ADOPTION OF CONCRETE BLOCK MANUFACTURERS OF JUST-IN- TIME: TOWARDS SDG ON RESPONSIBLE CONSUMPTION AND PRODUCTION

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ABSTRACT

The Just-In-Time (JIT) concept involves producing only what is needed, when it is needed, and in the required amount. This study sought to determine the adoption of concrete block industries in Just-In-Time towards SDG on responsible consumption and production. The researchers used structured questionnaires to gauge the respondents' level of adoption of Just-In-Time practices and employed interview guide questions to explore the various practices employed by manufacturers at each stage, as well as the challenges they faced. Data were analyzed using means and standard deviations for the respondents' level of adoption. Moreover, thematic analysis using a deductive approach and documentary analysis were employed to examine the practices and challenges faced by manufacturers in adopting Just-In-Time. With a mean of 2.85 and a standard deviation of .90, the results indicate that concrete block manufacturers adopted Just-In-Time production to a moderate extent. It was also revealed that the most prevalent challenge faced by the concrete block manufacturers was curing obstacles.

Keywords: Cost reduction, efficiency, inventory management, pull system, supplier relationship, waste reduction

INTRODUCTION

Rationale

Just-In-Time (JIT) is a core lean manufacturing philosophy aimed at reducing waste, optimizing operations, and improving efficiency in purchasing, production, and selling processes (Ahuja & Singh, 2012). Originating in the 1950s and adopted by Toyota in response to the 1973 oil crisis, JIT emphasizes a pull-demand system where materials and products are delivered precisely when needed, minimizing labor, storage costs, and waste (Hemmondharop, 2002; Parilla, 2020). Toyota's success with JIT was driven by employee engagement, streamlined processes, and synchronized production systems (Kootanaee et al., 2013). In the Philippines, JIT has been linked to enhanced organizational performance and sustainability, reducing waste and supporting resource conservation (Parilla, 2020). Similarly, in Kenya's cement industry, JIT improved inventory control and cost management despite challenges like supply chain issues and resistance to change (Munywoki, 2018). JIT offers practical benefits to stakeholders by enabling cost reduction, sustainable practices, and profitability improvements, while also serving as a foundation for future research into its long-term impacts on industries and communities. However, gaps in JIT research exist, particularly due to the reliance on self-reported data and limited scope in specific industries, highlighting the need for more comprehensive studies.

Just-In-Time (JIT) aligns inventory with consumer demand, improving product quality and reducing defects through continuous improvement and cost efficiency (Aroca et al., 2020; Shah & Ward, 2019). By optimizing supply chains and minimizing resource use, JIT enhances cash flow and operational performance (Leuveano et al., 2019; Krafcik, 1988). It is a proven waste-reduction strategy, particularly effective in industries like concrete block manufacturing, where it prevents storage-related risks and matches production with demand (Aradhye & Kallurkar, 2014; Raza et al., 2020).

Among the rising industries today is concrete block manufacturing. Industrialization and urbanization have driven increased demand for concrete blocks due to their affordability, quick construction, and structural benefits like insulation and earthquake resistance (Preston & Lehne, 2018; Bribián et al., 2011; Thorat et al., 2015; Sureshchandra et al., 2014). The growing adoption of sustainable construction methods in the concrete block industry highlights a shift toward responsible practices (Satyashri, 2018; Dimaculangan, 2023). Although only 26.3% of precast construction companies have fully implemented JIT, rising awareness suggests broader adoption in the near future (Anandh et al., 2020).

As expected in many industries today, sustainable development involves meeting current needs without compromising future generations' ability to meet theirs, balancing human activities and environmental preservation (United Nations, 1987; Liu et al., 2023). The concrete industry supports Sustainable Development Goal 12 by promoting sustainable consumption and production (SCP), reducing waste, and enhancing resource efficiency (Luthra et al., 2017; Oslo Symposium, 1994). The construction industry faces significant challenges, such as the declining availability of limestone, which threatens the cement sector; however, the durability of concrete blocks remains a vital factor in reducing the need for frequent reconstruction (Naik et al., 2003; Global Cement and Concrete Association, 2021).

Statement of the Problem

This study, conducted during the first semester of the 2024-2025 academic year, focused on measuring the adoption of Just-In-Time (JIT) approaches by concrete block manufacturers in promoting responsible consumption and production.

Specifically, the study sought to answer the following research questions:

1. What is the respondents' level of adoption of the Just-In-Time approach?
2. What are the practices employed by concrete block manufacturers along the following stages?
   2.1 Determination of Customer Demand
   2.2 Acquisition of Materials
   2.3 Storing of Raw Materials
   2.4 Batching and Mixing
   2.5 Molding
   2.6 Curing
   2.7 Packaging and Storage
   2.8 Distribution
3. What are the challenges faced by concrete block manufacturers in the adoption of Just-In-Time
   along the following?
   3.1 Determination of Customer Demand
   3.2 Acquisition of Materials
   3.3 Storing of Raw Materials
   3.4 Batching and Mixing
   3.5 Molding
   3.6 Curing
   3.7 Packaging and Storage
   3.8 Distribution
4. What recommendations may be forwarded to address the challenges in the adoption of Just-In-Time towards responsible consumption and production?

METHODOLOGY

The researchers employed a descriptive design, utilizing both quantitative and qualitative approaches to gather information about the adoption of Just-In-Time (JIT) practices by concrete block manufacturers towards responsible consumption and production. The quantitative approach was used to measure the respondents' level of JIT adoption. Meanwhile, the qualitative approach, through thematic analysis and documentary analysis, was applied to explore the various practices employed by manufacturers at each production stage and the challenges they faced. The study was conducted among concrete block manufacturers in the province of Nueva Vizcaya, specifically in the two municipalities of Solano and Bayombong. The respondents consisted of owners and employees of concrete block manufacturing establishments in these areas. A total of 10 respondents participated in the study, comprising 6 from Bayombong and 4 from Solano. All respondents were either owners or employees directly involved in production within DTI-registered manufacturing establishments that have been operational for at least five years, ensuring their experience and active participation in strategic and operational decision-making. For data collection, the researchers used a structured questionnaire and an interview guide. The questionnaire, adapted from Sharadchandra (2019) "Lean Manufacturing through Management of Manufacturing Flexibility in the Auto Component Industry," employed a four-point Likert scale to assess the level of JIT adoption across eleven statements. The interview guide focused on specific manufacturing stages, including determination of customer demand, acquisition and storing of raw materials, storing, batching and mixing, molding, curing, packaging and storage, distribution; and identifying challenges in JIT adoption. Data was analyzed using means and standard deviations, while thematic and documentary analyses were employed to examine responses from the interview guide regarding the practices and challenges faced by concrete block manufacturers.

RESULTS AND DISCUSSION

Section 1. Respondents' Level of Adoption of Just-In-Time

Table 2

Level of Adoption of Just-In-Time

Indicators	Mean	SD	Qualitative Description
1. The organization does not produce many products which have to be reworked or repaired.	2.90	.99	Adopted to a moderate extent
2. The percentage scrap rate is very low.	3.40	.84	Adopted to a moderate extent
3. The layout and location of the plant is such that excessive movement for picking up or stacking parts is not carved out.	2.70	.82	Adopted to a moderate extent
4. The company generally makes as many products as are ordered by the customers. Excessive numbers of products are not made and kept in warehouses.	2.20	1.14	Adopted to a little extent
5. Production is carried out just before the time that the products are to be supplied to the customers. It is not carried out much in advance.	2.30	1.06	Adopted to a little extent
6. Extent of wasted effort to transport raw material is very low.	3.20	.92	Adopted to a moderate extent

7. Extent of wasted effort to transport WIP between processes is very low.	3.30	2.67	Adopted to a moderate extent
8. Extent of wasted effort to transport finished goods into or out of storage is very low.	3.20	.92	Adopted to a moderate extent
9. Raw material inventory levels are maintained.	2.50	.85	Adopted to a moderate extent
10. WIP inventory is maintained.	2.30	.82	Adopted to a little extent
11. Waiting time for other resources is low and machines do not remain excessively idle on account of this.	3.40	.84	Adopted to a moderate extent
Overall Rating	2.85	.90	Adopted to a moderate extent

Adoption Scale: 1.00 – 1.49: Not Adopted; 1.50 – 2.49: Adopted to a little extent; 2.50 - 3.49: Adopted to a moderate extent; 3.50 - 4.00: Adopted to a great extent

The study reveals that concrete block manufacturers have made significant progress in adopting Just-In-Time (JIT) practices, with an overall rating of 2.85, indicating a moderate extent of adoption. However, areas like aligning production with customer orders and minimizing waste require further improvement. While human factors such as training and motivation are crucial, engineering aspects like layout optimization and setup reduction are equally important. Consistent with the findings of Anandh et al. (2020) and Hokoma and Amaigl (2019), the industry's JIT adoption is still in its initial stages, hindered by factors like knowledge gaps and management support. To fully realize the benefits of JIT, manufacturers must prioritize continuous improvement, invest in employee training, and address challenges in inventory management and production planning. By doing so, they can enhance efficiency, reduce costs, and strengthen their market position.

Section 2. Practices Employed by Concrete Block Manufacturers

2.1 Determination of Customer Demand

***Stock-First Strategy*.** The majority of concrete block manufacturers in this study employ a stock-first strategy, prioritizing stock availability to ensure timely production and meet immediate demand. This approach aligns with the findings of Malik and Sharma (2022), who noted the prevalence of advanced production techniques to maintain a steady supply of materials. While this strategy can help manage demand fluctuations and reduce lead times, it may lead to overproduction, excess inventory, and increased costs if demand forecasts are inaccurate.

Frequent Minimal Orders. The study reveals that 6 out of 10 concrete block manufacturers commonly experience frequent, small-order quantities, with many willing to accept orders as small as 50 blocks. This aligns with Walleigh's (1986) observation that small-scale businesses can benefit from JIT principles by reducing setup times, producing smaller batches, and manufacturing only when necessary. Kootanae et al. (2013) further emphasize the advantages of smaller order quantities in identifying and addressing quality issues promptly. By embracing JIT, these manufacturers can enhance responsiveness, meet fluctuating demand, and optimize resource utilization, leading to improved efficiency, reduced costs, and a competitive edge in the industry.

On-Demand Labor Utilization. The study reveals that 6 out of 10 concrete block manufacturers frequently employ a flexible labor strategy, hiring workers on an as-needed basis to adapt to fluctuating demand. This practice aligns with the core principles of Just-In-Time (JIT) production, as highlighted by Hokoma and Amaigl (2019). By utilizing labor resources precisely when needed, manufacturers can reduce waste, optimize production, and manage labor costs

effectively. However, careful planning and integration of temporary workers are essential to maintain efficiency and quality standards.

2.2 Acquisition of Materials

Strong Supplier Relationship. Eight out of 10 concrete block manufacturers prioritize strong supplier relationships to ensure timely material deliveries, reduce costs, and enhance production efficiency. As highlighted by Enz and Lambert (2012) and Olusanya (2018), collaborative relationships built on trust and effective communication are crucial for mitigating supply chain disruptions, improving quality, and optimizing supply chain performance. By fostering these relationships, manufacturers can adopt Just-In-Time (JIT) principles more effectively, minimizing inventory, reducing waste, and ensuring timely production. This approach enables manufacturers to adapt to changing market conditions and customer demand, leading to improved overall business performance.

Raw Material Quality Consistency. Four out of 10 concrete block manufacturers prioritize maintaining consistent material quality to ensure the quality of their finished products. As highlighted by Ariani (2018) and Kibbey (2021), the quality of raw materials is crucial and must be rigorously assessed before production. By using high-quality materials that meet predefined specifications, manufacturers can reduce defects, delays, and rework, which are particularly important in a JIT production environment. This approach ensures smooth production, minimizes waste, and optimizes resource utilization.

Scheduled Material Acquisition. Seven out of 10 concrete block manufacturers prioritize scheduled material acquisition to optimize inventory management and ensure production efficiency. By aligning material purchases with actual production needs and customer demand, manufacturers can prevent overstocking, reduce waste, and manage cash flow effectively. As highlighted by Ebole (2005), scheduling material acquisition is crucial for maintaining project timelines and avoiding complications associated with excessive inventory. This approach supports demand-driven scheduling, allowing manufacturers to optimize resource use, minimize downtime, and maintain a cost-effective operation.

2.3 Storing of Raw Materials

***Responsive Production Based on Material Availability*.** Six out of 10 concrete block manufacturers typically initiate production when raw materials become available, often with delays of one to two days. This reactive approach aligns with traditional production systems, as described by Singh and Ahuja (2014), where production occurs based on material availability rather than downstream demand. While JIT seeks to synchronize production with demand and minimize inventory, the observed practice challenges this ideal. Material delivery delays disrupt the smooth flow of production, hindering the full realization of JIT benefits.

Strategic Placement of Storage Facilities. Eight out of 10 concrete block manufacturers strategically locate their storage spaces close to key production areas to optimize inventory management and ensure efficient production processes. This aligns with the findings of Reyes et al. (2019) and Shih et al. (2008), who emphasized the importance of well-organized storage layouts for efficient warehouse management and precast concrete operations. By placing storage facilities at key points along the supply chain, manufacturers can reduce inventory holding costs, minimize waste, and ensure timely availability of materials, which are core principles of Just-In-Time production. This approach promotes a smooth production flow and enhances overall operational efficiency.

2.4 Batching and Mixing

Production Flexibility. Six out of 10 concrete block manufacturers primarily base their production levels on customer orders, machine capacity, and labor capacity. This aligns with the findings of Zhang et al. (2003), who emphasized flexibility as a key organizational attribute for effective resource management and adaptability to uncertainty. Anandh et al. (2020) further

highlighted the significant influence of production flexibility on the successful implementation of JIT technology in prefabrication construction. By aligning production with actual customer demand, JIT minimizes waste, optimizes resource utilization, and promotes sustainability. Real-time adjustments in production levels are essential for balancing resources and lowering operational costs, ultimately enhancing overall manufacturing efficiency.

***Quality Control and Standardization*.** Four out of 10 concrete block manufacturers in this study typically mix one sack of cement with 7-10 sacks of sand, producing an average of 45 blocks per cement bag. These findings align with Winarno (2019), who reported a common 1:7-9 cement-sand ratio for conventional concrete blocks. Darwish et al. (2021) emphasized the importance of standardization in implementing JIT, as it facilitates the availability and interchangeability of tools and parts, streamlining processes. By adhering to standardized material mixing ratios, manufacturers can minimize product variations, leading to more predictable and uniform output. This is crucial for effective JIT production, as it enables real-time adjustments to production levels to meet customer demand without overproduction, thereby reducing waste and optimizing resource utilization.

2.5 Molding

***Operational Efficiency*.** Seven out of 10 concrete block manufacturers in this study typically complete the batching and mixing stage within 5-15 minutes, aided by the use of mixers. The molding stage is even quicker, taking less than 5 minutes per block. This efficiency aligns with the findings of Smith and Brown (2023), who highlighted the significant role of automation in enhancing JIT manufacturing efficiency. By streamlining material handling, improving inventory accuracy, and enabling real-time data management, automation contributes to reduced errors, better production schedule alignment, and overall improved manufacturing performance. The rapid completion of production tasks positions these manufacturers to implement JIT principles effectively, minimizing lead times, reducing overproduction risks, and enabling easier adjustments to production volumes in response to customer demand. This high level of operational efficiency also supports reduced inventory levels, lower storage costs, and optimized resource utilization.

Automation Breakthroughs and Advanced Innovation. All concrete block manufacturers in this study utilize automated machines, including mixers and molders. This aligns with Uyar (2024), who highlighted the significant impact of automation on JIT manufacturing processes. Automation optimizes material handling, inventory tracking, and data management, leading to reduced errors, improved production schedule adherence, and increased operational efficiency. The use of specialized machinery and automatic molders enhances production capacity, efficiency, and flexibility, while backup equipment-based techniques minimize downtime and ensure continuous operation. Overall, technological advancements contribute to more precise, efficient, and effective manufacturing processes.

Maximizing Efficiency Through Frequent Machinery Use. Five out of 10 manufacturers report that operating their machines for molding six days a week is crucial for optimizing production efficiency. This approach prioritizes steady output with minimal downtime, minimizing waste and keeping machines in good condition. It aligns with the findings of Huthaifa et al. (2019) which demonstrated how Dler Company achieved a significant increase in Overall Equipment Effectiveness (OEE) through continuous use of highly automated machines. This frequent use optimizes energy utilization and reduces waste, both crucial factors for Just-In-Time (JIT) production. By operating machinery consistently, manufacturers can maintain steady output aligned with actual demand, minimizing idle time and operational costs.

2.6 Curing

Quality Monitoring and Assurance. This theme emphasizes continuous observation and quality assurance to ensure concrete blocks meet or exceed standards during the curing process. All 10 manufacturers reported practicing quality monitoring. These practices align with Wu and Hu (1993), which advocate for integrating quality assurance into production to prevent defects rather than relying on post-production checks. In line with the Just-In-Time (JIT) approach, consistent quality monitoring minimizes waste, ensures efficiency, and upholds product standards, supporting sustainable and lean manufacturing practices.

Optimal Curing Process. This theme examines curing methods that ensure concrete blocks achieve optimal strength and durability. Seven out of 10 manufacturers reported that curing takes 5 days or less to develop the required compressive strength for structural use. These practices align with Hage (2024), which highlights the importance of proper curing to prevent cracking and defects, ensuring long-term performance. Incorporating effective curing into production schedules supports Just-In-Time (JIT) principles by minimizing waste, optimizing resources, and integrating sustainable practices to enhance efficiency and reduce environmental impact.

2.7 Packaging and Storage

Non-Packaged and Open- Air Storage for Convenience. This study reveals that concrete block manufacturers do not practice packaging, relying instead on open-air storage for convenience. Nine out of 10 manufacturers stated they sell and deliver blocks without packaging. This approach minimizes construction waste, as noted by Merino et al. (2017), who highlighted the environmental benefits of reducing packaging. While this practice supports sustainability and operational efficiency, it poses risks such as weather exposure and physical damage, which can compromise product quality. Manufacturers must balance cost-efficiency with proper handling to ensure the durability and marketability of their blocks.

2.8 Distribution

Use of Logistics for Transportation and Delivery. Concrete block manufacturers rely on trucks for transportation and delivery, with 9 out of 10 owning their own trucks to ensure flexibility and timely service. This ownership improves customer satisfaction and operational efficiency by enabling better control over logistics, timely deliveries, and reduced costs. Studies by Chopra and Peter (2007) and Geunes and Taaffe (2008) underscore the importance of efficient transportation networks and delivery consolidation in optimizing vehicle movements and load efficiency. By managing their fleet, manufacturers enhance logistics, align with Just-In-Time (JIT) principles, and maintain high service quality while minimizing costs.

Customer Geographic Reach: Nearby. Concrete block manufacturers primarily operate to serve local customers, emphasizing convenience and accessibility for nearby communities. Six out of 10 manufacturers stated that they typically deliver products within and near their vicinity. This practice aligns with the study of Hasanbeigi et al. (2012), which emphasizes that concrete manufacturers prefer nearby deliveries due to logistical, economic, and environmental considerations. Localized deliveries reduce fuel consumption, costs, and emissions while preserving concrete's time-sensitive quality, ensuring structural integrity and operational efficiency. By adhering to Just-In-Time (JIT) principles, the industry minimizes waste, reduces transportation time, and avoids excess inventory, supporting lean, energy-efficient, and environmentally responsible processes that promote timely and reliable supply to meet construction needs.

Section 3. Challenges Faced by Concrete Block Manufacturers in the Adoption of Just-In-Time

***Bulk Order Pressure*.** Concrete block manufacturers face challenges in fulfilling large orders due to issues with production capacity, inventory management, and operational

efficiency. As noted by Bayraktar et al. (2007), while Just-In-Time (JIT) manufacturing is effective in reducing waste and improving efficiency, it struggles under the pressure of bulk orders. JIT's reliance on small-scale, timely production rather than large stockpiles makes it reactive, leading to operational difficulties. The need for maintaining stock, instead of waiting for orders to arrive, aligns with the manufacturers' concerns about the limitations of JIT in handling bulk or urgent orders.

***Timing Problems with Supplies*.** Concrete block manufacturers also often encounter challenges related to delays or issues with material deliveries, which disrupt production schedules. These delays can result in stock shortages, production delays, or inefficiencies within Just-In-Time (JIT) systems, as materials are not available when needed for smooth production. Parilla (2020) highlights similar challenges, emphasizing how timing problems with material supplies can significantly disrupt production schedules.

Exposure to Environmental Factors. Concrete block manufacturers face challenges related to the detrimental effects of environmental exposure on raw materials, particularly when stored in open spaces. Cement and sand, essential components in hollow block production, are highly sensitive to moisture. If not properly stored, cement can absorb moisture, leading to clumping or premature hardening, which weakens its binding properties. Scherer (2015) emphasizes this sensitivity, noting that raw materials exposed to drying environments lose water, resulting in drying shrinkage, micro-cracking, and a subsequent decline in mechanical properties and durability.

***Prolonged Mixing Process*.** Concrete block manufacturers often encounter challenges when materials or ingredients are not blended thoroughly, leading to an uneven distribution of components. This issue typically arises due to excessive mixing duration, improper equipment, or incorrect mixing techniques, all of which can negatively affect the quality, performance, and safety of the final product. As highlighted by Xuan et al. (2018), it is essential that the ingredients are mixed uniformly until a homogeneous mixture is achieved. By doing so, they can overcome the challenges of uneven blending and ensure a consistent, high-quality concrete block product.

Manual Production. The majority of concrete block manufacturers rely heavily on manual production methods for the extraction and shaping of materials, specifically through the use of molder. According to Reichenbach and Kromoser (2021), the construction industry's reliance on manual processes poses challenges in efficiency, productivity, and sustainability. Manual methods often lead to material wastage due to imprecise measurements, slower operations, and inconsistent quality.

Curing Obstacles. In concrete block manufacturing, the curing process plays a critical role in ensuring the strength and quality of the final product. However, difficulties arise when the Just-In-Time (JIT) inventory approach is applied to the curing process, leading to significant issues that impact both quality and efficiency. According to Yang et al. (2024), curing is essential for concrete products, including concrete blocks, as it allows the material to gain the necessary strength. However, improper curing practices, such as failing to keep the concrete moist enough or using incorrect methods, can lead to shrinkage, cracking, and a weakened product over time. The main issue with JIT production is that it does not allow sufficient time for the curing process to be completed properly, as JIT aims to produce items only when there is an order. As a result, this approach can compromise the quality of the concrete blocks and hinder overall production efficiency.

Handling Excess Production. One challenge that concrete block manufacturers encounter is managing goods that are produced beyond immediate demand and are not delivered to customers. These surplus products can lead to operational and financial difficulties, such as increased storage costs and logistical inefficiencies. According to Pal et al. (2022), overproduction often results in excessive waste and can trigger other forms of inefficiencies within Lean systems, including waiting, inventory buildup, extra processing, and defects.

Expensive Logistics. Concrete block manufacturers face significant challenges related to the high costs of transporting goods through the supply chain. These costs are often driven by factors such as inefficient delivery routes and rising fuel prices. According to Patlins (2024), transportation inefficiencies contribute to particularly high delivery costs. The study highlights that transporting small amounts of cargo is more expensive than transporting full loads, due to factors like costly small cargo transport and uncertain lead times.

Section 4. Basis for Recommendations to Address the Challenges in the Adoption of Just-In-Time Towards SDG on Responsible Consumption and Production

Collaborate with Suppliers. Collaborating with suppliers or outsourcing allows manufacturers to share resources more efficiently, coordinate delivery schedules more effectively, and ensure that materials such as cement, sand, and aggregates are delivered exactly when needed. By working closely with suppliers, manufacturers can minimize waste and resource use, reduce lead times, and avoid the costs associated with holding excess inventory. This aligns with SDG 12, focusing more on responsible consumption and reduced waste generation.

Use Covered Storage Structures. Covered storage structures help shield materials such as cement, sand, and aggregates from moisture, which can compromise the quality and increase waste, especially if materials become contaminated or degraded. By protecting raw materials from environmental exposure, manufacturers can maintain consistent quality and minimize the risk of spoilage or wastage. This aligns with SDG 12, which emphasizes reducing waste and ensuring responsible production practices by using resources more efficiently.

Automated Mixing Systems. Automated mixing systems significantly reduce the time required for mixing raw materials, such as cement, sand, aggregates, and water, into a uniform mixture for concrete block production. These systems are designed to operate continuously, making the mixing process faster and more efficient compared to manual or semi-automated methods. Faster mixing directly impacts the JIT system by ensuring that materials are ready for immediate use, thus reducing delays and avoiding the need to stockpile excess inventory. This contributes to the SDG 12 goal of promoting efficient production processes and reducing unnecessary waste from overproduction.

Invest in Automation of the Molding Process. Automated systems ensure consistent product quality, lower the chances of human error, and speed up production, in line with Just-In-Time (JIT) principles by producing blocks only when needed. Automation also helps avoid overproduction, cutting down on energy and material waste. This promotes responsible consumption by ensuring that only the necessary amount of concrete is produced, preventing excess and unnecessary waste.

Use Curing Admixtures. Use curing admixtures that speed up the curing process or help retain moisture for longer, especially in areas with fluctuating temperatures. This gives better control over curing, ensuring concrete blocks reach the required strength and durability more quickly, supporting JIT production. Curing admixtures reduce the need for long curing times and excessive energy use, helping to optimize the process and minimize resource waste. They contribute to sustainability by improving material efficiency and accelerating production cycles.

Local Partnership for Excess Inventory. Build partnerships with local businesses, contractors, or distributors to quickly move excess inventory. This could involve collaborating with other small manufacturers who need immediate blocks for their projects or negotiating with nearby construction firms to take surplus stock. Selling excess blocks locally helps small manufacturers reduce the need for long-term storage. It also supports sustainable production by minimizing carbon footprints and encouraging local, circular economies.

Increase Customer Pick-up option. Offer more options for local customers to pick up their concrete blocks directly from the manufacturer. This can help lower delivery costs and free

up storage space, especially for smaller orders. Allowing customer pickups cuts down on delivery expenses and emissions since fewer shipments are required.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

1. Concrete block manufacturers adopt Just-In-time production to a moderate extent.
2. Manufacturers focus on material quality, scheduled acquisition, flexible production, and quality control. They employ automation for efficiency and prioritized curing and storage practices. Distribution strategies involve owned logistics and geographic proximity to customers.
3. Bulk order pressures, supply chain issues, environmental factors, manual production methods, curing limitations, excess production, and high logistics costs hinder JIT adoption.
4. To overcome these challenges and enhance sustainability, manufacturers should collaborate with suppliers, utilize covered storage, automate processes, implement curing admixtures, establish local partnerships, and increase customer pick-up options.

Recommendations

For the Concrete Block Manufacturers. They may adopt JIT practices and implement recommendations like using curing admixtures, collaborating with suppliers, automating processes, establishing local partnerships, and increasing customer pick-up options.

For the Government. They can provide financial incentives for environmental practices, invest in infrastructure, and fund training programs on JIT practices.

For the School of Accountancy and Business. The school can integrate study findings into courses like Cost Accounting, Operations Management, and Total Quality Management, and continue supporting research initiatives. Moreover, the school's continued support for research initiatives like this will strengthen its role in addressing local business challenges while fostering academic excellence and community engagement.

For Future Researchers. Given that the study focused only on two prominent municipalities in Nueva Vizcaya, future researchers are encouraged to expand their scope to include a broader range of locations. Additionally, they should delve deeper into the identified challenges of JIT adoption to develop possible solutions that can help manufacturers fully implement JIT practices. Moreover, it is suggested that future researchers conduct observations of the actual process of producing concrete blocks, in addition to interviews, to obtain a deeper understanding of the procedures. This study can be used for exploring similar topics and addressing related issues in other contexts.

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