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Optimization of Raw Material Inventory Control Using *Linear Programming* Method at CV Sidomulyo in Palu City

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ABSTRACT

This study aims to optimize raw material inventory control and reduce cost waste at CV Sidomulyo using the linear programming method assisted by POM-QM for Windows software. The data used consists of primary data in the form of inventory quantities and raw material prices and secondary data from company documents. The linear programming method was chosen because it is able to provide an optimal solution in allocating limited resources by considering various existing constraints, making it suitable for inventory efficiency problems. The results of the analysis show that the optimal annual procurement quantities are 150 liters of paint, 20 kg of nails, 24 pcs of glue, and 2,480 sheets of wood or 24.80 m³. The application of this method resulted in cost savings of Rp68,814,500 compared to the previous cost. Theoretically, this research strengthens the application of efficiency and optimization concepts in operations management through a quantitative approach, and proves that linear programming can be used as a strategic tool in inventory decision making. The limitation of this study lies in the scope of data that only covers one production period and has not considered price fluctuations or seasonal demand. The findings are expected to be the basis for further research and practical reference in more efficient inventory management.

Keywords: Optimization, Inventory, Linear Programming, Raw Materials.

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INTRODUCTION

In the era of globalization, the development of the business world is very rapid along with the times and technology (Indah & Sari, 2019) . So that the development of retail and industrial businesses is currently showing very rapid progress(Daswati *et al*., 2021) . Based on data from the Ministry of Industry (2023), the Indonesian furniture industry contributes more than IDR 19 trillion to the national GDP with a growth rate of around 6% per year. As a result, the trade sector is the second largest contributor after the industrial sector in terms of employment in Indonesia Rombe(& Hadi, 2022) . In the face of increasingly intense business competition, accurate business planning becomes very important(Suparman *et al*., 2023) . To face the challenges of change, organizations have no other choice but to make adjustments to stay competitive (Adda *et al*., 2019) . This step not only supports companies in optimizing business processes, but also enables rapid response to market changes(Syamsuddin *et al*., 2023) . So that strategy is seen as a practice in the process that supports the achievement of certain advantages and benefits(Pasaribu *et al*., 2021) . In the Central Sulawesi region, especially Palu City, the furniture sector is growing rapidly along with the increasing need for household and office furniture, but most of the business actors are still small-scale and face obstacles in operational management, including raw material inventory control. Therefore, an effective inventory control system is an important element in maintaining operational stability and company profitability (Putra & Rofita, 2020).

CV Sidomulyo is one of the furniture businesses in Palu City that produces various types of furniture such as tables, chairs, cabinets, and beds. Fluctuating product demand and limited storage capacity cause an imbalance in raw material inventory. This condition leads to wasteful costs when stocks are excessive, as well as the risk of production delays when stocks are low. Most of the previous research in this field only uses the Economic Order Quantity (EOQ) method or a descriptive approach to determine the optimal order quantity (Putra & Rofita, 2020; Sahabuddin et al., 2024), while the application of mathematical optimization models such as linear programming in the local furniture industry is still rare.

This research offers novelty by applying the linear programming method assisted by POM-QM for Windows software to determine the most efficient combination of raw material purchases based on actual constraints at CV Sidomulyo. This approach allows multi-variable optimization and produces mathematical solutions that are more precise than the conventional EOQ method. Thus, this research not only makes a practical contribution in improving cost efficiency in the local furniture industry, but also enriches the theoretical literature on the application of quantitative optimization models in inventory control at the scale of small and medium enterprises.

Inventory control is one of the main aspects of operations management that aims to maintain a balance between raw material availability and cost efficiency. Efficiency is a concept in management that is used to assess managerial performance (Arham et al., 2020). Efficiency is the ability to carry out a task or job in the right way, without wasting excessive time, energy, or costs. Efficiency can also be interpreted as a comparison between the resources used (input) and the results obtained (output) or between the costs incurred and the benefits generated (Iqbal et al., 2020).

Various methods have been used to determine the optimal order quantity, including the *Economic Order Quantity* (EOQ) and *Linear Programming* (LP) methods. The EOQ method is used to determine the number of orders that minimize total inventory costs assuming demand is constant and does not consider resource constraints (Putra & Rofita, 2020; Sahabuddin et al., 2024). The advantages of EOQ are its ease of application and simple calculation, but this method has the disadvantage of not being able to handle complex situations involving many decision variables, such as variations in raw material prices, storage capacity, or different ordering times (Kurniawan & Widyaningrum, 2023). In contrast, Linear Programming is a mathematical optimization approach that is able to find the best solution from various alternative decisions by considering a number of constraints (Azhari & Adriantantri, 2020). In the context of inventory control, LP allows companies to determine the combination of raw material purchases that results in minimum costs without violating production, time, and storage capacity constraints. Thus, LP is more flexible and realistic in describing the actual conditions of the dynamic manufacturing industry.
Previous research shows that the application of linear programming can provide more optimal results than EOQ in situations with many types of raw materials and demand fluctuations (Mujiono & Sujianto, 2020; Santoso & Sukmono, 2023). Therefore, the use of the LP method in this study is considered more suitable for overcoming inventory control problems at CV Sidomulyo, which has various types of raw materials with different usage and cost characteristics.

The purpose of this study is to optimize raw material inventory control at CV Sidomulyo in order to obtain the most efficient order quantity and inventory costs through the application of the linear programming method.

METHODS

This research was conducted at CV Sidomulyo which is located on Jalan Dupa Indah, Layana Indah Village, Mantikulore District, Palu City, Central Sulawesi. This research uses quantitative descriptive methods with primary data and secondary data. Primary data collected is the amount of raw material inventory, the price of raw materials and the amount of demand. Secondary data obtained from literature and data that support this research. With the population being all raw material inventory management activities at CV Sidomulyo. The research sample includes the main raw material inventory data (paint, nails, glue, and wood) taken from the company's inventory records during the January-December 2023 period. The data collection techniques were carried out through documentation of reports on the purchase and use of raw materials, as well as the results of direct interviews with one business owner and two warehouse staff involved in the procurement and storage process of raw materials. Data analysis in this study uses linear programming simplex method with the help of POM-QM for windows software application.

The Linear Programming (LP) method was chosen because it is more suitable for overcoming inventory problems at CV Sidomulyo involving several types of raw materials with various constraints, such as storage capacity, order time, and cost limitations. Unlike the Economic Order Quantity (EOQ) method which is only effective for one type of raw material assuming ideal conditions, Linear Programming is able to optimize several variables simultaneously to obtain the most efficient combination of raw material procurement and minimum total cost. In addition, the use of POM-QM for Windows software helps the calculation process to be more accurate and faster, so that the results obtained better describe the real conditions of the company.

Linear programming is a mathematical technique used to solve problems, such as raw material inventory management, in order to find the optimal solution or calculate the best value under certain conditions (Bhattarai, 2018) . *Linear* programming is an optimization method that aims to maximize or minimize and find the optimal value of a *linear* objective function with respect to certain constraints Azhari(& Adriantantri, 2020) . The general form that presents the *linear programming* problem is as follows:
Maximize or minimize:

$$Z = C_1X_1 + C_2X_2 + C_3X_3 + C_4X_4 + \cdots C_nX_n$$

Constraints

$$a_{11}X_1 + a_{12}X_2 + a_{13}X_3 \ldots + a_{1j}X_j \leq b_1$$
$$a_{21}X_1 + a_{22}X_2 + a_{23}X_3 \ldots + a_{2j}X_j \leq b_2$$

Description:
Z : Objective function for which the optimal number is sought
C_j: Objective function coefficient
X_j: Decision component
a_{1j}: Constraint function coefficient
b_1: Right segment number
Safety Stock is additional inventory prepared in anticipation of changes in sales levels, production delays, or shipping delays (Devi Nurfatimah et al., 2024) .

$$SS = SD \times Z$$

Description:
SS: Safety stock
SD: Standard deviation of demand during ordering time

Z: Total deviation factor of confidence in service

Reorder Point is the point at which the company must reorder inventory to ensure the availability of materials on time. This point is determined based on the existence of *lead time* and *safety stock* so that there is no shortage of inventory(Bahar & Maulana, 2023) .

$$ROP = SS + A \times L$$

Description:
ROP: *Reorder point*
SS: *Safety stock*
A: Average daily demand
L: *Lead time*

RESULTS AND DISCUSSION

The problem faced by CV Sidomulyo in optimizing raw material inventory can be solved with a linear program. To meet inventory needs, the company has purchased raw materials such as paint, nails, glue and wood from several suppliers who have supported the supply of raw materials so far. The following is the company's inventory quantity data:

Table 1. Raw Material Inventory Quantity Data

CV Sidomulyo	Paint	Nails	Glue	Wood
	Unit			
Month	Liter	Kilogram	Pcs	Sheet
January	3	25	4	100
February	5	20	3	100
March	3	25	3	50
April	3	15	2	50
May	7	20	4	100
June	7	25	4	200
July	5	15	2	50
August	5	25	3	150
September	3	10	2	100
October	7	20	4	100
November	3	15	2	100
December	5	25	3	50
NUMBER	56	240	36	1.150
Average	5	20	3	95

Source: CV Sidomulyo, data processed 2024

Table 1 shows the stock of raw material inventory in 2023 in the raw materials of paint by 56 liters, nails by 240 kg, glue by 36 pcs, and wood by 1,150 sheets or 11.5 cubic. Purchases and use of raw materials tend to fluctuate and increase in certain months due to unstable demand. The price of raw materials used refers to the market price of the supplier in 2023. The following is data on the price of raw materials in the company in units:

Table 2. Raw Material Price Data

No	Type of Raw Material	Unit Price
1	Paint	85,000/liter
2	Nails	20,000/kg
3	Glue	22.000/pcs
4	Wood	1,400,000/cubic

Source: CV Sidomulyo, data 2024

Table 2 shows the raw material unit price of each material with paint at Rp. 85,000 per liter, nails at Rp. 20,000 per kg, glue at Rp. 22,000 per pcs, and wood at Rp. 1,400,000 per cubic.

The company produces 10 different products, namely guest chairs, school chairs, café chairs, 2-door cabinets, 3-door cabinets, 2-drawer nightstands, 3-drawer nightstands, TV buvets, beds and osing tables.

Table 3. Product Demand Data and Raw Material Usage

Product Name	Month	Quantity	Raw Material			
			Paint (Liters)	Nails (Kg)	Glue (Pcs)	Wood (Sheet)
Guest Chair	January	4	2	2	1	16
	February	4	2	2	1	16
	March	3	1,5	1,5	0,75	12
	April	6	3	3	1,5	24
	May	8	4	4	2	32
	June	4	2	2	1	16
	July	5	2,5	2,5	1.25	20
	August	3	1,5	1,5	0,75	12
	September	4	2	2	1	16
	October	6	3	3	1,5	24
	November	4	2	2	1	16
	December	8	4	4	2	32
NUMBER		59	29,5	29,5	14,75	236
School Chairs	January	42	21	21	3,5	84
	February	42	21	21	3,5	84
	March	26	13	13	2,5	52
	April	12	6	6	1	24
	May	12	6	6	1	24
	June	32	16	16	3	64
	July	42	21	21	3,5	84
	August	12	6	6	1	24
	September	12	6	6	1	24
	October	30	15	15	2	60
	November	24	12	12	2,5	48
	December	24	12	12	2,5	48
NUMBER		310	155	155	27	620
Cafe Seats	January	4	2	2	2	4
	February	4	2	2	2	4
	March	2	1	1	1	2
	April	6	3	3	3	6
	May	6	3	3	3	6
	June	2	1	1	1	2
	July	4	2	2	2	4
	August	4	2	2	2	4
	September	6	3	3	3	6
	October	6	3	3	3	6
	November	8	4	4	4	8
	December	6	3	3	3	6
NUMBER		58	29	29	29	58
2-Door Cupboard	January	3	3	1,5	1,5	63
	February	3	3	1,5	1,5	63
	March	2	2	1	1	42

	April	4	4	2	2	84
	May	6	6	3	3	126
	June	6	6	3	3	126
	July	5	5	2,5	2,5	105
	August	4	4	2	2	84
	September	4	4	2	2	84
	October	2	2	1	1	42
	November	3	3	1,5	1,5	63
	December	3	3	1,5	1,5	63
NUMBER		45	45	22,5	22,5	945
3-Door Cupboard	January	2	3	1	1	64
	February	2	3	1	1	64
	March	4	6	2	2	128
	April	6	9	3	3	192
	May	4	6	2	2	128
	June	4	6	2	2	128
	July	2	3	1	1	64
	August	3	4,5	1,5	1,5	96
	September	2	3	1	1	64
	October	8	12	4	4	256
	November	4	6	2	2	128
	December	2	3	1	1	64
NUMBER		43	64,5	21,5	21,5	1.376
Nakas 2 Drawers	January	8	4	4	4	24
	February	8	4	4	4	24
	March	6	3	3	3	18
	April	10	5	5	5	30
	May	2	1	1	1	6
	June	2	1	1	1	6
	July	4	2	2	2	12
	August	6	3	3	3	18
	September	5	2,5	2,5	2,5	15
	October	4	2	2	2	12
	November	3	1,5	1,5	1,5	9
	December	2	1	1	1	6
AMOUNT		60	30	30	30	180
Nakas 3 Drawers	January	3	1,5	1,5	1,5	12
	February	3	1,5	1,5	1,5	12
	March	2	1	1	1	8
	April	6	3	3	3	24
	May	6	3	3	3	24
	June	8	4	4	4	32
	July	5	2,5	2,5	2,5	20
	August	5	2,5	2,5	2,5	20
	September	2	1	1	1	8
	October	2	1	1	1	8
	November	4	2	2	2	16
	December	5	2,5	2,5	2,5	20
NUMBER		51	25,5	25,5	25,5	204
Buvet TV	January	2	1	0,5	1	12
	February	2	1	0,5	1	12
	March	4	2	1	2	24
	April	4	2	1	2	24

	May	3	1,5	0,75	1,5	18
	June	5	2,5	1,25	2,5	30
	July	4	2	1	2	24
	August	4	2	1	2	24
	September	6	3	1,5	3	36
	October	2	1	0,5	1	12
	November	2	1	0,5	1	12
	December	3	1,5	0,75	1,5	18
NUMBER		41	19,5	10,25	19,5	246
Beds	January	2	2	0,5	1	22
	February	4	4	1	2	44
	March	6	6	1,5	3	66
	April	6	6	1,5	3	66
	May	8	8	2	4	88
	June	8	8	2	4	88
	July	4	4	1	2	44
	August	4	4	1	2	44
	September	5	5	1,25	2,5	55
	October	5	5	1,25	2,5	55
	November	2	2	0,5	1	22
	December	4	4	1	2	44
NUMBER		58	58	14,5	29	638
Osing table	January	4	2	2	2	8
	February	4	2	2	2	8
	March	2	1	1	1	4
	April	2	1	1	1	4
	May	5	2,5	2,5	2,5	10
	June	3	1,5	1,5	1,5	6
	July	4	2	2	2	8
	August	2	1	1	1	4
	September	2	1	1	1	4
	October	6	3	3	3	12
	November	4	2	2	2	8
	December	4	2	2	2	8
NUMBER		42	21	21	21	84
TOTAL		**767**	**477**	**358,75**	**239,75**	**4.587**

Source: CV Sidomulyo data 2023

Table 3 shows that the demand for each product and the use of raw materials for 1 year is very large with 477 liters of paint, 358.75 kg of nails, 239.75 pcs of glue, and 4,587 sheets or 45.87 cubic wood. This will affect the costs incurred by the company.

Table 4. Raw Material Price Data

Type of Material	Raw Material Inventory	Unit Price	Total
Paint	477	85,000/liter	Rp 40,545,000
Nails	358,75	20.00/kg	Rp 7,175,000
Glue	239,75	22.000/pcs	Rp 5,274,500
Wood	4.587	1,400,000/cubic	Rp 64,218,000

Table 4 shows the raw material costs incurred by the company for 1 year with paint prices of 40,545,000, nails of 7,175,000, glue of 5,274,500 and wood of 64,218,000 with a total of 117,212,500.

The initial step in this analysis is to calculate optimization using the simplex method in *linear programming*, and re-plan the procurement of inventory stock based on data on raw material requirements from the previous period, namely 2023. Furthermore, the raw material ordering period will be determined based on the results of the simplex method calculation in *linear programming*.

Calculation Using *Linear Programming*

The objective function is a description of the goal in a linear programming problem that focuses on optimizing resources to achieve maximum efficiency. The objective Z value is obtained by minimizing the high stock of raw material inventory held by the company. Some of the constraints that must be considered include storage capacity, order time, and raw material prices. The following are data related to raw material storage obtained:

1. Determination of decision variables aims to determine the volume of raw materials that will be used to meet production demand for one year. These decision variables can be assumed as follows:
   X_1= Price of paint raw materials.
   X_2= Price of raw materials for nails.
   X_3= Price of glue.
   X_4= Price of wood raw materials.
   So the objective function can be formulated as follows:
   $Z_{Min} = 85x_1 + 20x_2 + 22x_3 + 1400x_4.$
2. Constraint function

Table 5. Constraint Function

Constraint	Cat (X_1)	Nails (X_2)	Glue (X_3)	Wood ( )X_4	Available Stock
Time/Hour	3	3	3	48	72
Raw Material Quantity	56	240	36	1.150	1.500

Source: CV Sidomulyo data 2023

Table 5 above relates to the constraint function in the optimization of raw material inventory stocks. Based on time constraints on the delivery of raw material orders on paint 3 hours, nails 3 hours, glue 3 hours, wood 48 hours out of 72 hours. With the quantity of raw materials in paint 56 liters, nails 240 kg, glue 36 pcs, wood 1,150 sheets or 11.5 cubic and available 1,500. The next constraint function data will be formulated in *linear programming* calculations to obtain the optimum value of raw material inventory stock.

Optimization of Raw Material Inventory

Optimization of raw material inventory is carried out to avoid excess or shortage of stock through the application of *linear programming, reorder point*, and *safety stock* methods.

1. The objective function is converted into an implicit function:
   $Z_{Min} = 85x_1 + 20x_2 + 22x_3 + 1400x_4.$
2. The constraint function is changed by giving a slack variable, to:
   a) $3x_1 + 3x_2 + 3x_3 + 48x_4 \geq 72$
      $3x_1 + 3x_2 + 3x_3 + 48x_4 + S_1 = 72$
   b) $56x_1 + 240x_2 + 36x_3 + 1150x_4 \geq 1500$
      changed to $56x_1 + 240x_2 + 36x_3 + 1150x_4 + S_2 = 1500$

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Finding the Optimum Solution of *Linear* Program Using *POM-QM Software*

To find the optimum solution of the problem above, we will use the *POM-QM software* program.

	X1	X2	X3	X4		RHS	Equation form
Minimize	85	20	22	1400			Min 85X1 + 20X2 + 22X...
Constraint 1	3	3	3	48	>=	72	3X1 + 3X2 + 3X3 + 48...
Constraint 2	56	240	36	1150	>=	1500	56X1 + 240X2 + 36X3 ...

Figure 1. Data input table

Source: POM-QM Software, 2025

Figure 1 is raw material data from paint, nails, glue, wood for 1 year, as well as *leat time* data from the purchase of each raw material and the unit price of raw materials.

Iteration Display Table

Iteration 6										
0	surplus 2	184,0	0	204,0	2.690,0	80,0	-80,0	-1	1	4.260,0
20	X2	1,0	1	1,0	16,0	0,3333	-0,3333	0	0	24,0
	zj	150	20	24	2480	-7	7	0	0	480
	cj-zj	-65,0	0	-2,0	-1.080,0	6,6667	-6,6667	0	0	

Source: POM-QM Software, 2025

Figure 2 is the result of the iteration calculation of raw materials carried out until the sixth trial with the objective function lineZ_j of each raw material of paint, nails, glue and wood no longer has a negative value, so the solution obtained is optimal. Then the optimum amount of raw materials that must be provided is 150 liters of paint, 20 kg of nails, 24 pcs of glue, and 2,480 pieces of wood or 24.80 cubic.

Table 6. POM-QM Calculation Results

Material Type	Raw Material Inventory	Unit Price	Total
Paint	150	85,000/liter	Rp 12,750,000
Nails	20	20,000/kg	Rp 400,000
Glue	24	22.000/pcs	Rp 528,000
Wood	2.480	1,400,000/cubic	Rp 34,720,000

Based on the results of the linear programming calculation in Table 6 with the help of POM-QM software, the optimum total cost was obtained at IDR 48,398,000, which means there was a savings of around 58% compared to the actual cost of the previous year. These results support the theory of resource efficiency (Arham et al., 2020) which states that optimizing the allocation of raw materials can reduce operational costs without disrupting the production process. This finding is also consistent with Santoso & Sukmono (2023) and Kurniawan & Widyaningrum (2023) research, which shows that the LP method is superior to EOQ in the context of multi-material inventory control. The greatest savings occur in wood materials because they have the highest cost portion in total inventory, indicating that focusing control on high-cost components has the most significant impact on overall efficiency. Thus, the results of this study not only strengthen the concept of optimization in operations management theory, but also provide practical implications for CV Sidomulyo in the preparation of future raw material purchasing and storage policies.

Table 7. *Safety Stock* Calculation Results

Raw Materials	*Safety Stock*
Paint	3
Nail	17
Glue	2
Wood	56

Table 7 shows the results of the *safety stock* calculation to anticipate excess and shortages in the raw materials of 3 liters of paint, 17 kg of nails, 2 pcs of glue, and 56 sheets of wood.

Determination of Reorder Procurement
Reorder point is a reorder point in the management of raw material inventory which is determined based on calculations using a *linear* program with the help of *POM-QM software*. It aims to ensure smooth production activities without obstacles. This process requires data that includes the amount of material requirements, waiting time, and safety reserve data.

Table 8. *Reorder Point* Calculation Results

Raw Materials	*Reorder Point*
Paint	63
Nails	257
Glue	38
Wood	1196

In table 8, the results of the *reorder point* calculation show data that describes the minimum amount of raw material inventory that requires reordering so that production can run smoothly, namely 63 liters of paint, 257 kg of nails, 38 pcs of glue and 1196 sheets or 11.96 cubic wood.

The results of the above research can provide a concrete picture for CV Sidomulyo management in managing raw material inventory more efficiently. The application of the Linear Programming method allows companies to determine the optimal amount of raw material orders based on capacity constraints, waiting time, and purchase costs. With the results of this optimization, the company can reduce storage costs and avoid excess stock without disrupting smooth production. In addition, the results of this study can be used as a reference in the preparation of annual procurement policies, budget planning, and strategies for purchasing raw materials from suppliers, thereby supporting the sustainability of operations and financial efficiency of the company.

Theoretically, this study strengthens the concept of efficiency and resource optimization in the theory of operations management and inventory control. The results obtained support the findings of Santoso & Sukmono (2023) and Kurniawan & Widyaningrum (2023) that the Linear Programming method is able to produce optimal solutions in a multi-raw material inventory system with various constraints. This research also expands the application of mathematical models in the context of the small-medium scale furniture industry, which was previously more often applied to large manufacturing industries. Thus, this research contributes to the development of empirical literature on the use of linear programming as a quantitative analysis tool in inventory management.

The results also confirm the principles of the Economic Order Quantity (EOQ) model, namely that there is an order quantity that minimizes the total inventory cost, but with a wider scope because LP can handle more than one type of raw material and various resource constraints. In addition, the optimization results are close to the Just-in-Time (JIT) concept because they produce a minimum amount of inventory that is still able to meet production demand in a timely manner. Thus, the application of Linear Programming at CV Sidomulyo not only provides cost efficiency, but also reflects the application of modern inventory control theory that emphasizes efficiency, timeliness, and balance of operational costs.

CONCLUSION

This study aims to optimize raw material inventory control at CV Sidomulyo so that the production process runs efficiently and costs can be reduced to a minimum. Based on the results of the analysis with the Linear Programming method using POM-QM for Windows software, an optimum solution is obtained which shows that the allocation of raw materials can be arranged more efficiently than the conventional system applied previously. Theoretically, the results of this study strengthen the concept of *trade-off* between storage costs and out-of-stock costs and expand the application of *Economic Order Quantity (EOQ)* theory through a multi-material optimization model. Practically, the findings provide guidance for CV Sidomulyo management in planning raw material requirements efficiently, avoiding excess stock, and supporting smooth production. For future research, it is recommended that the model be developed by considering seasonal demand fluctuations, changes in raw material prices, and the application of a combination of other methods such as Just-in-Time or simulation-based optimization to obtain more comprehensive results.

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