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PRODUCTION OPTIMIZATION THROUGH THE MATERIAL REQUIREMENT PLANNING (MRP) METHOD IN THE NIAS TOFU PRODUCT BUSINESS IN ONOMAMOLO VILLAGE I LOT

Solfin Desmeni Mendrofa[1], Serniati Zebua[2], Martha Surya Dinata Mendrofa[3], Jeliswan Berkat Iman Jaya Gea[4]
[1,2,3,4]Universitas Nias, Indonesia
E-mail: solfinmdf@gmail.com[1], sernizebua97@gmail.com[2], martha.mendrofa@gmail.com[3], jeliswan89@gmail.com[4]

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Abstract

The main objective of this study is to compare and analyze the effectiveness of the MRP (Material Requirement Planning) method in optimizing raw material inventory management in the Nias Tofu business. This study uses a mixed method. Primary data in this study were obtained directly from the Nias Tofu business through observations and interviews, while secondary data were obtained from the company in the form of production data from the Nias Tofu Product business in 2024. Data analysis was conducted using descriptive analysis techniques and the steps taken in the method analysis.MRP. According to the analysis results, the 2024 soybean raw material purchasing and demand data using the conventional method showed a shortage of raw materials of 14,200 kg with an order frequency of 14 times. Inventory management experienced inefficiencies, namely storage costs of IDR 1,600,000 and ordering costs of IDR 400,000, and raw material shortages still occurred, while the application of the MRP method resulted in order planning with an order frequency of 6 times, a fixed order quantity of 16,784 kg, and a much lower total inventory cost of IDR 335,160. The implementation of the MRP method has proven successful in eliminating raw material shortages and reducing operational costs so that the production process runs more smoothly and efficiently. This study proves that the application of MRP is effective in managing raw materials and optimizing production in the Nias Tofu business, making a significant contribution to smooth production and inventory cost efficiency.

Keywords: *Keywords: Material Requirement Planning, Production Optimization*

INTRODUCTION

The manufacturing industry plays a crucial role in economic growth, particularly in creating added value through the production process that transforms raw materials into finished products, and also contributes to increased employment. One subsector with significant potential within the manufacturing industry is tofu production, with national economic growth expected to reach 5.03% according to Gross Domestic Product (GDP) data in 2024. This demonstrates that the development of tofu manufacturing businesses not only has the potential to increase business owners' incomes but also contributes to local and national economic growth.

According to Soeltanong and Sasongko (Nuraeni & Santoso, 2024), within a company, the production function plays a vital role in transforming raw materials (inputs) into final products (outputs) that meet quality standards. This process can be viewed as a series of steps focused on creating added value at each stage. Production requires a variety of processes, including raw materials, labor, machinery, production planning, production scheduling, and so on.

One of the factors contributing to smooth production is good management. Good management plays a crucial role in ensuring effective operation and optimal profit. One way to achieve optimal profit is to implement a management policy that takes into account optimal inventory management. Proper inventory management can lead to cost efficiency. Inventory control is a managerial function that significantly impacts a company's physical inventory, as significant investments in the company impact its physical inventory (Sari, 2022).

Based on direct observations by researchers, the Nias tofu business remains dependent on soybean raw material supplies from outside the region, particularly from Medan, the city where soybean raw material is distributed. Orders for raw materials take approximately one week to arrive on Nias Island, making it challenging for the Nias tofu business to determine the order quantity each time they place an order from the raw material distribution center.

The problem of determining the quantity of raw materials ordered indicates a weakness in the planning of raw material ordering requirements in the Nias Tofu business, where a system is not yet in place to accurately and efficiently estimate needs. Conventional inventory management, based solely on habits and estimates, leaves the Nias Tofu business vulnerable to soybean stockouts. This indicates the need for a more systematic, precise, and data-driven inventory management strategy to ensure the Nias Tofu business can maintain production continuity efficiently.

THEORY

Production Optimization

According to Zulkifli (2020), optimization is defined as achieving desired results, thus being effective and efficient. This means that in every process or decision-making process, available resources must be utilized optimally to achieve the best results without waste.YR Akbar & Mar'aini, (2022)states that production is a process, method or technique used to increase the utility value of goods and services by utilizing the production factors owned by the company.

ThenYR Akbar & Mar'aini, (2022)defines production optimization as adding value or utility to goods and services through production factors by maximizing the maximum and minimum limits. Nekky and Titiek(Rahmiyati & Rachmawati, 2024)explains several benefits in implementing production optimization, including:

1. Improve overall efficiency of tools and equipment
2. Minimize delays in the production process
3. Reduce damage in equipment use
4. Creating effective use of equipment
5. Periodically monitor equipment availability and reliability
6. Improve product quality
7. Visualize all forms of performance, identify waste and inefficiencies

8. Reduce unplanned overtime
9. Maximizing energy utilization for cost efficiency

In this context, optimization is not simply about finding feasible solutions, but rather about finding the best solution that meets certain criteria, such as maximizing profits or minimizing costs, while considering various existing constraints. This process involves identifying interrelated decision variables, formulating an objective function, and establishing constraints that must be met. Thus, optimization is an essential tool in designing effective and efficient decision strategies in various fields, including economics, engineering, and management (Rahmadani, 2022).

Material Requirement Planning (MRP)

The Material Requirement Planning (MRP) method assumes a system involving material composition, stock, estimated order volume, and a master production plan to determine raw material requirements (Thamrin & Helma, 2023). The implementation of MRP has been shown to positively correlate with the smooth operation of a company's business. Meanwhile, according to (Ida Ayu Rai Widhiawati, Anak Agung Diah Parami Dewi, 2022), MRP is a system used to determine the amount of raw material required and its availability time in the process of producing a product.

According toGabriel Elisabeth (2023)The MRP processing process can be carried out in stages, including Netting (Calculating Net Requirements), Lotting (Determining Lot Size), and Offsetting (Determining Ordering Time). Lot size is the quantity of raw materials that must be ordered for a period.

According to(Aryansyah, 2018)Companies need to maximize the use of all their resources, including raw materials, to produce products that meet company and consumer expectations, both in terms of quality and quantity. Efficient raw material use significantly impacts a company's financial performance, particularly in terms of achieving profit within a given period.

Tofu Business

According to Hasanah(in Fauziah et al., 2024)Micro, small, and medium enterprises (MSMEs) are productive businesses owned by individuals or business entities that meet certain criteria, such as a relatively small number of employees, business scale, and turnover, and are typically operated with limited capital. According to Rahmawati,(Herdhiansyah et al., 2022)Tofu consumption in Indonesia reaches 18.6 kg per capita per year in urban areas and 13.9 kg per capita per year in rural areas. This figure is more than four times higher than the consumption of chicken and beef, which are sources of animal protein.

According to Ahmad(Widjayanti, 2021)The general stages in the tofu making process include soybean selection, weighing, soaking, washing, grinding, extraction, filtering, boiling, coagulating, whey separation, packaging, pressing, cooking, and packaging.

RESEARCH METHODS

This study uses a sequential model (sequential combination) with a sequential explonatory strategy. In the stages, the researcher will first collect data in the form of raw

material ordering data and production data from the company, then process and analyze it to answer the problem formulation, namely production optimization using the Material Requirement Planning (MRP) method. The researcher will then measure production optimization using Material Requirement Planning (MRP) in streamlining soybean raw material inventory costs through interviews conducted with the company owner and company employees.

To obtain the data needed for this research, the researchers used three methods of data collection: interviews, observation, and documentation. The data analysis techniques employed in this study included descriptive analysis and MRP calculations. This analysis was used to determine the most economical quantity of raw materials to be ordered each time.

RESULTS AND DISCUSSION

Results

Table 1. Raw Material Inventory Data

No	Month	Purchase	Request	Lack
1.	January	6,000 kg	7,000 kg	1,000 kg
2.	February	5,000 kg	6,000 kg	1,000 kg
3.	March	7,000 kg	8,200 kg	1,200 kg
4.	April	5,000 kg	5,500 kg	500 kg
5.	May	8,000 kg	9,000 kg	1,000 kg
6.	June	6,000 kg	7,000 kg	1,000 kg
7.	July	7,000 kg	8,500 kg	1,500 kg
8.	August	7,000 kg	8,000 kg	1,000 kg
9.	September	8,500 kg	10,000 kg	1,500 kg
10.	October	6,500 kg	7,500 kg	1,000 kg
11.	November	9,000 kg	10,500 kg	1,500 kg
12.	December	7,000 kg	9,000 kg	2,000 kg
Total		82,000 kg	96,200 kg	14,200 kg

Source: Nias Tofu Business, 2025

Based on the data in the table above, it can be seen that the total shortage of soybean raw materials in 2024 is 14,200 kg, this number is obtained from the amount of raw material purchases minus the amount of raw material demand.

In managing raw materials, the business owner implements a strategy based on estimating weekly production needs, adjusted to market demand. He acknowledged that the system used is still conventional, relying heavily on experience to determine purchase

quantities. "We've been ordering raw materials according to our weekly needs, usually tailored to customer demand. However, we realize that this method isn't entirely effective."

One employee also provided information about raw material management. He said, "Once the soybeans arrive at the location, the employees usually store them in a storage warehouse. During production, they take them according to need, usually at a predetermined dosage. They also ensure the soybeans are not wet or damaged before use, as this can affect the quality of the tofu produced."

After the raw material management based on company policy was determined, the data obtained from the Nias Tofu business was then processed using the Material Requirement Planning (MRP) method. The purpose of this step was to compare raw material management between company policy and the MRP method. In practice, the MRP method is expected to provide strategic solutions in raw material management to increase efficiency and provide more optimal results for the company's profits.

1. *Bill of Materials*(BOM) Nias Tofu Business
   Bill of Material(BOM) is a complete list of all raw materials and components needed to produce tofu in the Nias Tofu business. The Bill of Materials (BOM) is an important document in the production process that details all raw materials, components, and equipment needed to produce a final product. To see the BOM list, see the following table:

Table 2. Bill of Material (BOM) for Nias Tofu Business

No	Name of Raw Material	Unit	The Needs of Each Production	Total Daily Needs
1.	Soya bean	Kg	10	260
2.	Clean water	Liter	60	1,560
3.	Vinegar	Liter	0.5	13
4.	filter cloth	Sheet	2	52
5.	Tofu mold wood	Fruit	2	52
6.	Bucket	Fruit	2	52
7.	Soybean Grinding Machine	Unit	1	1

Source: Author's processed results (2025)

The Bill of Materials (BOM) table above shows a complete list of components and raw materials needed to support the tofu production process at the Nias Tofu business. Therefore, this table plays a crucial role in helping business managers identify detailed daily material requirements and serves as a basis for efficient raw material procurement planning and inventory control.

2. *Master Production Schedule*(MPS) Nias Tofu Business
   Master Production Schedule(MPS) is a master production schedule for the Nias Tofu business which is prepared based on demand in 2024. The Master Production Schedule is the main production plan which outlines the amount of soybean raw material needed for the tofu production process in the 2024 period. Based on field observations,

the Nias Tofu business operates daily and only closes on religious holidays. Therefore, the assumed working days used in calculating the MPS are 28 to 31 days per month. The following table summarizes the monthly MPS for the Nias Tofu business:

Table 3 Master Production Schedule (MPS) of Nias Tofu Business

Month	Production Demand (Kg)	Number of Production Days	Average Daily Requirement (Kg/day)
January	7,000 kg	30 days	233.3 kg
February	6,000 kg	28 days	214.3 kg
March	8,200 kg	30 days	273.3 kg
April	5,500 kg	29 days	189.7 kg
May	9,000 kg	30 days	300.0 kg
June	7,000 kg	30 days	233.3 kg
July	8,500 kg	31 days	274.2 kg
August	8,000 kg	31 days	258.1 kg
September	10,000 kg	30 days	333.3 kg
October	7,500 kg	31 days	241.9 kg
November	10,500 kg	30 days	350.0 kg
December	9,000 kg	31 days	290.3 kg

Source: *Author's processed results (2025)*

Table 3. shows that the monthly soybean requirement varies depending on demand and operational conditions in each period. In developing the master production schedule, the average daily requirement is calculated by dividing the total monthly soybean demand by the number of working days in that month. For example, in January 2024, soybean demand was 7,000 kg and the number of working days was 30, resulting in an average daily requirement of 233.3 kg. Meanwhile, in November, demand reached 10,500 kg with 30 working days, resulting in a daily requirement of 350 kg. The highest daily requirement occurred in November, while the lowest was in April, at 189.7 kg per day.

Overall, the total soybean raw material requirement for 2024 is 96,200 kg. This data forms the basis for Material Requirement Planning (MRP), which will be used to determine gross and net requirements, as well as the optimal quantity of raw materials to order to ensure smooth and efficient production.

3. *Explosion*

*Explosion*Exploitation is a process within the MRP method that aims to break down the raw material requirements of a final product into its basic components. In this case, the final product is tofu, and the primary raw material required is soybeans. The explosion process is carried out based on net requirements and the master production schedule (MPS). To determine when and how much raw material must be available for smooth production, see the following table:

Table 4 Explosion of Raw Material Requirements for Nias Tofu Business

No	Month	Net Tofu Requirement (Kg Soybeans)	Production Day	Daily Soybean Requirement (Kg/Day)	Date Requirement (Beginning of Month)
1	January	7,000	30	233.3	January 1-30
2	February	6,000	28	214.3	February 1-28
3	March	8,200	30	273.3	March 1-30
4	April	5,500	29	189.7	April 1-29
5	May	9,000	30	300.0	May 1-30
6	June	7,000	30	233.3	June 1-30
7	July	8,500	31	274.2	July 1-31
8	August	8,000	31	258.1	August 1-31
9	September	10,000	30	333.3	September 1-30
10	October	7,500	31	241.9	October 1-31
11	November	10,500	30	350.0	November 1-30
12	December	9,000	31	290.3	December 1-31
Total		96,200	-	-	-

Source: *Author's processed results (2025)*

Based on the results of the explosion table above, it is known that the soybean raw material requirement for tofu production at Nias Tofu Business needs to be detailed based on production time so that procurement can be carried out accurately. Through the explosion process, the raw material requirement of 96,200 kg per year is broken down into daily requirements based on the number of working days per month. For example, in January, with a net requirement of 7,000 kg and a working day of 30, the daily soybean requirement is approximately 233.3 kg. This process is carried out for the entire month so that the company can determine when and how much soybeans need to be available in the warehouse to avoid disrupting the production process.

4. *Offsetting* (Determining the Time of Ordering Raw Materials)

*Off setting*is the process of determining the right time to order raw materials, so that they are available before they are needed in the production process. The ordering time is determined by considering the lead time from ordering to receiving the materials. Based on observations and interviews with the owner of a Nias Tofu business, the lead time for soybean raw materials sent from Medan to Nias is approximately 7 days. Raw material requirements will be received at the beginning of each month, so orders must be made 7 days in advance, namely a week before the 1st of each month. The schedule for determining the timing of raw material orders (Offsetting) can be seen in the following table:

Table 5. Offsetting

No	Production Month	Requirement Date	Lead Time (7 Days)	Ideal Ordering Time
1	January	January 1, 2024	7 days	December 25, 2023
2	February	February 1, 2024	7 days	January 25, 2024
3	March	March 1, 2024	7 days	February 23, 2024
4	April	April 1, 2024	7 days	March 25, 2024
5	May	May 1, 2024	7 days	April 24, 2024
6	June	June 1, 2024	7 days	May 25, 2024
7	July	July 1, 2024	7 days	June 24, 2024
8	August	August 1, 2024	7 days	July 25, 2024
9	September	September 1, 2024	7 days	August 25, 2024
10	October	October 1, 2024	7 days	September 24, 2024
11	November	November 1, 2024	7 days	October 25, 2024
12	December	December 1, 2024	7 days	November 24, 2024

Source: Researcher's processed results (2025)

In the offsetting stage, researchers calculate the appropriate time to order raw materials to ensure soybeans are available according to the production schedule. Based on observations, it was discovered that soybean raw materials are shipped from Medan to Nias with a delivery time of approximately 7 days. Therefore, raw material orders must be made at least one week before the actual need date in the following month. For example, for February production needs starting on February 1, orders must be made on January 25. By implementing this offsetting, the Nias Tofu business can avoid delays in raw materials, ensuring a smooth production process.

5. *Lotting*(Optimal Order Size Determination)

Lotting is the process of determining how much raw material to order each time. The goal is to optimize inventory costs by balancing ordering costs with holding costs. The following is a method for determining lotting in the Nias Tofu business.

a. Lot For Lot (LFL) Method

The Lot For Lot (LFL) method is an ordering method that adjusts the quantity of raw material orders to the net requirements in a certain period (Order Quantity = Net Requirements), meaning that raw materials are only ordered when needed and in the amount needed, using monthly demand data for the Nias Tofu business in 2024. The net requirement for soybean raw materials per month using the Lot For Lot (LFL) method can be seen in the following table 4.12:

Table 6. *Lot For Lot*(LFL)

Month	Net Requirement (Kg)	Quantity Ordered (Kg)
January	7,000 kg	7,000 kg
February	6,000 kg	6,000 kg
March	8,200 kg	8,200 kg

April	5,500 kg	5,500 kg
May	9,000 kg	9,000 kg
June	7,000 kg	7,000 kg
July	8,500 kg	8,500 kg
August	8,000 kg	8,000 kg
September	10,000 kg	10,000 kg
October	7,500 kg	7,500 kg
November	10,500 kg	10,500 kg
December	9,000 kg	9,000 kg
Total	96,200 kg	96,200 kg
Average	8,016.66 kg	8,016.66 kg

Source: Author's processed results (2025)

Based on the results in the Lot For Lot (LFL) method table for the Nias Tofu business, it is implemented by ordering soybean raw materials each month according to actual production needs, leaving no inventory for the following month. For example, in January, net demand was 7,000 kg, so the order amount was the same, and the same was true for subsequent months. The ordering frequency is 12 times per year (once a month).

b. *Economic Order Quantity Method* (EOQ)

*Economic Order Quantity*Economic Order Quantity is a method used to determine the optimal order quantity to prevent a company from having excess or insufficient raw materials. Simply put, Economic Order Quantity is a strategy for determining the most economical order quantity. This method is used in raw material inventory management through Material Requirement Planning to determine the optimal order quantity before analyzing the raw material requirements. To determine this economic quantity, it can be calculated using the following formula:$\boldsymbol{EOQ} = \sqrt{\frac{\boldsymbol{2DK}}{\boldsymbol{H}}}$

Information :
D = Demand/average needs
K = Order cost/ order cost per order
H = Holding cost/storage cost per period

$$EOQ = \frac{\sqrt{2} \text{ x } 96.200 \text{ x } 28.571}{19,51}$$

$$EOQ = \sqrt{281.758.382}$$

EOQ = 16,784 kg

Number of ordering frequencies:

$\frac{96.200}{16,784} = 5.78\ 6 \approx$

Based on the EOQ calculation above, it can be seen that the first step is to multiply 2 by the total annual needs and ordering costs, then divided by the storage costs and produce a value of 281,758,382. This value is then rooted to obtain an EOQ result of 16,784 kg, which is the optimal amount of soybean raw material ordered in one order. Next, to determine the frequency of orders in a year, the total annual needs are divided by the EOQ

value to produce a value of 16,784. This means that the Nias Tofu business places orders 6 times a year, with each order amounting to 16,784 kg to achieve inventory cost efficiency.

c. Period Order Quantity (POQ) Method

In the Material Requirement Planning (MRP) method, the Period Order Quantity (POQ) approach is one of the techniques for determining the optimal order size (Lotting) which aims to determine the size of raw material orders by accumulating net requirements for a certain period, then ordering all of these requirements at once at the beginning of the period. To find out the total, it can be calculated using the following formula:

$$POQ = \frac{EOQ}{\text{Kebutuhan Per Bulan}}$$

$$POQ = = 2.1\frac{16,784}{8.016,66} \approx 2$$

Based on the calculation of the EOQ value of the Nias Tofu business, which is 16,784 kg and the average monthly requirement of 8,016.66 kg, the POQ period is obtained for two months. This means that the Nias Tofu business only needs to order raw materials every two months with an amount that covers two months' needs. To find out the amount of raw material orders, see the following table:

Table 7*Period Order Quantity*(POQ)

Booking	Period (Month)	Total Needs	Order Quantity (kg)
1	Jan – Feb	7,000 + 6,000	13,000
2	Mar – Apr	8,200 + 5,500	13,700
3	May – June	9,000 + 7,000	16,000
4	Jul – Aug	8. 500 + 8,000	16,500
5	Sep – Oct	10,000 + 7,500	17,500
6	Nov – Dec	10,500 + 9,000	19,500

Source: *Researcher's processed results (2025)*

The POQ table above can help the Nias Tofu business plan raw material purchases more efficiently. The POQ method used only requires six orders per year (every two months), thus reducing the frequency of orders.

Discussion

The researchers' analysis of production optimization in the Nias Tofu business revealed that traditional raw material management methods left them vulnerable to soybean stockouts. This impacted the company's productivity and necessitated the implementation of a more structured, accurate, and data-driven inventory management strategy to ensure smooth and efficient production.

In accordance with the background in the previous chapter, one appropriate method for managing raw material inventory in the Nias Tofu business is the Material Requirement Planning (MRP) method. This is in line with previous research conducted by(Hermanto et al., 2020), which states that the implementation of the Material Requirement Planning (MRP) method has a positive impact on the company, in addition to reducing inventory costs, it can also ensure the smooth running of the production process so that the production process takes place efficiently.

Based on the analysis of the research results, there are significant differences between the conventional method and the Material Requirement Planning (MRP) method. To see the extent of the differences resulting from the implementation of the MRP method compared to the conventional method or policies currently used by the Nias Tofu business, see the following table:

Comparison Table of Conventional Method and MRP Method

Information	Conventional	MRP method
Total raw material purchases	82,000 kg	96,200 kg
Order frequency	14 times	6 times
Order quantity	Varies	Still 16,784 kg
Total storage costs	Rp. 1,600,000	Rp. 163,734
Total cost of booking	Rp. 200,000	Rp. 171,426
Lack of raw materials	14,200 kg	-
Total inventory cost	Rp. 2,000,000	Rp. 335,160

Source: Author's processed results (2025)

Based on the comparison of the conventional method with the MRP method in the table above, it can be seen that the conventional method currently used by Nias Tofu Business has several weaknesses in raw material management. This method relies on procurement based on short-term needs without systematic planning, resulting in a frequency of orders reaching 14 times a year with varying quantities.

The application of the Material Requirement Planning (MRP) method with the Economic Order Quantity (EOQ) approach provides more efficient results. With an EOQ of 16,784 kg per order, the order frequency can be reduced to only 6 times a year and the total ordering cost is reduced to Rp 171,426. With the application of the MRP method, storage costs have decreased significantly to Rp 163,734, while conventionally the raw material storage cost is Rp 1,600,000.

From the total inventory cost, conventionally the Nias Tofu business spends Rp. 2,000,000, while according to the MRP method the inventory cost required is only Rp. 335,160. This significant difference makes the Nias Tofu business save Rp. 1,664,840 in the goal of raw material inventory cost efficiency. So based on the analysis and results obtained, it can be said that to increase the efficiency of raw material inventory costs, the company will be more profitable if it uses the Material Requirement Planning (MRP) method.

CONCLUSION

Based on a comprehensive analysis of soybean raw material inventory management data at the Nias Tofu business in 2024, inefficiencies were identified in the raw material inventory management system. This condition reflects a suboptimal production process and is a factor hindering the achievement of the company's overall goals. Using the Material Requirement Planning (MRP) approach, this study aims to address issues related to raw material management and optimize production in a more efficient and measurable manner.

1. During 2024, the Nias Tofu business did not use a structured raw material requirements planning system. Raw material orders were placed periodically and based on experience or short-term demand estimates. As a result, the company frequently experienced raw

material shortages when needed and lacked control over the frequency and quantity of orders. This was evident from the purchase data of 82,000 kg, which still resulted in a raw material shortage of 14,200 kg against the production demand of 96,200 kg, as well as high total inventory costs reaching Rp 2,000,000 per year.

2. Production optimization using the MRP method provides more efficient and systematic results in raw material management. By applying the Economic Order Quantity (EOQ) approach, the company can determine the optimal order size of 16,784 kg per order with a frequency of only 6 times a year. This method reduces total inventory costs to Rp 335,160 per year, reduces the frequency of orders from 14 times to 6 times, and avoids excess or shortage of stock. In addition to EOQ, lotting methods such as Lot for Lot (LFL) and Period Order Quantity (POQ) were also analyzed, but EOQ proved to be the most efficient method in terms of costs and operations to be implemented in the Nias Tofu Product Business.

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