

UNIVERSITY OF WISCONSIN, PLATTEVILLE

UNITED STATES OF AMERICA



The attached educational project, by Mason McCauley, entitled Just-In-Time Inventory: Does it fit into all Supply Chains?, when completed, is to be submitted to the Graduate Faculty of the University of Wisconsin- Platteville in partial fulfillment of the requirements for the (MASTER OF SCIENCE IN INTEGRATED SUPPLY CHAIN MANAGEMENT) degree.

Approved: Mary Bartling Date: 5/11/20
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Suggested content descriptor keywords:

Just-In-Time Inventory and the impact it has
made on the Supply Chain and is continuing
to make Pros and Cons How it has bigger
impacts in certain industries versus others Is
it sustainable and will it become a
requirement of doing business

A Paper

Submitted to the Graduate Faculty of

the

University of Wisconsin, Platteville By

Mason McCauley

in Partial Fulfillment for the Degree of

MASTER OF SCIENCE IN INTEGRATED SUPPLY CHAIN MANAGEMENT

Year of Graduation: Spring 2020

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Seminar Research Paper Proposal
University of Wisconsin-Platteville
12/19/19

The impact of Just-In-Time Inventory (JIT) on the supply chain and how it differs from industry to industry what that impact is.

The topic of this paper will cover the supply chain concept of Just-In-Time Inventory and the impacts it has on the supply chain, and how the type of industry also falls into the impact of JIT.

I. Introduction and Statement of the Problem

Just-in-time inventory an inventory strategy that manufacturers use to increase efficiency. The process involves ordering and receiving inventory for production and customer sales only as it is needed to produce goods, and not before. JIT is also known as lean manufacturing or TPS (Toyota Production System). It is a supply chain concept that has become more and more popular in recent years as more organizations are looking to their supply chains to reduce/cut costs. While JIT is a benefit to the organization implementing it, it may not be as beneficial to the other members within the supply chain. The impact of JIT also varies based on the type of industry in and what products are being manufactured. The purpose of this research paper is to analyze if JIT is beneficial to all organizations or is there only certain industries that this supply chain concept belongs. The one industry this paper will focus on is the Food/Dairy industry as JIT fits perfectly in some cases, but other times it has a negative impact. Besides the Food/Dairy industry other industries such as the automotive industry (where JIT was created) will be analyzed as well.

II. Purpose of the Study

The primary purpose of this study is to analyze the use of JIT and its benefits, and downfalls based on the industry. Also analyzing how the benefits to one organization could have a negative impact of other members who are a part of that same supply chain. Another purpose of this study is to breakdown by industry and analyze why JIT is more effective and beneficial in some areas and not others. While also analyzing what the future will look like and if JIT will be a concept that continues to grow, or will it start to diminish.

IV. Methodology

The methodology behind this study will be looking at cases of businesses that have implemented and operated JIT systems. While also studying those businesses that don't operate on JIT but have suppliers and/or customers that operate on one. The primary research will be on case studies of businesses who have implemented JIT operations and businesses that don't utilize JIT but have customers or suppliers that do. The secondary research will be on the methodology and concepts behind using a JIT system and why it is beneficial or not to a business.

V. Research Contributions

The research will contribute to organizations that are looking to switch to a JIT operation, while also benefit organizations trying to manage customers or suppliers that operate with JIT. It will also contribute to those organizations who are already operating with a JIT system and could look to improve or change how they operate based on how they are impacting their entire supply chain.

VI. Outcome Anticipated

Anticipated outcome is to determine the benefits of JIT but understand the full effect throughout the supply chain and how operating at JIT in one link of the chain may not be beneficial for other links

Just-In-Time Inventory: Does it fit into all Supply Chains?

A Seminar Paper
Presented to
The Graduate Faculty
University of Wisconsin-Platteville

In Partial Fulfillment
Of the Requirement for the Degree
Master of Science in Integrated Supply Chain Management
Integrated Supply Chain Management-Logistics and Warehousing

By
Mason McCauley
Year of Graduation – Spring 2020

Abstract

The impact of Just-In-Time Inventory (JIT) on the supply chain and how it differs from industry to industry what that impact is.

The topic of this paper will cover the supply chain concept of Just-In-Time Inventory and the impacts it has on the supply chain, and how the type of industry also falls into the impact of JIT. While the JIT concept works well for one business it could cause a negative impact for another business within the supply chain. Having a collaborative supply chain network is one way to ensure the whole supply chain benefits. As businesses have looked to their supply chains to cut and reduce costs, concepts like JIT are being utilized more often in an effort to reduce inventory costs and make the supply chain more efficient. A concept that originated in the auto industry and worked to perfection began to spread to other industries. Fast forward to forty years later and the JIT concept is being used in a wide variety of industries.

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I. Introduction

Just-in-time inventory is an inventory strategy that manufacturers use to increase efficiency. The process involves ordering and receiving inventory for production and customer sales only as it is needed to produce goods, and not before. JIT is also known as lean manufacturing or TPS (Toyota Production System). It is a supply chain concept that has become more and more popular in recent years as more organizations are looking to their supply chains to reduce/cut costs. While JIT is a benefit to the organization implementing it, it may not be as beneficial to the other members within the supply chain. The impact of JIT also varies based on the type of industry and what products are being manufactured. The purpose of this research paper is to analyze if JIT is beneficial to all organizations or are there only specific industries where this supply chain concept belongs. The one industry this paper will focus on is the Food/Dairy industry as JIT fits perfectly in some cases, but other times it has a negative impact. Besides the Food/Dairy industry, other industries such as the automotive industry (where JIT was developed) that will be analyzed.

Statement of problem-Just-in-time inventory is a widely accepted supply chain strategy by many businesses, and the assumption is that it is beneficial for all parts of the supply chain. The issue lies for the businesses that are supply-driven and have a constant supply to manage. In those cases, JIT is more detrimental than it is beneficial.

Purpose of the study-The purpose of this study is to identify where the JIT strategy has successfully been used and identify where the JIT strategy does not work. Also, to understand how differing supply chain strategies can be adjusted to produce the best overall outcome of the end to end supply chain.

Significance of the Study- In recent years, businesses have looked to their supply chain to reduce overall costs. It is essential to understand how a strategy like JIT will not only affect the internal business, but how it will impact the other businesses within the supply chain.

Assumptions-Just-in-time Inventory is a supply chain strategy that reduces inventory and costs for a business, and it should work in all areas of business.

Methodology-The methodology behind this research paper is a personal experience with the negative impacts of a JIT strategy when it is forced upon members of the supply chain instead of working cohesively to implement multiple supply chain strategies that are functional end to end in the supply chain.

In the food/dairy industry, the JIT concept works great in many cases, but when taking a step back, JIT can have a negative impact as well. When dealing with perishable products, it is ideal to only have the products on hand when needed, and then shelf life can be maximized at the store level. The problem JIT creates in the food industry, especially the dairy industry, the raw materials that go into these perishable products are also perishable and have a limited window in when they must be produced into a finished product. Currently, many buyers of dairy products are putting that management piece back onto the supplier of raw materials to balance their needs and allow them to execute on their JIT goals. As one business is benefiting, another is suffering in order to accommodate their customer. Throughout this paper, there will be further analysis into this industry and take a look at each supply chain and how JIT may work at one place in the supply chain but understanding the impact that it is causing throughout the supply chain.

The automotive industry is one industry where the JIT method has thrived, as it should since this is the industry that came up with the concept. Many of the supply chain concepts of Lean, Six Sigma, and JIT all came from the auto industry (Toyota). In a sense, they found a way

to perfect the supply chain for their industry, and then found a way to apply it to other industries. These tools have been beneficial to many businesses as the supply chain is where many companies look to cut costs and improve processes to increase revenue.

Lastly, throughout this paper, further analyzing specific business cases where JIT did not exist, and it was implemented, and it was a success or failure, also looking at businesses that do not operate on JIT but supply to customers that are on a JIT system.

Literature Review

JIT is a concept that has been implemented by many different businesses over the years. Many have been successful, and others it has not been as successful. In some cases, the implementation at one business has been successful, but has had adverse effects on other parts of the supply chain. The JIT concept has even moved beyond the manufacturing world, and people in the medical field have started to utilize this concept for patient management and to keep their processes following.

In the article “Economical delivery strategies of products in a JIT system under a global supply chain” by Victor Kreng and I.C. Wang, they analyze the utilization of JIT in a global supply chain setting. The first case they examine dealt with a tech hardware company producing these products throughout China that then shipped the products frequently all over the world via air freight. Since the overall weight of the product they were manufacturing was light and would not be constrained to certain types of air freight, they were able to operate in a JIT model for their customers by shipping products every day. In the second case, the products were delivered to a distribution center. They also scheduled periodic shipments of the exact volume that the manufacturer would need to meet. Since this product is much more substantial and needed to move via container shipment, the lead times and transit times are much higher, but

being the product is delivering to a distribution center versus direct to the customer allows some flexibility. "The goal to reduce cost in the JIT system under a global supply chain can be attained by setting up an economical product delivery strategy according to whether the significance of an economic lot size." (Kreng & Wang) As reviewed in the article, the success of the whole supply chain is dependent on the details. In the first case, when a light product was being shipped, it was cost-effective for the manufacturer to ship every day via air and still control their costs. In the second case, a much larger product was being moved, but the customer had specific order sizes and times of delivery that fit having a longer transit and lead time for the product to deliver. When talking about a global supply chain, there will always be added challenges because of the increased transit times and the lead times involved with it, because not every product can be effectively moved via air shipment, for many suppliers/customers air freight is a last resort and only utilized when freight needs to be expedited. When building a JIT model for a global supply chain, it will look much different than the model for a domestic supply chain.

In the article "Just-in-Time Retail Distribution: A Systems Perspective on Cross-Docking" by Paul Buijs and others discusses the concept of JIT in a distribution model and the utilization of Cross Docking. "Cross-docking is a just-in-time strategy for distribution logistics. It is aimed at reducing inventory levels and distribution lead times by creating a seamless flow of products from suppliers to customers." (Buijs) Cross-docking not only used in JIT methodology but is a common practice in many supply chains. One industry that leverages cross-docking is the food industry when moving perishable products. In this study, the researchers were assessing a grocery retailer and the fresh produce that they were moving. One great example of the utilization is a grocery chain that is getting in a truckload of bananas; now, one store does not need an entire load of bananas. In this scenario, a centralized location can be utilized for cross-

docking and that one load of bananas can be broken down into five different shipments, each going to a different location. Furthermore, the bananas can be loaded on the same load with the maximum number of products being moved from the centralized location to the destination. In the case of this grocery chain, they were working with many suppliers that deliver to two national distribution centers, and then the shipments are sent to 4 regional distribution centers where they can be consolidated and cross-docked to be then shipped to their final destination. In a cross-docking scenario, the layout of the facility is crucial to ensure correct product flow and avoid any potential traffic bottlenecks.

In the article “Analysis of the bullwhip effect in multi-product, multi-stage supply chain systems” by P. Wangphanich and others discusses the bullwhip effect and the way that a JIT model can have an impact on creating the bullwhip through the supply chain. "A supply chain encompasses all activities associated with the flow and transformation of goods and services from the raw materials stage to the end-user. It is made up of many interrelated parties, starting with raw material suppliers, parts and components suppliers, subassembly suppliers, manufacturers, distributors, and ending with the end-users." (Wangphanich) With many different entities involved in the supply chain, if a JIT model is to be followed, all parties need to be operating on the same model. Alternatively, have an understanding with their links of the supply chain how they need to manage their customer or supplier operating within a JIT model. Managing the uncertainty and variability is one of the most challenging pieces as no one throughout the supply chain wants to bear the costs of additional inventory for the 'what if' scenarios. The bullwhip effect can have many negative impacts on the supply chain and force unforeseen costs onto suppliers, that any savings achieved by implementing JIT can be thrown

out the window by one event. The bullwhip effect still occurs in supply chains that do not operate with a JIT model, but they have more flexibility to deal with variability because they carry a certain amount of inventory that would allow them to react better to unforeseen events. (Wangphanich)

Discussion

Just-in-Time inventory management is not a sound technique that is a "one size fits all" it is a philosophy that organizations can utilize and apply it to their business correctly. The original meaning of JIT was the production of goods to meet customer demand precisely in time, quality, and quantity. In this scenario, whether it was going to the end customer or another processor, it applied to all parts of the supply chain. The meaning of JIT has now shifted towards eliminating waste, whether the waste is excess inventory or wasted time/resources producing excess inventory. The concept of JIT began back in the 1970s when Toyota started to implement the different activities to cut down on waste, become more efficient, and still maintain a high level of quality. Early on, Toyota realized that the only way this new philosophy would be successful is if everyone in the organization bought in and adhered to the set of standards. Toyota was able to adopt the philosophy of JIT successfully and perfected it, that it is used across the world today in a wide variety of industries. "Just-in-time has evolved from a specific practice to be implemented on the factory floor to a philosophy of management that is aimed at the elimination of waste and continuous improvement." (Vokurka) "These quality and just-in-time initiatives improve cycle times and begin to solve the trade-offs between efficiency and flexibility. Firms strive to focus on producing in quantities as low as one and expanding their improvement initiatives beyond their firm to the entire supply chain." (Vokurka)

While JIT is a philosophy/strategy that businesses can strive for, there are many different elements of JIT that can be implemented or practiced operating the business as a JIT operation. The two main elements of JIT are continuous improvement and the elimination of waste. Continuous improvement consists of; attacking fundamental problems, devising systems to identify problems, striving for simplicity, product orientated layout, quality control at the source, poka-yoke, and preventative maintenance. Eliminating waste has seven different considerations of waste: overproduction, waiting time, transportation, processing, inventory, motion, and product defects. (Cambridge) Every business is different, which means that not all these practices will apply to their business. Continuous improvement is something every business should be striving for because if the business is not continually evolving and improving, they will eventually no longer be competitive in their respective industry. The consumer today is always looking for the next best thing; this also applies to business to business relationships. The world of social media and the web have allowed more visibility to the world to see what is going on and what other businesses have to offer.

JIT applies to all the different aspects of the supply chain: manufacturing, purchasing, inventory management, sales, logistics, and delivery. While the philosophy may differ a little for each supply chain function, overall, it has the same end goal of continuous improvement and the elimination of waste. The two supply chain functions that it has the most significant impact on is manufacturing and inventory management (which inventory management ties into other functions of the supply chain). The manufacturing process can endure the most change, whether it be adding automation to the process, or simply just changing the layout to make processes more efficient. Inventory management can be difficult, depending on the relationships that exist between the customers and suppliers. If there is a collaborative relationship with both suppliers

and customers, and there is transparent visibility into the supply chain, it allows a business to manage their inventories and be more efficient as well work more closely together. If there are not well-established relationships in the business, then more inventory may have to be carried to allow them to be more reactive to demand changes. The new trend throughout the supply chain, is to provide more visibility to the whole supply chain to allow for more collaborative efforts and to make the supply chain more efficient and reduce costs at every link.

The advantages of implementing JIT methodology can have considerable benefits to the business by the efficiencies and effectiveness it can create. The JIT philosophy increases the need for communication within the organization, along with outside the organization; this creates more visibility into the process and allows for fewer errors. This will also lead to reduce purchasing costs because of the elimination of excess inventory that is likely to become obsolete and just thrown away. “JIT implementation helps to minimize the amount of work-in-process inventory, raw material, and the finished goods.” (Qureshi) While there are many different advantages to utilizing the JIT philosophy, there are some potential problems that could arise.

Implementing JIT can be a complicated process that will result in cost savings and efficiency for a business, but there are some potential setbacks throughout the implementation process. An example the Japanese faced when they first implemented this was placing the blame on their suppliers for inconsistent deliveries due to traffic problems. In the JIT methodology, if something is not on time, it can lead to many different problems. Something as simple as a supply shipment being a day late to the production facility can cause a significant chain reaction through the supply chain that likely will lead to missed production and missed customer order fulfillment. Individual experts believe that the JIT methodology removes the blame from the larger businesses and places the burden on the smaller organizations to adhere to their requests.

Lastly, businesses that operate on a JIT philosophy are much more vulnerable to natural disasters and unpredictable events that disrupt the supply chain. Even if the natural disaster does not impact their facility, but their supplier is, it will put a disruption into the supply chain that could lead to missed production.

One example of implementation identifies five business areas, which are major contributing factors to implementing JIT. These five areas are product design, total quality control, inventory, supply chain management, and production plan. Product design is crucial because it determines how complex the manufacturing process may have to be, if a design is intricate and requires many components it adds more difficulty to the process of achieving just in time execution. Total quality control is essential because part of the philosophy is zero defects, and to achieve that, quality needs to be heavily involved in the process. Also, when there is no excess inventory, any quality issues could lead to missed order fulfillment. Inventory is vast because the business is trying to eliminate excess inventory and make it as efficient as possible, but in some scenarios, inventory may be needed, so the design for inventory management would be specific to the business's needs. Supply chain management is vital because this implementation does not only impact the one business; it also impacts other members of the supply chain. To have a successful implementation, it is critical to involve the other members of the external supply chain and establish how the business may be changing. Lastly, the production plan is essential because it is the end to end process of how the product is going to be produced and how it is going to move through the supply chain.

The scenario where the JIT philosophy can be the most successful is in supply chain networks where there is consistency. Consistency and the JIT methodology fit very well together, and here is a prime example. Company C which is the end customer receives 100 units

every week (20 units per day M-F) from Company B. Company B receives the raw materials from Company A to manufacture the product they sell to Company C. Each day Company B receives the raw materials from Company A to manufacture just 20 units each day. After Company B completes the manufacturing, they ship the 20 units to Company C. In this example, there is no excess inventory, and inventory is being moved or manufactured upon receipt. Many businesses follow this simple example having purchase orders, order releases, and transportation set up on "auto," where an ERP system is continually running on set parameters executes the ordering and movement through the supply chain. Having a supply chain with this type of simplicity allows for the supply chain to be as efficient as possible, there will always be exceptions to the rule, but in most cases, the 80/20 rule can apply. When referencing 80/20, it means that 80% of the time, the plan is executed. The other 20% of the time, there are expectations of the norm. If businesses can perfect the 80% and mitigate the impact of the 20%, they will be able to operate cost-effectively.

A scenario where the JIT philosophy does not work well is in a supply-driven supply chain. If there is a constant supply of material, but demand varies, then obtaining the goals of the JIT philosophy becomes very difficult. While an actual JIT inventory management system might not be achievable, there are still parts of the methodology that can be utilized. The issue with a supply-driven supply chain is inventory needs to be generated that potentially does not have a demand and could be sitting in storage for an extended period. The alternatives to not producing excess inventory is selling the supply to another vendor (often at a discount) or pay the penalty to the supplier for not receiving the supply. No matter the outcome, there are unavoidable additional costs that will be incurred when dealing with a supply-driven supply chain. The best way to minimize the costs involved with that is to have a strategy in place to utilize the supply

when there is not a demand. An example would be having a make to stock item that can be manufactured at a low cost and is highly marketable to the open market. This item likely will not make any margin but will hopefully hit a break-even point so that the business is not losing any money.

To successfully implement a JIT strategy is a process and takes effort from multiple parts of the business to make it successful. When a business wants to implement a JIT strategy, it is crucial that they first understand their current supply chain. First, understanding what the demand requirements the business has and if that will cause any constraints, if so, is it something that can be negotiated with the customer. Next is understanding any constraints with the current suppliers. Sometimes there are preexisting agreements as far as order quantities and what is required of the supplier. Once there is an understanding of the current situation, a business can begin to implement the JIT strategy. When implementing this, the technological capabilities of the business can be a crucial factor. If the business has numerous manual processes as it relates to inventory, it can make the implementation much more challenging. If the business has more technology available that automates many, if not all, the processes involved with inventory, it can make the implementation much more smoother and leave less room for error.

It is not always a given that if the JIT strategy is implemented, that will work successfully. Sometimes it could just be a rough start as the business is adjusting to the new way of doing business, but in some cases, JIT is just not the answer for that business. An excellent example of JIT failure would be if the manufacture does not have enough raw material on hand in time to meet their customers demand because they did not order enough raw material, or their supplier did not deliver on time. Depending on the business, some build in more flexibility into their business model to be able to avoid a total shutdown if an inbound shipment is delayed or

the customer changes their order. While they might not be fully efficient, they can better respond to adversity.

One industry that JIT seems like a perfect fit is the food industry, which in some cases it works great, and others it has a negative impact. When dealing with perishable products, the shelf life is typically concise, and the execution throughout the supply chain needs to be efficient to ensure the product can make it to the end consumer. In the case of most food products, if there is any processing that needs to take place before it reaches the end customer. Those processing activities should be minimal, and products should move swiftly through the process, anyone besides the end customer should hold no inventory. The struggle with JIT in this industry is the volatility in customer demand, this is especially difficult in situations where the supply is constant, and the demand can fall below that supply level or go above that supply level. In the food industry, the utilization of distribution centers is prevalent, and that is to help manage the volatility in demand, while it adds an extra step to the supply chain, it is the necessary balancer in most cases to properly manage the changes in demand.

The industry where JIT has negative impacts is the dairy industry. Dairy is unique in that it is supply-driven 365 days of the year, and the supply level is relatively constant with little variation. Many farms are a part of a cooperative, which is a business that has an agreement with each farm that they will always purchase their milk regardless if they have a use for it. It is up to the cooperative to process it or market the supply on the open market. The dairy industry has seasonality where milk is in short supply and when it is hugely oversupplied. One cause of this seasonality is schools, typically schools are in session September through May, through the summer months June-August the schools demand for milk is slim to none. Due to that May through July, supply is abundant because those customers have no demand. In most cases, that

supply is sold to other processors below market value. In August, the supply/demand curve goes the other way when the processors for schools come back into service, and they must build supply back up for the start of the school year. During this time, the supply moves at premium prices. It also creates a shortage of supply in the market (hence the premium prices).

The other challenging times in the dairy industry are around the major holidays because many processors close their doors during the holidays cutting down the available processing capacity, with the incoming supply remaining constant. During these times, supply is sold at discounted prices, and the processors that are still operating are often manufacturing products that do not have orders. This is why the JIT philosophy does not work well in the dairy industry because the supply and demand rarely align, and at times are on two separate ends of the spectrum. The challenge in the dairy industry is processors of milk are looking to implement or already have implemented the JIT philosophy into their business. By adhering to the JIT philosophy, it has put the burden back on the cooperatives or the farms to balance the supply based on their demands. Due to this erratic demand from customers, many cooperatives have facilities that are dedicated to balancing the ever-changing demand in the market. The balancing facilities are not often profitable, but it is a “least loss” for the cooperative.

The other issue in the dairy industry and for dairy manufacturers is the utilization of assets and keeping their operation profitable. Since the demand varies so drastically, it can leave open capacity in the market or exceed the available capacity in the market. For a production facility to be profitable, they need to be operating and manufacturing products to be sold for a profit to make their margin cover their fixed costs and still show a profit. One solution that has been utilized in the dairy industry is in times when demand is deficient, and the supply is in excess that finished products are produced and put into freezer programs to be utilized later. This

solution solves two problems, it helps manage the oversupply when there is little supply, and it also solves the problem when demand in the market exceeds the available production capacity. One issue with the freezer programs is inventory and the costs associated with that inventory. In some scenarios, the customer will assume some responsibility for these products. In most cases, all the burden is on the manufacturer. While this is a feasible solution for dairy manufacturers, it goes against the philosophy of JIT and minimizing the amount of inventory that is being held.

One solution for dairy manufacturers that goes against the philosophy of JIT is to implement make-to-stock programs. Having make-to-stock programs allows manufacturers to manage through the variation in demand and available supply. The downside to these programs is that some products have a short life span, making it challenging to make all items make-to-stock. The manufacturers should have the flexibility to produce a make-to-stock item to fill a potential open capacity. While this is a viable solution, it does not follow the principles of JIT, but it does allow these manufacturers to properly manage the supply while also meeting the customer's demands while they operate their businesses following the JIT principles.

An industry where the JIT philosophy works excellent is the auto industry, where the methodology was developed and perfected. When comparing the auto industry to the dairy industry, there are two key differences. One difference being the auto industry supply is not constant; their limitation is production capacity, where the dairy industry has a constant supply that must be processed. The other difference is that products in the dairy industry are perishable. They only have so long to be processed and to get to the end consumer, where the auto industry is operating on the timetable of customers' needs. For an auto manufacturer, they could have the requirement of making ten cars per day, and they would receive the material in for just those ten cars and only produce those ten cars. The next day they may only need to manufacture eight cars,

so they would only manufacture those eight cars and only receive supplies for eight cars. That is why the JIT philosophy works so well in the auto industry because the supply, demand, and processes align well with the principles of JIT.

In the most recent history, the pandemic of COVID-19 has created many different disruptions and problems across all supply chains. In the early stages, supply chains were disrupted by any materials that came from China; those manufacturers were unable to receive their regular materials and had to find alternative sources. If businesses operate according to the JIT philosophy, they could have potentially missed production due to this if the proper contingency were not in place for an alternative supply source. Later the pandemic would make its way to the U.S., where eventually all non-essential businesses were shut down, and the essential businesses by default turned into a JIT operation because of the high demand for products (mostly grocery stores). The other drastic impact the COVID-19 pandemic has had is in the dairy industry where the demand for dairy was so low that farms had to dump their supply. Simply because there was not any processing capacity available, and there were no other alternatives.

Conclusion

Just-in-Time (JIT) is not a one size fits all strategy; it is a philosophy that was developed and perfected by the Japanese back in the 1970s. Along with the JIT philosophy, they developed other supply chain tools such as Lean Six Sigma and Total Quality Management (TQM). All of these were developed to make the manufacturing and supply chain processes more efficient and, more importantly, reduce the cost involved. Continuous improvement and eliminating waste are the two critical components of the JIT philosophy. The JIT philosophy can be applied to all the

functions within the supply chain. The two main focuses are usually manufacturing and inventory management. The goal of implementing JIT is to reduce costs and create efficiencies in the supply chain, JIT, in general, can work for most businesses in some form. One industry that JIT philosophy has created some issues in the dairy industry because of the supply-driven supply chain and extreme market seasonality. The JIT philosophy also hurts manufacturers that operate in make-to-stock programs, since JIT's primary goal is to eliminate excess inventory and keep carrying and storage costs to a minimum. JIT has excellent benefits to the businesses that can successfully implement the philosophy, but it is something that is not the right strategy for every business to utilize.

References

OMAR, M., & ZULKIPLI, H. (2014). An Integrated Just-In-Time Inventory System with Stock-Dependent Demand. *Bulletin of the Malaysian Mathematical Sciences Society*, 37(4), 1085–1097.

Kim, C. O., Jun, J., Baek, J. K., Smith, R. L., & Kim, Y. D. (2005). Adaptive inventory control models for supply chain management. *International Journal of Advanced Manufacturing Technology*, 26(9/10), 1184–1192.

OCHOA-BRILLEMBOURG, H. (2013). Just-in-Time Immigration Reform. *International Economy*, 27(2), 64–80.

Memari, A., Ahmad, R., Rahim, A. R. A., & Hassan, A. (2018). Optimizing a Just-In-Time logistics network problem under fuzzy supply and demand: two parameter-tuned metaheuristics algorithms. *Neural Computing & Applications*, 30(10), 3221–3233.

Yang, M.-F., Lin, Y., Ho, L. H., & Kao, W. F. (2016). An Integrated Multiechelon Logistics Model with Uncertain Delivery Lead Time and Quality Unreliability. *Mathematical Problems in Engineering*, 1–13.

Carvalho, C. P., Carvalho, D. S., & Silva, M. B. (2019). Value stream mapping as a lean manufacturing tool: A new account approach for cost saving in a textile company. *International Journal of Production Management & Engineering*, 7(1), 1.

Yao Zhao, & Simchi-Levi, D. (2006). Performance Analysis and Evaluation of Assemble-to-Order Systems with Stochastic Sequential Lead Times. *Operations Research*, 54(4), 706–724.

Emde, S. (2017). Scheduling the replenishment of just-in-time supermarkets in assembly plants. *OR Spectrum. Quantitative Approaches in Management*, 39(1), 321

Whitcomb, J. E., & Shafa, M. (2001). Treating patients like customers. Just-in-time inventory control for patient-centered care. *Physician Executive*, 27(5), 16–21.

Steyn, P. D. ., & du Toit, A. S. A. 1. adutoit@uj. ac. z. (2010). Investigating the potential for the development of a just-in-time knowledge management model. *South African Journal of Business Management*, 41(2), 1–12.

McBride, M., Harrison, S., & Clark, B. (2000). Dock-to-shop is just-in-time. *IIE Solutions*, 32(9), 34–38.

Kinney, M. R., & Wempe, W. F. (2002). Further evidence on the extent and origins of JIT's profitability effects. *Accounting Review*, 77(1), 203–225.

Gurahoo, N., & Salisbury, R. H. 1. salisbury@ukzn. ac. z. (2018). Lean and agile in small- and medium-sized enterprises: Complementary or incompatible? *South African Journal of Business Management*, 49(1), 1–9.

Zylstra, K. (2005). Distribution made lean. *Industrial Engineer: IE*, 37(1), 31–35.

Badar, M. (2013). Reducing the Bullwhip Effect in the Supply Chain: A Study of Different Ordering Strategies. *Journal of Technology Studies*, 39(1), 52–63.

Vokurka, R. J., Lummus, R. R., & Krumwiede, D. (2007). Improving Manufacturing Flexibility: The Enduring Value of JIT and TQM. *SAM Advanced Management Journal*

University of Cambridge. JIT Just-in-Time manufacturing. *University of Cambridge-IfM Management Technology Policy*.

Qureshi, M. I., Iftikhar, M., Bhatti, M. N., Shams, T., & Zaman, K. (2013). Critical elements in implementations of just-in-time management: empirical study of cement industry in Pakistan. *SpringerPlus*.