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Just In Time (JIT) Based Manufacturing Innovation for Production Cost Efficiency: Empirical Analysis at CV. Natural

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Abstract:
Background, The production process at CV Natural is critical because the sales results of the product are to turn the wheels of the company's economy. The duration of production significantly affects the company because of the targets it must meet. In the production process of wooden carpets and various interior mat products from wood, there is much waste of wood raw materials, while if the wood is stored for too long, damage will occur. So, with this waste, there is a waste of storage costs on wood raw materials.
Aim: This study aims to determine the application and role of Just In Time (JIT) in the efficiency of the company's production costs.
Methods, JIT methods can streamline production costs without having to reduce product quality—determination of the optimal order quantity, applying JIT to the production line with the concept of line balancing.
Results: The company's raw material inventory policy is not optimal and has not shown production cost efficiency compared to using the Economic Order Quantity (EOQ) method or the JIT method.
Conclusions: if using the EOQ method, the company can save 63.89% or Rp. 113,473,933.41 of production costs, and if using the JIT method, the company can save 95.47% or Rp. 112,332,193.00 of the total inventory cost of Rp. 177,655,932.73.
Implication, CV. Natural's JIT implementation has the potential to improve production cost efficiency significantly, provided it is managed with a solid supply chain management strategy and supported by adequate information systems. However, risk mitigation is required through strategic minimum buffers and close supplier relationships.

Keywords: Agile manufacturing, manufacturing company, efficiency, EOQ, JIT.

INTRODUCTION

The current situation and conditions of the global and Indonesian economy are entering an era of uncertainty. The many financial and resource issues related to industrialisation that have emerged have led to a paradigm shift in manufacturing industries, requiring them to produce products sustainably while maintaining global competitiveness (Ali & Wasim, 2022). With the issues outlined, more and more manufacturing companies are now widely recognising their important role and responsibility in undertaking sustainable development, particularly in addressing cost efficiency issues. Many companies are working towards becoming agile manufacturers (Deniša et al., 2023; Banáš & Chovanová, 2023). By focusing on the principle of cost efficiency, companies strive to make their products efficient to minimize waste.

In order to improve production efficiency and reduce costs, the Just In Time (JIT) system can be implemented. Just In Time is a philosophy that encourages organisations to improve their products and production processes by eliminating waste (Urohman et al., 2023). The application of JIT can be done by summarising the system using waste elimination, namely selecting everything that does not affect the value of the product, including eliminating non-value-added activities and adding value-added activities. In an effort to implement the JIT system, a company that produces carpet products and interior mats made from wood, namely CV, can do so. Natural, which is a company engaged in privately owned manufacturing. The production process at CV Natural is fundamental because the sales results of the product are to turn the wheels of the company's economy. The duration of production greatly affects the company because of the targets that the company must meet (Hari & Setiawan, 2020). In the production process, there is a lot of waste of wood raw materials, while if the wood is stored for too long, damage will occur. So, with this waste, there is a waste of storage costs on wood raw materials. In order to increase company profits maximise product quality and minimise shortages (Oktaviani et al., 2022). Business actors should use their potential effectively and efficiently.

The EOQ and JIT methods at CV. Natural have not been applied, so what happens is that expenses are high and ineffective and efficient. To overcome this, the application of JIT is needed. Methods to meet low production costs, be on time in sales, and produce better production quality (Setiawan & Rinamurti, 2020). Based on the above problems, the application of the JIT method can overcome and become a way out of the constraints of CV. Natural.

LITERATURE REVIEW

Inductive Study

Delay is an obstacle that production companies have. This problem attracts several researchers to analyse it and then provide solutions to the problem. The following are some previous studies on delay minimisation in Table 1.

Table 1: Previous Relevant Research

No	Penulis	Judul	Objek	Metode	Tujuan
1.	Purba, V., Lalujan, V., & Phangnesia, C. (2024)	An implementation of internet of things for digitalization of kanban production system	Real-time information transfer in the production process	Integration of Internet of Things (IoT) based information system with JIT and Digital Kamban	The use of a digital Kanban system to facilitate real-time information transfer in the production process, which supports reduced lead times and improved efficiency. This provides a way to respond to market needs faster and more precisely, which is a fundamental principle of JIT strategies in modern practice.
2.	Urohman, T., Suryana, A., & Pandin, M. (2023)	Meta analysis: impact of just in time implementation on cost efficiency and profit	Overall JIT implementation can reduce inventory costs, improve time efficiency, and lower production costs	Reduce inventory costs, improve time efficiency, and lower production costs	Focus on improving the quality and profitability of the company
3.	Oktaviani, S., Listianti, S., & Tripalupi, R. (2022)	Implementation of JIT as a solution to controlling company inventory during the covid-19 pandemic	Application of specialised JIT in inventory control	Inventory control on cost reduction	The focus on inventory control also leads to cost reduction, which makes JIT relevant as a solution to management problems in a dynamic environment.
4.	Purnamasari, M. and Fitriah, E. (2021)	Analysis of the application of JIT in improving production cost efficiency	Optimisation of production process activities	Inventory reduction and resource management	Identified that the implementation of JIT at PT PINDAD can improve production cost efficiency by optimising production activities and reducing unnecessary waste, through in-depth observational data collection and comprehensive qualitative descriptive analysis techniques.
5.	Burda, A. and Maliki, F. (2020).	The role of the just in time method in cost efficiency in the provision of raw materials in pt suzuki indomobil motor division die casting	Reduce variability in the process	JIT is not only limited to inventory reduction, but also includes improvements in the production process	elimination of wastage and achieving proper and timely delivery resulting in overall increased productivity

From previous research, it can be concluded that the JIT method is suitable for identifying waste in a production system. With the identification of waste, a new, leaner production system will be created. With this streamlining, it can reduce costs that arise due to waste (HS et al., 2024). In the research, the JIT method will be used to perform production cost efficiency on carpet products and interior mats from wood. This is a differentiator from previous research. Furthermore, this study will also compare before and after the application of JIT in the production process.

Deductive Study

Inventory is a stock or stash of goods in the company (Mwamba & Yangailo, 2024). Raw materials are goods purchased from suppliers and will be used or processed into finished products that will be produced by the company (Sichoongwe, 2023). Without the inventory of raw materials, the production process in a company will be disrupted. The raw materials in the company are used as materials that will be processed into finished goods through the production process. In the JIT system, it is intended to purchase and store inventory only in the quantity needed. The company's operational activities related to inventory, of course, will find problems with costs related to inventory. Cost is a sacrifice made by the company to obtain goods / services. Ilahy Rosihan et al., (2024) reveal that 'Cost is cash or cash equivalents sacrificed (paid) for goods or services that are expected to provide benefits (income) at this time or in the future for the company'. Inventory costs include: 1) Ordering costs, 2) Purchase costs, 3) Storage costs, and 4) Inventory shortage costs**.**

According to Purnamasari et al., (2021), inventory in JIT is inventory designed to get goods in a timely manner. Just In Time inventory requires eliminating inventory needs because there are no production activities that cause wasteful purchases. The Just In Time system is intended to implement buying inventory only in the quantity needed. The steps for implementing JIT on inventory according to Hustanto, namely: 1) Make a raw material requirement plan, 2) Calculate the cost of purchasing raw materials, 3) Calculate and determine ordering costs, 4) Calculate storage costs consisting of warehouse costs, electricity usage and cleanliness, and 5) Total inventory costs.

Production costs are costs incurred by the company during the manufacturing or management process with the aim of producing products that are ready for market. This production cost calculation will be carried out from the beginning of processing, to finished or semi-finished goods. The types are; raw materials, direct labour, factory overhead costs (indirect materials, indirect labour, other indirect costs). According to Burda & Maliki, (2020), efficiency is a performance measurement that looks in terms of workmanship in accordance with the planned time, it will even be better if savings are made more intensively. Another definition related to production cost efficiency is how resources (inputs) are used optimally in the production process without wasting costs in producing a product (output). Based on the two definitions above, the researcher concludes that production cost efficiency

is the use of resources (inputs) in the production of a product (output) without waste so that savings can be made in terms of costs.

EOQ is one of the oldest and most widely recognised inventory control techniques. This technique is relatively easy to use but is based on several assumptions (Dey, 2024): a) demand is known, fixed, and independent. b) lead time, i.e. the time between ordering and receiving the order, is known and constant. c) Receipt of inventory is instantaneous and complete. In other words, the inventory of an order arrives in one batch at a time. d) discounts due to quantity are not possible. e) the only variable costs are the cost of setting up or ordering (set up costs) and the cost of holding or storing inventory over time (storage or warehousing costs). The purpose of this model is to determine the quantity (Q) of each order (EOQ) so as to minimise the total cost of inventory.

Bryan & Moriano, (2023) state that the JIT System is 'A continuous approach and forced problem solving that focuses on spending and inventory reduction'. JIT is a system in the production process that is carried out when there is demand from consumers by reducing the cost of waste and meeting consumer needs in the most efficient way possible in the production of a product. The goal of JIT is to reduce waste by means of continuous improvement. With Just In Time, all materials, machinery and equipment, human resources, capital, information, managerial, processes and others that do not add value to the product are referred to as waste. The goal of JIT is to produce products according to the number of products ordered by consumers to prevent waste. The benefits of JIT are numerous such as, reducing the amount of inventory, it will substantially reduce the overall inventory level so that wastage in terms of inventory does not occur and purchases under Just in Time require a much shorter delivery time. Reduced lead times and improved reliability, also contribute to a significant reduction in safety cost requirements. Other benefits of Just in Time are: a) low inventory levels that save on storage space and associated costs, b) reduced risk in inventory, c) avoiding the accumulation of unsold finished products, d) reducing direct material costs through the purchase of goods, e) with low inventory levels, the possibility of waste due to outdated, expired, and damaged or obsolete products will be lower. On the basis of these characteristics, the production department will have a fixed production schedule. If the goods produced have not been distributed to customers, they will be stored in the warehouse. The marketing department is responsible for promptly marketing the products that have accumulated in the warehouse. Traditional systems encourage sales and marketing activities (Setiawan et al., 2024b). The JIT system is the opposite of the traditional system.

Where the company will carry out production activities if there is a definite demand from customers. So, production activities in the JIT system are pulled (push) by customers.

Table 2. Differences between JIT and Traditional Systems

No.	Differentiating Factor	Just In Time (JIT)	Traditional
1	Characteristics	Full-through system	Full-through system
2	Inventory Quantity	A little	Many
3	Manufacturing Structure	Mobile manufacturing	Department structure
4	Employee Qualifications	Multidisciplinary	Specialist
5	Quality Policy	Quality control	Tolerance of defective products
6	Service Facilities	Scattered	Centralised

METHOD

The object of this research is the production process division of wooden carpet products and various interior mat products from wood materials by implementing JIT. The data collected are primary and secondary data, the calculation of the number of orders and the total cost of inventory with EOQ is then processed to determine the optimal order quantity and the application of JIT to the production line with the concept of line balancing (Setiawan & Rinamurti, 2020). This research was carried out in several processes. The process includes a literature review in the form of inductive and deductive studies, problem formulation, collection of necessary data in the form of secondary and primary data, calculation of the number of orders and total inventory costs. The next process is data processing starting from determining the optimal order quantity to calculating the total inventory cost using the JIT method (Setiawan et al., 2024a). The process is followed by analysis and discussion of the processing results of determining the optimal order quantity to the calculation of total inventory costs using the JIT method. The last process is making conclusions on the research conducted (Setiawan, Susanto, Rinamurti, et al., 2025c).

DISCUSSION

Raw Material Ordering Quantity and Total Cost

In simplifying the calculation of the cost of ordering bamboo raw materials at CV. Natural is done using the formula for raw material requirements divided by the frequency of ordering wood raw materials made by the company. So that the calculation obtained the amount of ordering raw materials for wooden carpets and interior mats of 3.3 tonnes per message. The next calculation carried out in this study is the total cost of ordering to make carpet products and wooden interior mats in one year. This research refers to the company's historical data in 2024 using the formula Total cost of raw materials based on company policy (TIC). So that the calculation found that the total cost was IDR. 177,655,932.73. The costs

stated above are the number of orders and the total cost of ordering wood raw materials incurred by the company during the running of one year, namely 2024. The JIT principle has not been applied to the company. Later these costs will be compared again after the JIT principle is applied to CV. Natural.

Application of the Economic Order Quantity Method

After classifying the company data in the form of data on raw material requirements, order costs, and raw material storage costs in 2024, the next step is to determine the most optimal amount of raw material purchases using the principles of the EOQ method. So the amount of purchase for each purchase of raw materials is 6.7 tonnes of wood raw materials. Then to determine the most effective purchase frequency in one year can be known by the calculations described in the previous chapter, namely 21 times.

From the results of the calculation analysis using the EOQ formula, it was found that the most optimum purchase amount in 2024 was 6.6 tonnes of wood raw materials in each purchase with a purchase frequency of 21 times in 1 year. The results of these calculations can be economical if they fulfil the assumptions that: 1) The price of raw materials per unit is constant for each period. 2) Storage warehouses are sufficiently available for the amount of raw materials purchased. 3) The raw materials purchased are durable raw materials. The EOQ method can also see the total cost of ordering if this principle is applied. In calculations carried out using the formula The total cost of raw materials for the EOQ method or T * is obtained at IDR. 113,473,933.41. Compared to the initial total cost T* IDR. 113,473,933.41 is smaller than TIC IDR. 177,655,932.73.

Application of the Just in Time Method

In the calculations carried out in this study, the Just in Time principle or widely known as JIT is used. Basically, the purpose of this JIT concept itself is to carry out continuous improvement activities by eliminating various forms of waste that occur in the company. The data needed in applying JIT principles are the average specific target inventory, the optimal order quantity based on the EOQ method, historical data on the use of wood raw materials, storage costs, and packaging costs. The first data obtained is the optimal JIT delivery number, which is 5 times. The next calculation obtained is the amount of wood that needs to be ordered each order, namely 22.3 tonnes of wood raw material. Furthermore, the optimal amount of raw material obtained every time a delivery is made is 3.9 tonnes of wood raw material. After that, it is known that the frequency of purchasing raw materials based on the JIT system is only 5 times a year. From the calculations obtained, it

can be calculated that the total order cost based on the JIT concept is IDR. 112,332,193.00. It can be seen that T_{jit} IDR. 112,332,193.00 < T* IDR. 113,473,933.41 < TIC IDR. 177,655,932.73.

Proposal Generation

Making proposals in order to improve production cost efficiency using a comparison of three method approaches (Setiawan, Susanto, Rinamurti, et al., 2025b). The first calculation was carried out based on the policy applied by CV Natural, the second calculation was carried out using the EOQ method, and the last calculation used the JIT method. The difference in costs generated from when the method approach can be seen in Table 3.

Table 3. Comparison of Costing Approach Methods

No.	Description	Company Policy	EOQ Method	JIT Method
1.	Explanation	Routine ordering every month adjusted inventory in the warehouse	Optimal purchase with order cost and store minimum	Purchasing with small lot size, and frequency high order frequency
2.	Raw material requirements	61,5 ton	61,5 ton	61,5 ton
3.	Optimal order quantity	3,2 ton	6,6 ton	6,6 ton
4.	Frequency of purchase/year	35	21	21
5.	Frequency of arrival of raw materials/year	35	21	21
6.	The number of raw materials each time it comes	3,2 ton	6,6 ton	6,6 ton
7.	Total cost of storage	IDR. 21.363.236,00	IDR. 38.274.611,00	IDR. 24.692.861,00
8.	Total order cost	IDR. 82.978.299,73	IDR. 38.273.171,41	IDR. 24.692.141,00
9.	Total shipping cost	IDR. 73.314,397,00	IDR. 36.929,151,00	IDR. 62.947,191,00
10.	Total cost of inventory	IDR. 177.655.932,73	IDR. 113.473.933,41	IDR. 112.332.193,00

From Table 3. it can be seen that the quantity of raw material purchases based on company policy is 3.2 tonnes of wood material, while when using the EOQ and JIT methods it is 6.6 tonnes of wood material. From these data it is known that the order quantity is greatly increased if using the EOQ or JIT method, because the warehouse capacity of the company can accommodate ± 80 tonnes of wood raw materials, the company is not constrained if using the EOQ or JIT method. The number of times the frequency of purchasing raw materials each year with company policy is 35 times, while when using the EOQ or JIT method the frequency of purchases is 21 times. However, from this data it can be seen that using the JIT method can reduce ordering costs, but the company must consider the time to QC raw materials, because each shipment of raw materials requires QC time for 2-3 hours. The number of times raw materials come or the number of delivery frequencies each year with a company policy of 35 times, while when using the EOQ and JIT methods the frequency of delivery is 21 times, this is because every purchase of raw materials the supplier must send 5 times. So if the company buys raw materials 6 times a year and each supplier

purchase must send 5 times, the frequency of delivery will be 35 times a year. The total storage cost incurred based on company policy is IDR. 21,363,236.00. If using the EOQ method, the total storage cost is IDR. 38,274,611.00. If using the EOQ method, the storage cost is very high, this is because the optimal order quantity in the EOQ method also increases by 6.6 tonnes of wood material. While the cost of storing using the JIT method is IDR. 24,692,861.00, this storage cost is lower than using the EOQ method but still higher than company policy, this is because the optimal ordering quantity is also low by 3.2 tonnes of wood. The total cost of messages issued based on company policy is IDR. 82,978,299.73. When using the EOQ method the total cost of the message is IDR. 38,273,171.41. While the cost of messages using the JIT method is IDR. 24,692,141.00 so that it can be seen that the total cost of messages is greatly reduced compared to company policy, this is because the frequency of purchases per year also decreases, in the company's policy the frequency of ordering or purchasing is 35 times if using the EOQ and JIT methods only becomes 21. The total shipping costs incurred based on company policy are IDR. 73,314,397.00. When using the EOQ method the total shipping cost is IDR. 36,929,151.00. Meanwhile, the total shipping cost using the JIT method is IDR 62,947,191.00 so it can be seen that the company's policy is still the highest while the lowest is the EOQ method, this is because the amount of shipping costs depends on the number of delivery frequencies (Setiawan & Rinamurti, 2021). In the table it can also be seen that the cost of storing and ordering costs using company policy has a very large difference, while if using the EOQ method and the JIT method, the cost of messages together with the cost of storing is almost similar. This is because the company policy only uses traditional methods while the EOQ method and the JIT method are more modern which causes storage costs and message costs to be almost similar (Setiawan et al., 2023).

The total inventory cost incurred based on company policy is IDR. 177,655,932.73. When using the EOQ method the total cost of inventory of bamboo raw materials is IDR.113,473,933.41 so that it can save costs of IDR. 64,181,999.32 (63.67%). Meanwhile, when using the JIT method the total inventory cost of bamboo raw materials is IDR. 112,332,193.00 so that the total cost that can be saved is IDR. 65,323,739.73 (63.23%). The results of this study prove that the inventory control policy carried out by the company is not optimal, it can be seen from the results of the calculation and analysis of production costs using the JIT method that it shows more efficient results in controlling inventory and in

spending production costs compared to using the EOQ method and policies carried out by the company (Kusmindari & Setiawan, 2021).

CONCLUSION

Based on the results of the calculation of inventory control policies carried out by the company, it can be seen from the results of the calculation and analysis of production costs using the JIT method that the results are more efficient in controlling inventory and in spending production costs compared to using the EOQ method and policies carried out by the company. So that the application of the Just In Time method to the company can be done, it is because the company's capacity can fulfil the policies of applying the JIT method. Based on the results of this study in the discussion chapter, it shows that in raw material inventory, the company's policy is not optimal and has not shown the efficiency of the production costs incurred by the company compared to using the EOQ method or the JIT method. Therefore, if using the EOQ method the company can save 63.89% production costs or IDR. 113,473,933.41 and if using the JIT method the company can save 95.47% or IDR. 112,332,193.00 of the total inventory cost of IDR. 177,655,932.73.

IMPLICATION

Positive implications of JIT for production cost efficiency at CV Natural; (1) Inventory cost reduction. With the JIT system, CV Natural only produces goods when there is demand and raw materials are ordered according to actual needs. This reduces the cost of storing goods, the risk of expiration or damage to raw materials, and the cost of capital held in stock. (2) Improved production flow. Production becomes more scheduled and smooth, so that waiting time between processes can be reduced, labour efficiency increases because work does not accumulate, and machine usage becomes more optimal (Setiawan, Susanto, Rinamurti, et al., 2025d). (3) Quality enhancement. Since production is carried out in small batches and continuously; quality problems can be more quickly detected and corrected and there is no accumulation of a large number of defective products. (4) Waste reduction. As per the lean manufacturing principle inherent in JIT: Minimise waste of materials, time, labour, and internal transportation, and increase the added value of each production process (Setiawan, Susanto, Budiarto, et al., 2025). (5) Increased responsiveness to consumer demand. With JIT, CV Natural can: more quickly adjust the type and volume of products, and meet market demand in a timely manner and in the right amount.

Challenges and Risks of JIT Implications at CV Natural; (a) Dependence on Suppliers. If suppliers are inconsistent or untimely, the entire production system can be disrupted. Strong partnerships and real-time communication with suppliers are required. (b) The need for strict production management. Scheduling must be very precise. Small errors in forecasting can lead to material shortages. (c) Risk of production interruption. In a JIT system, there is no buffer stock. In the event of machine breakdowns or logistics delays, production can come to a halt. (d) Initial investment for system adaptation. HR training and information system adjustment (light MIS/ERP) are required (Setiawan, Susanto, Rinamurti, et al., 2025a). Need to change mindset from mass production to demand-based production

Empirical analysis (based on field studies / interviews / CV. Natural data). If CV. Natural has implemented JIT, then the empirical analysis may include: data before and after JIT implementation: total production costs, level of raw material wastage, frequency of excess or shortage of stock, production cycle time, level of customer complaints. So it can be concluded that the implementation of JIT at CV Natural has the potential to significantly improve production cost efficiency, as long as it is managed with a solid supply chain management strategy and supported by adequate information systems (Rinamurti & Setiawan, 2021). However, it is necessary to mitigate risks through strategic minimum buffers and close supplier relationships.

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