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The Impact of Just in Time Implementation on Efficiency and Performance in Various Manufacturing Sectors: A Literature Review

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Abstract: The current industrial development requires every company to have strategies to remain competitive and minimize losses caused by poor production management. One of the strategies that can be adopted to improve the sustainability of the production process is by using the JIT (Just in Time) method. This literature review discusses about JIT strategy across three manufacturing sectors, including automotive industry, garment industry, and culinary industry. The purpose of this literature review is to examine the impact of implementation of JIT concept on production processes in automotive, fashion, and culinary manufacturing sectors. The data used in this literature review were obtained from the Google Scholar platform using the several keyword. Based on the review of the three articles, it was found that the impact of JIT on manufacturing in the automotive, garment, and culinary sectors is highly efficient in eliminating excess raw material inventory costs. PT Chuhatsu Indonesia successfully saved the raw material inventory costs up to IDR 11,575,218.9 in 2016, IDR 12,594,887.78 in 2017, and IDR 12,488,051.43 in 2018. Winonamodest also successfully minimized raw material inventory costs from a total of IDR 5,166,375 to IDR 2,713,776.380 meanwhile, Bakso Bontotangnga was able to reduce total inventory costs by Rp 8,115,672.77. Hopefully, this literature review can be further examined and serve as additional information in the field of industrial engineering.

Introduction

In contemporary manufacturing industries, supply chain synchronization and downstream to upstream production control encompassing raw material procurement through to final product distributio constitute critical determinants of operational efficacy. Strategic regulation of raw material procurement serves as a pivotal mechanism to mitigate qualitative degradation, optimize warehouse capacity utilization, curtail redundant inspection lead times, and minimize inventory holding costs.

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To resolve these logistical inefficiencies and eliminate systemic waste, manufacturing enterprises extensively adopt the JIT (Just in Time) production framework. Under this operational methodology, material inputs are acquired and integrated into the assembly process precisely when required, thereby enhancing systemic productivity through the systematic elimination of non-value-adding activities (Apriyanti et al., 2021). Furthermore, robust JIT orchestration mitigates the risk of catastrophic operational disruptions, such as production line halts "Stop Line" driven by material deficits, while simultaneously preventing suboptimal capital allocation associated with surplus inventory accumulation (Suradi, 2010; as cited in Eddy, 2010).

However, while the conceptual merits of JIT are universally acknowledged, its empirical execution yields distinct operational anomalies across heterogeneous industrial sectors. In the automotive manufacturing domain, enterprises such as PT Chuhatsu Indonesia encounter significant financial liabilities generated by residual material waste and the subsequent inflation of holding costs for specialized components (Anwar & Nurhidayat, 2020). Conversely, the textile and garment sector, exemplified by micro industries like Winonamodest, faces severe qualitative degradation of sensitive textile media, such as lycra jersey fabrics, during prolonged storage a vulnerability that substantially elevates defect rates (Apriyanti et al., 2021). Parallel complexities are observed within the culinary sector as documented by Nurmiyalah et al. (2024) in the context of the Bontotangnga Meatballs home industry, practitioners grapple with severe preservation constraints regarding highly perishable biological assets, such as fresh beef, where extended storage directly jeopardizes biochemical integrity and product safety.

Despite the proliferation of literature evaluating JIT methodologies, a critical theoretical fragmentation persists. Extant literature remains disproportionately biased toward single industry empirical investigations, predominantly isolating JIT performance assessments within high volume, highly standardized paradigms like automotive assembly. Consequently, current academic consensus fails to elucidate how JIT principles adapt when subjected to radically contrasting supply chain architectures. A profound empirical void exists regarding comparative analyses that evaluate JIT implementation across sectors characterized by fundamentally divergent material lifecycles specifically contrasting durable industrial components, semi durable polymers/fabrics, and highly perishable biological inputs. Absent such cross sectoral comparative frameworks, the operational boundaries of JIT remain poorly defined, leaving unresolved questions regarding its efficacy in environments dictated by rapid product obsolescence and volatile shelf-lives.

To address this empirical gap, this literature review establishes a rigorous cross-sectoral comparative analysis evaluating the adaptability of JIT frameworks across three distinct industrial spectrums: automotive, garment, and culinary. Moving beyond monolithic operational assumptions, the objective of this study is to systematically analyze and contrast the definitive impact of JIT integration through four core performance vectors: the efficiency of inventory cost reduction, the optimization of ordering frequency, the capacity for waste minimization, and the enhancement of overall production efficiency. The overarching novelty of this research lies in its multi tiered synthesis, shifting the analytic paradigm from single industry isolation to a multi-sectoral matrix. By modeling the operational flexibility of JIT under diverse material and financial constraints, this review provides a novel strategic benchmark for contemporary supply chain management and academic literature.

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Research Method

In research that uses statistical data or in the form of numbers and analysis in the process, the methodology used is a quantitative method. This method has fulfilled scientific principles, namely concrete, empirical, objective, measurable, and systematic. (Abdullah *et al*., 2021). In the research, Anwar and Nurhidayat (2020) stated that in the process of collecting data for their research at PT Chuhatsu Indonesia about the design JIT In the production process, the control of the inventory of component raw materials is carried out by a quantitative method where the data obtained is primary data that is collected through direct observation in the warehouse and production for the availability and use of raw materials.

Squirt *et al*. (2021) conducting research on the application of the JIT for the efficiency of raw material inventory control in *home industry* Winonamodest by means of observations carried out in the environment *home industry* Winonamodest. The data obtained is then used as primary data which will be supported by the use of secondary data obtained from scientific journals, books, and previously existing data archives.

Quoted from Abdullah *et al*. (2021) by Emzir (2009), a quantitative approach is an approach that primarily uses the postpositivist paradigm in developing science (such as thinking about cause and effect, reduction to variables, hypotheses and specific questions using measurements and observations as well as theoretical testing), using research strategies such as experiments and surveys that require statistical data.

Nurmiyalah *et al.* (2024) in his research also explained that research on application analysis JIT as an effort to improve production efficiency in *home industry* Bontotangnga meatballs use a quantitative approach where data collection is carried out by interviewing industry players and documentation in the environment *home industry*

This study employs a systematic literature review (SLR) approach to comprehensively evaluate the cross-sectoral adaptability of the JIT production framework. To ensure a transparent, objective, and reproducible selection process, the literature search was meticulously structured across digital databases, primarily utilizing Google Scholar as the foundational data source. The identification of relevant literature was executed through targeted boolean search strings to capture the intersections of the production framework across various fields. The primary operational search parameters included combinations of keywords such as "Just In Time", "automotive manufacturing", "inventory control"; "Just In Time", "garment industry", "textile", "waste minimization"; as well as "Just In Time" "culinary sector" or "food industry".

To maintain academic rigor and strict topical alignment, explicit inclusion and exclusion criteria were established during the screening process. For the inclusion criteria, studies were required to be peer-reviewed journal articles or empirical case studies focused directly on JIT implementation within manufacturing domains, and they had to explicitly discuss inventory costs, ordering frequencies, waste elimination, or production line efficiencies. Furthermore, the publication years were strictly limited to a contemporary six-year window between 2020 and 2026 to ensure the retrieval of modern supply chain dynamics. Conversely, the exclusion criteria filtered out conceptual working papers, textbooks, non-peer-reviewed white papers, and literature evaluating JIT within non manufacturing domains such as digital software development or pure service industries. Studies that lacked explicit empirical data on material management or financial implications were also systematically omitted.

Although the initial database query yielded a broader spectrum of publications regarding JIT lean systems, the screening process intentionally narrowed the final selection

to three primary anchor articles: Anwar and Nurhidayat (2020), Apriyanti et al. (2021), and Nurmiyalah et al. (2024). The deliberate restriction to these three specific studies was fundamentally driven by the methodological requirement for an extreme case comparative matrix rather than an exhaustive statistical aggregation. These three articles uniquely serve as empirical representatives of completely contrasting supply chain architectures with fundamentally divergent material lifecycles. Anwar and Nurhidayat (2020) isolates JIT dynamics within a heavy, non-perishable automotive component environment characterized by high holding costs of raw materials. Apriyanti et al. (2021) contextualizes JIT application within a semi-durable consumer goods environment facing time sensitive qualitative material degradation of textiles. Finally, Nurmiyalah et al. (2024) addresses JIT under extreme operational vulnerability within the culinary sector, involving highly perishable biological assets with rapid biochemical spoilage rates. By synthesizing this tightly controlled, purposive sample of three highly contrasting manufacturing archetypes, this methodology provides the exact comparative empirical depth necessary to thoroughly map the operational boundaries and flexible adaptability of JIT frameworks.

The screening process intentionally narrowed the final selection to three primary anchor articles as the core empirical data: Anwar and Nurhidayat (2020), Apriyanti et al. (2021), and Nurmiyalah et al. (2024). The deliberate restriction to these three specific studies was fundamentally driven by the methodological requirement for a tightly controlled, extreme-case comparative matrix where exact quantitative data could be calculated across contrasting material lifecycles (durable automotive, semi-perishable garments, and highly perishable culinary assets). To satisfy the demand for a comprehensive multi-industry validation without disrupting this core mathematical matrix, the methodology incorporates a secondary tier of empirical literature. Specifically, the macro-infrastructure study by Istiqomah et al. (2023) and the chemical process-based manufacturing study by Widjojo (2022) are deployed strictly as secondary comparative baselines. These additional studies are not subjected to the primary mathematical evaluations but are integrated within the qualitative discussion to cross-examine and validate the broader cross-sectoral adaptability, limits, and operational boundaries of the (JIT) framework.

Result and Discussion

Quoted from Dwiningsih and Pratama (2021) Inventory can be defined as materials that are stored in warehouses to be used in the next production process or sold. Inventory can be in the form of raw materials for the purposes of processing goods that are still in the process of processing. Inventory is also a staple as the proper function of a processing or manufacturing business. According to Freddy Rangkuti (2013), in the book Inventory Management "Inventory is one of the most active elements in the company's operations that is continuously acquired, rechanged, resold".

Inventory in manufacturing companies is inventory of finished goods, goods in process, raw materials, supplies of auxiliary materials, consumable supplies, and spare parts inventory. Abubakar and Wibowo (2002).

In their research, Anwar and Nurhidayat (2020) obtained raw material inventory data at PT Chuhatsu Indonesia in the period of 2016, 2017 and 2018 which is presented in the following table.

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Table 1. Raw Material Inventory of PT Chuhatsu Indonesia

Year	purchase frequency	Initial inventory (kg)	Purchase (kg)	total inventory (kg)	Usage (kg)	Remainder (kg)
2016		3.22	163.434	166.654	163.379	3.275
2017	12	3.275	165.638	168.913	165.643	3.27
2018		3.27	165.065	168.335	165	3.715

From table 1 we can see that the availability of raw materials in the PT Chuhatsu Indonesia comes from the remaining raw materials for wire steel in the previous year and the purchase of wire steel in the current year. From the table, it can be seen that every year PT Chuhatsu Indonesia has the remaining raw materials that are not used and must be stored. In 2016 there were 3,275 kg of unused wire steel, in 2017 as much as 3.27 kg and in 2018 as much as 3,715 kg of unused wire steel that had to be stored in warehouses.

Arens *et al.* (2003: 599-600) states that the function of inventory concerns the physical flow of goods and the flow of related costs, therefore there is adequate control for both.

Anwar and Nurhidayat (2020) also calculated the cost of inventory consisting of ordering costs and storage costs of unused wire steel. Table 2 presents data on costs resulting from residual raw materials that must be stored in the period of 2016, 2017 and 2018.

Table 2. Raw Material Inventory Cost

Year	Booking	Storage	Total
2016	IDR 15,360,000	IDR 2,982,670	IDR 18,342,670
2017	IDR 16,680,000	IDR 3,064,301	IDR 19,744,301
2018	IDR 18,000,000	IDR 3,094,967	IDR 21,094,967

In another study, the results of observations conducted by Apriyanti *et al*. (2021) in Winonamodest it is known that every month Winonamodest has unused raw material leftovers, Winonamodest raw material inventory data is presented in the following Table 3.

Table 2. Winonamodest raw material inventory

Raw Material	Month	Purchase (Meter)	Usage (Meter)	Remaining (Meter)
Lyra Jersey Fabric	January	223	222.25	0.75
	February	176	174.65	1.35
	March	87	86.1	0.9
	April	233	232.05	0.95
	May	241	240.1	0.9
	June	104	102.9	1.1
	July	105	102.9	2.1
	August	90	87.85	2.15
	September	80	78.75	1.25
	October	133	132.3	0.7
	November	108	107.1	0.9
	December	105	103.95	1.05
Total		1685	1670.9	14.1
Average		140.41667	139.24167	1.175

Table 3 shows that each month Winonamodest has an average of 1.175 meters of fabric remainder, and to store the rest of these raw materials, storage costs and raw material ordering costs are required. This data uses 2019 data as a reference and is tabulated in Table 4 below.

Table 4. Raw Inventory Cost

Year	2019
Booking Fee	IDR 5,040,000
Storage Costs	IDR 126,375
Total	IDR 5,166,375

Latest research by Nurmiyalah *et al.* (2024) obtained the results of interviews and documentation from the Bontotangnga Meatball culinary industry on the purchase and use of fresh beef as a raw material for making meatballs. The results obtained from the interviews are tabulated in Table 5.

Table 5. Raw Material Inventory of Bontotangnga Meatballs

Raw Material	Month	Purchase (Kg)	Usage (Kg)	Remaining (Kg)
Fresh Beef	July 2022	7,500	6,300	1,200
	August 2022	6,200	6,050	150
	September 2022	5,300	5,200	100
	October 2022	5,400	4,500	900
	November 2022	5,500	4,700	800
	December 2022	5,800	5,500	300
	January 2023	6,800	6,100	700
	February 2023	5,500	4,750	750
	March 2023	5,400	5,000	400
	April 2023	5,500	4,700	800
	May 2023	6,600	6,350	250
	June 2023	6,000	5,550	450
Total		**71,500**	**64,700**	**6,800**

Table 6 presents data that there are hundreds of kg of fresh beef left every month, even in July 2022 the remaining unused meat reached 1200 kg. Meanwhile, the costs used to store the remaining raw material inventory in July 2022 are as follows

Table 6. Raw Material Inventory Cost

Year	2022
Booking Fee	IDR 13,360,000
Storage Costs	IDR 12,207,800
Total	IDR 25,567,800

Quoted from Wahyudi *et al.* (2023) Inventory control has the following objectives:

1. Provide products quickly according to customers' requests.
2. Maintain production continuity and prevent inventory runs that can stop the production process.

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3. Increase the company's sales and profits, if possible.

The main problem to be achieved in inventory control is to minimize the company's total operating costs. So, there are two decisions that need to be made in this case, namely how much to order/produce each time order/production and when the order/production is made. Dwiningsih and Pratama (2021)

The use of costs used for the storage of residual raw materials at PT Chuhatsu Indonesia, Winonamodest and Bakso Bontotangnga as previously explained was then circumvented by efforts to apply the method JIT, from Apriyanti *et al.* (2021) It is known that the JIT also known as zero inventories or stockless production. The goal of this method is to eliminate residual items on all work sequences, starting from product design to final product delivery to consumers. By applying the JIT The required materials arrive at the manufacturer exactly where the materials will be used. Nurmiyalah et al. (2024) explained to apply the JIT It is necessary to calculate the quantity of raw material orders with the following equation:

$$Q = \sqrt{\frac{2\ X\ O\ X\ D}{C}} \quad (1)$$

Description:
Q = Order Quantity
O = Booking Fee
D = Total Raw Material Usage
C = Storage Fee

Furthermore, by calculating the total minimum inventory of raw materials with the equation (2)

$$T = \frac{C\ x\ Q}{2} + \frac{O\ x\ D}{Q} \quad (2)$$

Description:
T = Total Minimum Inventory

Calculate the optimal delivery quantity each time an order with the following equation (3)

$$na = \left(\frac{Q}{2\ x\ a}\right)^2 \quad (3)$$

Description:
na = Optimal Delivery Quantity
Q = Order Quantity
A = Average Inventory Specific Target

Next, the calculation of the order quantity for a single message uses the equation (4)

$$Qn = \sqrt{na}\ x\ Q \quad (4)$$

Description:
Qn = Order Quantity
na = Optimal Delivery Quantity

The next step is to calculate the shipping quantity with the following equation (5)

$$q = \frac{qn}{na} \quad (5)$$

Description:
q = Shipping Quantity
Qn = Order Quantity
na = Optimal Delivery Quantity

Calculate the frequency of purchasing raw materials *just-in-time* with the following equation

$$n = \frac{D}{Qn} \quad (6)$$

Description:

n = Purchase Frequency

The last step is the calculation of the total cost of inventory using the *just-in-time method* with the equation (7)

$$T_{jit} = \frac{1}{\sqrt{n}} \, x \, T \quad (7)$$

Description:

TJIT = Total Cost of Inventory

n = Purchase Frequency

T = Total Inventory

The results of the calculation of the entire series *of JIT methods* are tabulated in the following table.

Table 7. Calculation Results of the *JIT Method*

Calculation Result of JIT Method	Chairul and Asep (2020)	Apriyanti et al. (2021)	Adel et al. (2024)
Q	30,901.60 kg	1,362.5 m	4,266.25 kg
T	IDR13,534,903.2	IDR2,452,598.6	IDR3,896,376.9
na	2 times	4 times	10 times
Qn	43,701.46 kg	2,725.1 m	13,364.57 kg
q	21,850.73 kg	681.275 m	1,336.45 kg
n	4 times	1 time	5 times
Tjit	IDR6,767,451.60	IDR2,452,598.6	IDR17,425,127.2

Table 7 is the result of the optimal value calculated by the *JIT* where Q (Number of orders), T (Total cost of ordering and storage), na (Number of shipments per period), Qn (Size of shipments per batch), q (Quantity per order), n (Frequency of shipments per period), Tjit (Total cost of JIT).

The empirical outcomes tabulated across the three manufacturing archetypes demonstrate that the structural efficacy of the JIT framework is profoundly contingent upon industry specific supply chain configurations. Rather than yielding uniform operational improvements, JIT performance systematically diverges when subjected to variations in inventory characteristics, material perishability, demand predictability, and supplier integration parameters.

A critical comparative synthesis of the data reveals that the automotive component sector, exemplified by PT Chuhatsu Indonesia (Anwar & Nurhidayat, 2020), possesses high value, durable, and highly standardized inventory characteristics where material degradation over time is virtually non-existent. However, this sector is uniquely vulnerable to massive holding costs and rigid capital tying from unused material residues. Because automotive manufacturing operates under highly predictable, long term contractual demand patterns, JIT successfully downscaled purchasing frequencies from 12 shipments to mere periodic intervals, generating an exceptional 62% inventory cost reduction. This profound efficiency is highly realizable because the industry exhibits low supplier dependency vulnerabilities; components are heavily standardized, allowing highly synchronized scheduling without immediate material spoilage risks.

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Conversely, the operational dynamics of the home garment sector (Winonamodest) and the culinary sector (Bontotangnga Meatballs) present significant contrasts due to material perishability constraints. In the garment industry, raw materials like lycra jersey fabrics are categorized as semi-perishable inventory, suffering unique qualitative degradation through physical distortion or staining during extended warehousing (Apriyanti et al., 2021). By implementing JIT, the enterprise successfully achieved a 53% reduction in raw material costs and optimized the ordering frequency down to a single, hyper efficient delivery; this compressed inventory cycle directly mitigates the material's shelf-life risks, translating into structural waste minimization and lower defect rates.

The most volatile application of JIT, which explains the significant difference in numerical findings, is observed in the culinary sector, where the raw material consists of fresh beef a highly perishable biological asset subject to rapid biochemical spoilage (Nurmiyalah et al., 2024). Unlike the rigid, predictable automotive or semi-durable garment industries, the demand pattern in food micro industries is highly volatile and dictated by immediate, short-term consumer consumption behaviors. Consequently, while JIT managed to reduce inventory costs by 31.85% and contract the ordering frequency from 10 shipments to 5, its efficiency ceiling is significantly lower than that of the automotive sector (62%). This performance gap occurs because culinary JIT operations are bounded by extreme supplier dependency; practitioners cannot aggressively eliminate buffer stocks without jeopardizing food safety or halting production during sudden supplier delivery delays.

Ultimately, this comparative analysis provides a deeper analytical rationale for the varying outcomes: while JIT functions as a powerful mechanism for inventory cost reduction and waste minimization across all three industries, its operational optimization curve is steepest in durable, predictable sectors (automotive) and becomes progressively constrained as material perishability risks, fluctuating demand patterns, and supplier dependencies increase (garment and culinary).

Table 7 is a comparison between the initial policy and the results of the implementation of the JIT, The results obtained prove that the initial inventory control policy that has been carried out by producers, in this case PT Chuhatsu Indonesia, Winonamodest and Bakso Bontotangnga, has not been optimal and the results of the calculation method JIT shows more optimal results with minimal costs compared to previous policies without using the JIT.

Based on the calculation of JIT Anwar and Nurhidayat (2020), the purchase of raw materials in 2016 decreased from 12 shipments in one order during the period of 2016, 2017 and 2018 to 2 times during 2016, 2 times during 2017 and 3 times in the 2018 period. In addition, Anwar and Nurhidayat also stated that with the JIT method, PT Chuhatsu Indonesia can save the raw material inventory budget of IDR 11,575,218.9 in 2016, IDR 12,594,887.78 in 2017, and IDR 12,488,051.43 in 2018. In this case, the inventory cost savings by using the JIT method for 3 years reached 62%.

Directly proportional to this, in other studies Apriyanti *et al.* (2021) stated based on the application of the *JIT* in the garment industry, Winonamodest can reduce raw material inventory costs from IDR 5,166,375 to IDR 2,452,598.62 which means more efficient as much as IDR 2,713,776.38. This means that it can reduce inventory costs to 53%. With the application of the JIT method, it can also save the frequency of purchasing raw materials 1 time, from 12 times efficient to 11 times purchases.

Nurmiyalah et al. (2024) also agree that the just-in-time method has better production efficiency than the Bontotangnga Meatball home industry policy. This efficiency is known from the results of calculations carried out using the JIT method where based on the

simulation of the JIT method, the frequency of ordering raw materials has decreased from 10 shipments a year to only 5 times a year. The cost of raw material inventory has decreased significantly, namely 31.85%. The cost of raw material inventory in the Bontotangnga Meatball home industry with the previous home industry policy reached IDR 25,567,800 while the cost of raw material inventory with the application of the JIT method was only IDR 17,425,127.23 which means that the Bontotangnga Meatball home industry was able to reduce the total inventory cost of IDR 8,115,672.77 in a period of one year.

Table 7. Comparison of Initial Policy Raw Material Inventory Costs to JIT *Method*

Researches		Initial Policy	Method *JIT*	Savings
	2016	IDR 18,342,671	IDR 6,767,452	IDR 11,575,219
Anwar and Nurhidayat (2020)	2017	IDR 19,744,302	IDR 7,149,414	IDR 12,594,888
	2018	IDR 21,094,967	IDR 8,606,916	IDR12,488,051
Apriyanti *et al.* (2021)	2019	IDR 5,166,375	IDR 2,452,598	IDR 2,713,776
Nurmiyalah *et al.* (2024)	2022	IDR25,567,800	IDR 17,452,127	IDR 8,115,673

Expanding the evaluation of macro infrastructure to further elevate the analytical of this review and establish a truly comprehensive multi-industry validation, the core matrix is cross-examined against two distinct macro industrial studies: heavy infrastructure management and chemical polymer manufacturing. The integration of JIT within large-scale, project-based infrastructure, as exemplified by PT Waskita Karya Tbk (Istiqomah et al., 2023), offers a completely unique operational paradigm that redefines traditional lean boundaries. Unlike the continuous, steady-state assembly lines of automotive components (Anwar & Nurhidayat, 2020) or the short cycle processes of garment and culinary production, infrastructure development manages bulky, non standardized material flows (such as read -mix concrete and structural steel) dictated strictly by rigid project milestones rather than steady or seasonal market demand.Through quantitative regression modeling, Istiqomah et al. (2023) demonstrated that JIT implementation exerts a statistically significant positive effect on minimizing warehousing overhead and driving operational efficiency, evidenced by an R-square value of 71.8%.

In this infrastructure sector, inventory characteristics are massive and highly capital-intensive. Consequently, establishing a synchronized supply flow directly mitigates the immense holding costs and degradation risks of deadweight materials at project sites.However, a deeper analytical juxtaposition reveals that while the automotive sector enjoys low supplier vulnerability due to component standardization, strategic supplier partnership serves as the absolute linchpin for Waskita Karya. Ensuring zero delay delivery is mandatory to prevent catastrophic idle-labor costs downstream. This highlights a high-magnitude supplier dependency that mirrors the operational urgency of the culinary sector (Nurmiyalah et al., 2024), but transfers it from a micro biological scale to a macro structural project framework.

While a culinary delay spoils fresh beef, an infrastructure supply disruption paralyzes heavy machinery and contracted labor forces, making JIT execution a high stakes financial risk management tool rather than a mere efficiency choice. In parallel, another vital dimension of JIT adaptability is highlighted in process-based chemical manufacturing at PT Aristek Highpolymer (Widjojo, 2022), which bridges the gap between mechanical assembly and biophysical material constraints. Transitioning from a traditional push production system, this polymer and resin manufacturing firm faced high storage costs, prolonged lead times, and inconsistent product quality vulnerabilities shared by both the traditional textile processes in

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the garment sector (Apriyanti et al., 2021) and the unmanaged inventories of the culinary industry.

The structural dynamics outlined in Table 8 provide the empirical foundation required to systematically analyze and contrast the definitive impact of JIT integration across the study's four core performance vectors:

Table 8. Comprehensive 5-Way Comparative Matrix of JIT Framework Adaptability

Industry Sector (Study Source)	Inventory Characteristics	Perishability Risk	Demand Pattern	Supplier Dependency	Primary JIT Operational Breakthrough / Outcome
Automotive Component (Anwar & Nurhidayat, 2020)	High-value, rigid steel wire, highly standardized parts	None (Durable mechanical assets)	Highly Predictable (Long-term contractual volumes)	Low to Medium	Achieved an exceptional 62% inventory cost reduction and compressed delivery frequency from 12 shipments to periodic slots.
Home Garment (Apriyanti et al., 2021)	Semi-durable textiles, highly versatile lycra jersey fabrics	Medium (Qualitative degradation through physical storage distortion)	Seasonal & Trend-driven volatility	Medium	Generated a 53% raw material cost reduction and consolidated procurement down to a single, hyper-efficient delivery cycle.
Culinary / Micro-Food (Nurmiyalah et al., 2024)	Highly perishable fresh beef, volatile biological assets	High (Rapid biochemical spoilage and strict shelf-life limits)	Volatile (Driven by immediate, short-term consumer shifts)	High (Extreme structural vulnerability)	Secured a 31.85% cost reduction; efficiency ceiling rigidly capped by inescapable safety-stock biological mandates.
Heavy Infrastructure (Istiqomah et al., 2023)	Bulky, capital-intensive raw materials (concrete, structural steel)	Low to Medium (Site-specific environmental damage)	Project-Based (Strictly bound to macro-milestone)	Very High (Cascading idle-capacity and penalty risks)	Established a statistically significant 71.8% variance (R2) control over structural warehousing and overhead costs.
Chemical & Polymer (Widjojo, 2022)	Synthesized industrial resins, active chemical compounds	Medium (Chemical shelf-life and reaction boundaries)	Batch-driven contractual orders	High	Orchestrated a post-traditional transition from push-production to streamlined cellular manufacturing layouts.

The integration of JIT metrics specifically establishing long-term supplier alliances, restructuring layouts into dedicated manufacturing cells, and conducting intensive workforce cross training profoundly overhauled their operational flow.Widjojo (2022) found that near-zero inventory boundaries successfully accelerated lead times and compressed warehousing overhead. Crucially, the introduction of manufacturing cells enabled real-time quality inspections at every processing stage, allowing early defect detection. This represents a distinct departure from automotive manufacturing and a crucial point of synthesis with the garment and culinary sectors. In automotive lines, a defect can often be reworked or isolated without stopping the entire plant. In contrast, during chemical synthesis much like industrial food preparation quality variations must be corrected instantly within the process cell to avoid ruining entire downstream batches.Thus, for PT Aristek Highpolymer, JIT transitions from being an essential tool for quantitative cost-cutting (as seen in the automotive 62% reduction) into a mechanism for qualitative standardization and chemical stability, proving that JIT can govern complex chemical reaction timelines just as effectively as it controls steady state mechanical supply lines.

The cross sectoral findings across the five distinct industries directly validate and expand foundational concepts within Lean Production and JIT theories. The substantial variations in inventory cost reduction ranging from 62% in automotive assembly to 31.85% in culinary micro industries illustrate the practical physics of inventory minimization as a tool to eliminate *Muda* (waste). In traditional manufacturing frameworks, inventory acts as a buffering mechanism to hide operational inefficiencies. By forcing a systematic reduction in inventory levels, JIT acts as a catalyst for continuous improvement (Kaizen), exposing underlying structural vulnerabilities such as weak supplier reliability or flawed shop-floor layouts.

This exposure is clearly operationalized in the chemical process environment of PT Aristek Highpolymer, where the reduction of raw material buffers forced the implementation of dedicated manufacturing cells. This structural shift highlights the theoretical intersection of waste elimination and qualitative standardization: when buffer inventories approach zero, real-time quality containment becomes a structural mandate rather than an operational choice. Similarly, the project-based framework of PT Waskita Karya Tbk proves that lean waste minimization principles can scale beyond localized factory floors to govern macro logistical networks, proving that stabilizing structural lead times is identical to eliminating physical assembly line bottlenecks.

The empirical matrix established in this study yields vital practical implications for manufacturing executives and operational managers. First, decision makers must recognize that a zero inventory target is a variable continuum rather than a fixed industrial benchmark. For durable, predictable sectors (automotive), aggressive buffer elimination drastically frees up tied capital; however, for perishable or high-vulnerability sectors (culinary and heavy infrastructure), managers must purposefully maintain a calibrated safety stock to buffer against strict biological product expirations or high stakes downstream idle labor penalties. Second, operational transitions toward JIT must prioritize deep, long term supplier alliances and internal layout reorganizations (such as cell configurations) over simple purchasing adjustments, as localized purchasing shifts without structural shop-floor modifications fail to generate sustainable efficiency curves.

From an academic perspective, these findings provide substantial implications for future inventory management research. This review challenges the conventional, homogenous application of JIT models by introducing a clear multi industry adaptability. Future academic inquiries should move away from isolated, single industry case studies and

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focus on developing mathematical optimization models that incorporate raw material perishability coefficients, macro-milestone contractual risks, and chemical process setup constraints directly into core JIT safety-stock formulas. Furthermore, this study establishes a foundational qualitative and quantitative baseline for future researchers to empirically investigate how decentralized supply networks can utilize digital tracking frameworks to balance the structural tension between lean inventory minimization and supply chain resiliency.

Conclusion

Based on the results of the calculation data with the JIT In each study, it is known that Anwar and Nurhidayat (2020) stated that the JIT proven to show maximum results with a minimum cost of wire steel inventory compared to the policy carried out by PT Chuhatsu Indonesia. Squirt et al. (2021) also explained that to save the cost of inventory of fabric raw materials lycra jersey di home industry Winonamodest can be done by applying the JIT. The results of the study are also strengthened by the latest research from Nurmiyalah et al. (2024) which states that the JIT proven to be able to overcome excess raw materials and large storage costs, and provide good production efficiency because the required raw materials arrive on time, avoiding home industry Bentotangnga meatballs have an excess supply of fresh beef which will cause waste of storage and ordering costs. So that the JIT It is the right strategy to be used to increase production efficiency and optimize the use of costs in both the automotive, garment and culinary industry sectors.

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