,063	1,063	1,063	1,063	1,063	1,063	1,063
10	120,349	998	998	998	998	998	998	998	998

Table 2. Holding Cost and Demand at Retailer

Retailer (R)	**Holding Cost (h_{Ri}) (IDR/month)**								**Demand (D_{Ri}) (box)**							
	i = 1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8
1	1,522	1,522	513	521	757	871	4,337	696	209	101	5	3	5	3	2	2
2	1,512	1,521	512	521	756	870	4,333	696	464	145	87	64	11	2	1	2
3	1,527	1,535	517	526	764	878	4,375	703	329	225	12	28	7	5	2	7
4	1,515	1,523	513	522	757	871	4,430	697	1,089	236	10	26	5	2	2	2
5	1,555	1,564	527	536	778	895	4,456	715	324	153	41	23	5	3	1	4
6	1,539	1,539	519	527	765	880	4,384	704	186	94	5	2	1	5	2	2
7	1,578	1,587	535	543	789	908	4,521	726	297	155	4	15	4	2	2	2
8	1,671	1,680	566	575	835	961	4,787	769	100	41	2	3	1	3	2	1
9	1,528	1,528	515	523	760	874	4,353	699	188	99	3	8	2	6	2	2
10	1,630	1,630	549	558	811	933	4,645	746	118	64	1	3	1	2	2	2

Currently, distributor and each retailer have its own policy to order product. Distributor has a fix quantity order to manufacturer and every retailer has a fix period order to distributor. The minimum inventory total cost with innovative heuristic method is reached by 147 iteration process and can be shown at Table 3. Based on calculation process with current method which no integration among them and innovative heuristic method with integration, the comparison inventory total cost can be shown at Table 4 and the ordering interval and ordering quantity at distributor and each retailer can be shown at Table 5.

Table 3. Iteration Process with Innovative Heuristic

No	**Total Cost (IDR/month)**	**Qri<1,4**	**No**	**Total Cost (IDR/month)**	**Qri<1,4**	**No**	**Total Cost (IDR/month)**	**Qri<1,4**	**No**	**Total Cost (IDR/month)**	**Qri<1,4**	**No**	**Total Cost (IDR/month)**	**Qri<1,4**
1	10.553.397	No	31	10.475.963	No	61	10.441.605	No	91	10.426.058	No	121	10.420.124	No
2	10.553.124	No	32	10.475.117	No	62	10.440.904	No	92	10.425.801	No	122	10.420.019	No
3	10.546.888	No	33	10.473.963	No	63	10.440.568	No	93	10.425.634	No	123	10.419.826	No
4	10.540.669	No	34	10.472.737	No	64	10.440.206	No	94	10.425.006	No	124	10.419.756	No
5	10.534.568	No	35	10.471.515	No	65	10.439.882	No	95	10.424.781	No	125	10.419.874	No
6	10.531.792	No	36	10.470.297	No	66	10.439.539	No	96	10.424.546	No	126	10.419.829	No
7	10.525.765	No	37	10.467.919	No	67	10.439.212	No	97	10.423.983	No	127	10.419.547	No
8	10.523.736	No	38	10.466.779	No	68	10.438.446	No	98	10.423.751	No	128	10.419.745	No
9	10.520.989	No	39	10.464.955	No	69	10.436.803	No	99	10.423.523	No	129	10.419.953	No
10	10.518.980	No	40	10.464.400	No	70	10.435.966	No	100	10.423.084	No	130	10.419.823	No
11	10.516.260	No	41	10.463.241	No	71	10.435.743	No	101	10.422.874	No	131	10.419.714	No
12	10.514.961	No	42	10.462.132	No	72	10.434.957	No	102	10.422.531	No	132	10.419.661	No
13	10.509.133	No	43	10.461.315	No	73	10.434.506	No	103	10.422.404	No	133	10.419.606	No
14	10.507.813	No	44	10.460.239	No	74	10.434.176	No	104	10.422.307	No	134	10.419.557	No
15	10.505.180	No	45	10.458.029	No	75	10.433.409	No	105	10.422.118	No	135	10.419.510	No
16	10.503.918	No	46	10.457.493	No	76	10.432.067	No	106	10.422.006	No	136	10.419.424	No
17	10.502.609	No	47	10.456.705	No	77	10.431.472	No	107	10.421.828	No	137	10.419.285	No
18	10.501.354	No	48	10.454.546	No	78	10.431.186	No	108	10.421.613	No	138	10.419.249	No
19	10.500.378	No	49	10.452.412	No	79	10.430.498	No	109	10.421.511	No	139	10.419.225	No
20	10.498.559	No	50	10.452.040	No	80	10.430.206	No	110	10.421.304	No	140	10.419.183	No
21	10.493.008	No	51	10.450.993	No	81	10.429.567	No	111	10.421.168	No	141	10.419.163	No
22	10.490.480	No	52	10.449.955	No	82	10.429.147	No	112	10.421.068	No	142	10.419.118	No
23	10.489.266	No	53	10.449.112	No	83	10.428.944	No	113	10.420.974	No	143	10.419.054	No
24	10.488.007	No	54	10.447.492	No	84	10.428.640	No	114	10.420.829	No	144	10.419.015	No
25	10.486.111	No	55	10.447.147	No	85	10.428.250	No	115	10.420.559	No	145	10.419.022	No
26	10.485.153	No	56	10.446.153	No	86	10.427.700	No	116	10.420.572	No	146	10.419.033	No
27	10.483.392	No	57	10.445.201	No	87	10.427.116	No	117	10.420.589	No	**147**	**10.419.006**	**Yes**
28	10.480.906	No	58	10.444.238	No	88	10.426.977	No	118	10.420.512	No	148	10.419.064	Yes
29	10.478.457	No	59	10.443.278	No	89	10.426.829	No	119	10.420.404	No	149	10.419.055	Yes
30	10.477.209	No	60	10.441.960	No	90	10.426.316	No	120	10.420.343	No	150	10.419.041	Yes

Table 4. Comparison of Inventory Total Cost

Position	Current Method (IDR/month)	Innovative Heuristic Method (IDR/month)
Distributor	5,502,198	4,375,562
Retailer 1	576,961	447,938
Retailer 2	665,275	555,047
Retailer 3	1,097,611	805,079
Retailer 4	1,735,456	1,240,577
Retailer 5	621,876	508,229
Retailer 6	563,561	434,555
Retailer 7	1,092,285	790,237
Retailer 8	546,537	404,338
Retailer 9	574,088	443,409
Retailer 10	552,378	413,675
Total	13,528,226	10,419,006

Table 5. Comparison of Ordering Interval and Ordering Quantity

Position	Current Method		Innovative Heuristic Method	
	Ordering Interval (month)	Ordering Quantity (box)	Ordering Interval (month)	Ordering Quantity (box)
Distributor	-	6,150	1.401	7,121
Retailer 1	0.250	83	0.350	116
Retailer 2	0.250	194	0.350	272
Retailer 3	0.125	77	0.175	108
Retailer 4	0.083	115	0.117	161
Retailer 5	0.250	139	0.350	195
Retailer 6	0.250	75	0.350	105
Retailer 7	0.125	61	0.175	85
Retailer 8	0.250	39	0.350	54
Retailer 9	0.250	78	0.350	109
Retailer 10	0.250	49	0.350	68

4. CONCLUSION

Based on calculation process, result and discussion, innovative heuristic method has a minimum inventory total cost compared with current method. Currently, distributor and each retailer have its own order policy and give an impact that inventory total cost is expensive. This innovative heuristic method has optimal ordering interval and integration between distributor and retailers.

This method also gives saving about 3,109,220 IDR/month or 23%/month. Integration and minimum inventory total cost will increase competitiveness among retailers.

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