

Just-In-Time: An Industrial Analysis

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Abstract— The just in time system of manufacturing or production is a system that was developed mainly in the 1960s and 1970s with an aim at cutting down the production time as well as the time taken to respond from the supplier to the consumer. This system is convenient as it cuts down on the costs companies have to incur during production to acquire huge amounts of inventory and store them as they get ready for production, it ensures that raw materials are delivered to the production floor when they are required for production ensuring efficiency and less cost of production as cost of storage and security of raw materials is taken from the producer. This paper seeks to look at some of the ways this system can be applied in different fields in industries to reduce cost and maximize efficiency.

Keywords—Just In Time, Quality, Waste Reduction, Continuous Improvement.

I. INTRODUCTION

The Just in Time process is a coordination of manufacturer and the supplier. If the manufacturer is facing a high demand of products and suddenly, if the supply of raw materials has been stopped from the supplier, the production may fall to zero. So, to overcome this situation and to reduce the risk factors, there are various solutions that can be implemented effectively. Along with that included, the inputs that are required and the process that is followed in different stages will be discussed in the paper together with the applications for just in time in industry [1].

II. BACKGROUND AND HISTORY

The just in time system or otherwise known as the Toyota production system is a system developed in japan in the 1970s and 1980s whose main aim was reduction of time taken to source raw materials from the suppliers and delivery of the products to the client. Also known as the "Kanban system" although a mistake as Kanban is part of the just in time system. It is pointed out that this system was developed to fulfill the need to have a standardized system, it ensures that materials are available to the production floor just when they are required. This saves the producer time wasted waiting for raw material to arrive, space required to store preordered inventory for production, money that would have also been used to acquire the additional storage space, hiring of employees to handle the inventory and the extra security required at the storage warehouses.

The growth of this system was credited to the current situation of japan after the war whereby: japan was cash strapped hence they could not afford to fund the big batch large inventory systems of production that were popular elsewhere, as an island japan lacked space to build big factories with space for inventory, its geography put it as a disadvantage as it lacked natural resources with which to produce products, the high unemployment rate in japan meant that methods which relied on the efficiency of labor were not a guaranteed pathway to success hence the only way of ensuring efficiency was to have a system that was as lean as possible with very little reliance on human labor. The Japanese hence had to find means to lean out their system and they did this by building smaller factories which only housed material that was being worked on at the moment managing to keep inventory at a minimum, with the investment in natural resources that had been purchased being quickly turned around to purchase additional material [2].

III. INDUSTRIAL JUST IN TIME EXAMPLES

A. *The Pull Through Production System*

One of the strategies of the just in time manufacturing system is the pull through production system, it is a strategy whereby a company sends an item into the production once an order has been received by the company. Companies utilize a system known as the pull system, which is a method for controlling the flow of resources through a system. For resources to be pulled into the system and production pipeline they must have been requested or needed [3]. This system is customer reliant and production begins once an order has been placed and products are made based on actual demand, referred to as custom or made to order, a pull through strategy responds to customer needs in real time. It works well for products that can be replenished or manufactured easily, for products whose demand is uncertain and products which do not benefit from economies of scale, that is even when produced in bulk there is no economic advantage in making a lot of it.

This strategy has numerous advantages and disadvantages. The ability to sell without the added expense of carrying an actual inventory, if a company can deliver without incurring and absorbing this extra cost it should result in a much lower cost of goods sold and a profit margin that is considerably higher. Basing production on actual orders rather than anticipated orders can result in a much lower cost on storage, raw materials, insurance, factory overhead and finished product. It also enables a company to cost effectively tailor an item to the customers specifications which

drives a customer's loyalty to stick with a company in the future.

Some of the few notable disadvantages to this system is that with job lots as small as single units, more overhead may be required in terms of setting up equipment with the right production process, or the need to order smaller quantities of raw materials.

B. The Do It Right the First Time System (DRIFT)

Another strategy of the JIT system is the do it right the first time (DRIFT) system in management accounting. This system aims to reduce wastage and increase efficiency in the production system. It is part of the inventory management system whereby the only inventory materials ordered are the ones that are needed to reduce cost of inventory. This system can help businesses reduce production delays and boost efficiency. The importance of this system arises from the goal of decreasing the cost of idle raw material. The main idea behind this system is the desire by management to ensure that all the processes that make up the JIT philosophy are done efficiently and correctly to avoid delays in the production process [4].

C. Key Factors of the JIT System

For the JIT system to function some key methods were very important and although not exhaustive they are a key factor in this system, they include: proper housekeeping, this deals with discipline and the physical organization of the company, a system that gets it right the first time ensuring there are little or no defects in the production unit, reducing the footprint of the setup as much as possible, ensuring the size of each lot is down to a single unit, also ensuring that the load on the plant is level, ensuring balance in scheduling through organizing flow, reducing the number of workers through employing multiskilled workers, through effective communication mediums that ensure very little time is wasted passing information, carrying out preventive maintenance to ensure no breakdowns hence flawless running of the plant and reducing wastage of time that would have been used to make repairs and replace the parts that have broken down [5]. Having a plant that is product oriented and compact in its layout such that everything is conveniently placed in a place where it can be easily accessed, a smooth and streamlined system of handling materials that ensures materials are where they are required at the correct time they are required for use, having a wide and diverse network of suppliers who are basically an extension of the company as they can be called on anytime, this and other key methods are very important to the smooth and efficient running of this system.

D. JIT Advantages and Disadvantages

The main advantages of this system are that it reduces greatly the cycle time, lead time and flow time significantly, it's also significantly reduces the amount of buffer inventory required and a reduction in the number of suppliers needed. Its major drawbacks

include it is key that the suppliers of the materials are close nearby or can deliver at a moment's notice, failure by the supplier to the plant also affects, production and delivery, also sudden orders may affect also affect the delivery of the products to the final consumer, workers who work in JIT factories are at a precarious work with many employees being contract or temporary workers. Manmade and natural disasters will affect the flow of products and required services while also messing with the flow of energy. Natural disasters like disease outbreaks restrict any international commercial activities and trade interrupting supply in general while lacking the necessary inventory stockpile to manage the disruption, while panicking buying will affect normal demand [6].

This system although effective just as its name suggests means that for there to be any success there has to be precise coordination between the suppliers and the business to ensure fast delivery of materials and since there is no protection in the form of inventory businesses stand to suffer greatly in case there is any delay in any single element of production. The low inventory aspect of this system although beneficial to a company's bottom line, a great deal of coordination is required to run a business this way and they must be synchronization of every aspect of the business, from the sourcing of the raw material to ensuring it is delivered on time as needed on the factory floor for manufacturing. Most business applying this system have invested in the implementation of information technology to ensure suppliers are automatically notified as soon as orders arrive. Some of the drawbacks of this system include:

IV. JIT PRODUCT STRATEGY PROBLEMS

A. Supply Shock

Supply shock, under traditional inventory based production model, orders for materials are placed to wholesalers in large quantities with many items being produced from one shipment and as the raw material inventory from the first order is depleted businesses place orders for more products and as it is being shipped there is a buffer from the remaining inventory as the other shipment is in transit [7]. This system means that a company must have a network of suppliers that are willing to fulfill small repetitive frequent orders at a very short notice, this means having a network of local suppliers within the company's locality to reduce shipping time and expense. Having no buffer of back stock of inventory or raw material having any issue in the supply chain can lead to delivery delays and very unhappy clients. Issues with the sourcing of materials, shortages in materials, political instability and natural disasters have the ability to pose a serious threat to a company's ability to serve its customers effectively.

B. Demand Shock

Just as there is supply shock, demand shock exists in the JIT system, which is not the best system to deal

with any unexpected eventuality since it is based entirely on satisfying existing orders. Companies that uses the JIT strategy may not be properly prepared to handle any unexpected surge in demand for products [8]. Lack of back up inventory means that the client will have to wait for the company to receive supplies and produce the product, as a result of this there may be delays that are extended, unhappy and dissatisfied customers, and if any part in the supply chain fails the company may be forced to forfeit the order of part of it.

C. Large Orders

Large orders can also be a headache to companies that apply this inability to satisfy this order can be a headache for any company especially when they are required within a specified timeframe can cost a business money. There are other hidden costs in the JIT system that are also important although less pronounced. A production system that is producing goods for sale in smaller quantities means spending little with each shipment of raw materials, but in the end it can be an added expense to the company at the end of it all as the advantage of having an economy of scale enjoyed by businesses with high production level since as production increases the average cost of producing an item decreases this is partly because there are huge bonuses given by the supplier on purchase of huge orders, normally referred to as quantity based orders.

The smaller more frequent orders put companies that rely on the JIT production strategy at a disadvantage since they fail to qualify for this generous quantity-based discounts and price breaks enjoyed by the companies that buy in bulk. Factoring the additional shipping and delivery package that accompany this frequent order they may negatively affect a company's bottom line and the environment.

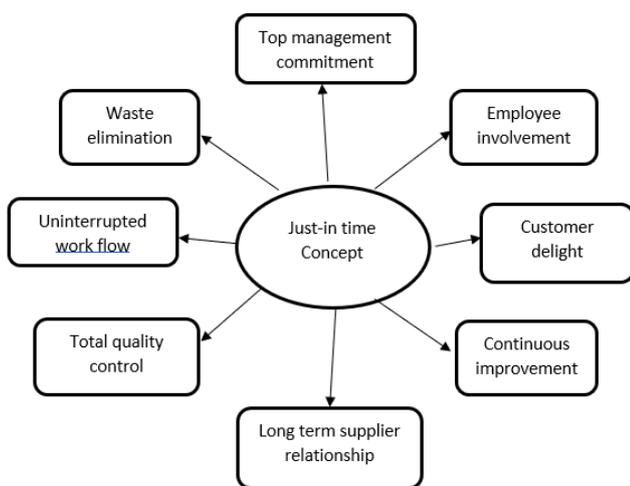


Figure 1: Applications of Just in Time

V. APPLICATIONS OF JUST IN TIME

Just in time has been applied in different sectors of the industry to ensure that products can only be received at the time when they are needed, thus minimizing waste and enhancing efficiency. This also helps in reducing the cost of the inventory. Some of the applications of just in time are explained in detail as follows:

A. Construction Industry

In any construction project the management of material and their cost contribute a huge amount to the overall total construction cost [9]. With the need for the site to be fully prepared for the project materials are usually pre-ordered days or even weeks prior to the commencement of the project which leads to an uneconomical build-up of inventory at the construction site and at the constructors warehouses, in building material inventory there is the cost to procure the materials, cost to hire space to store them, cost to insure them against any unforeseen eventualities like theft or arson and cost just in case the inventory becomes obsolete. The JIT system is key here as it helps in the control of inventory in management of construction. This system ensures that goods are delivered to the construction floor by suppliers to achieve reduction in inventory or do away with it altogether which will trickle down to reduction in cost. Implementation of this system in construction Management has the ability to achieve the same results gained in manufacturing which has seen companies reap much better far reaching results [10]. However there are some key relevant factors to consider in application of the JIT system for material inventory management in construction, some include: the relationship between the constructor and suppliers has to be strong and efficient to ensure delivery of materials is prompt and steady, also the implications for construction quantity and output, design and production management and planning are also key, the source of materials is also key and also the education and training of the contractor and his employ to ensure minimization of wastage.

B. Retail Sector

Retailers, both big time retailers and small-scale retailers are also taking advantage of the JIT system to provide their customers with a wide range of products while at the same time minimizing the cost of inventory [11]. Most big retail stores for example target such that their seasonal merchandise begin arriving just when demand for some key items begins to pick up and as the season comes to a close and demand begins to go down they clear the previous stock to make way for new stock which is usually what's in season. Small retailers are also not left behind and can take advantage of the JIT system to streamline their delivery system, for example a company that sells tables and does not manufacture them can place an order to the manufacturer once an order has been placed by the customer with the manufacturer

delivering it directly to the customer saving the retailer the cost of handling inventory.

C. Food Industry

Some fast-food joint has also not been left behind; they have substantial inventory of ingredients for key meals e.g. burgers but they are not processed until the customer makes an order. This is key in reducing wastage and also giving bragging rights to the chains for the quality and freshness of their meals.

D. Technology

In the technology space companies like Apple who operated their own warehouse and manufacturing factories switched to the JIT system, thanks to their new CEO, Tim Cook, who has vast knowledge and experience of the system since his time at IBM and Compaq computers, he closed down all Apple's warehouses and construction factories, choosing instead to develop just in case relationship with manufacturers most of whom were based in china where labor was cheap as well as the cost of goods. His improvement of the supply chain has reduced the amount of time the company's inventory has had on the company's financial bottom line and the balance sheet from months to days. He has credited this change to the improvement in Apple's growth and profitability.

E. Publishing Industry

In the publishing world on demand publishing is one key example of the JIT inventory method with its popularity among independent publishers and self-publishing business being very high. This is because under this system only master copies of books are kept at hand and copies are made on demand on a need basis, reducing bookstore inventory and wasted pulping of books that have not been sold [12].

The Dell computer company is also trailblazing in application of this system, instead of storing vast supplies of inventory in the form of parts which would incur holding cost, it negotiated with its suppliers to keep reasonable amounts of inventory that could be ordered and delivered within a short notice. It was popular with suppliers as they could now rely on a flow of orders that was reliable. This system worked for Dell, who also no longer needed to store massive amounts of miscellaneous parts.

Effective use of working capital and enhanced cash flow is what has made the JIT system so popular among both big and small scale organizations, it is essentially very helpful to startups as it reduces the amount of cash required to get the company up and running as there is less money tied up in unnecessary inventory and less storage space is required.

F. Fashion Industry

In the fashion industry JITM model has been applied by companies that subscribe to the fast fashion brand of marketing for example Zara whose supply chain is able to bring items to the market in an

extraordinary quick manner, they have a philosophy that inventory is equals to death of the company and commits six months in advance only about a quarter of the seasons line and produces about 50% of its seasons line at the beginning of each season meaning that the other half is designed during the course of the season, this gives them room to maneuver and adjust to any changing trends in the fashion sector, if a certain trend or design becomes popular Zara reacts by quickly designing it and getting them into stores while the trend is still at its peak and exploiting customer trends by satisfying seasonal demand.

G. Automotive Industry

In the automotive industry small companies like Tesla motors, although being popular and the tremendous growth over the years it is still one of the smallest companies in the industry and cannot enjoy the same economies of scale. With Tesla taking complete ownership of the supply chain and shunning distributors and being vocal in their rejection of the traditional franchise-dealer sales model. By producing on demand and keeping little inventory, Tesla minimizes the amount of risk and capital tied up with storing excess inventory. This exclusivity and the wait encourage additional customization which comes at a premium something the customer would have chosen not to pay for it the customer had driven a stock car off the lot.

H. Snack Industry

In the snack industry companies like Kellogg's who mostly deal with perishable products the JITM system is used as a stock management system to ensure that just enough product is made to satisfy demand and little stock is kept in hand.

At Toyota, where this system was founded, there was a realization among the executives that for daily production it was more cost effective to restock parts or finished goods only when they are immediately needed for pending orders, hence the need to fill up warehouses with side mirrors or window wipers was done away with as it could have the parts delivered a couple of hours just before they were due to be used on the assembly line, and have them delivered to the specific assembly station right before they were due to be installed.

I. Clinical Supply Arena

With an ever-growing number of an aging global population there is a need to respond to their growing healthcare needs by working on existing treatments and develop new ones that improve, extend and save the life of patients this has prompted a massive shift in drug development [13].

This has prompted a growth in the industry from single research centers in one country to multiple global clinical trials. This growth has been driven by more than just globalization, but rather the need to develop new drugs that negate the need for invasive surgery and the numerous negative side effects of

small molecular drugs there has been rapid and disruptive growth in biologics. Although hugely beneficial for the global human health, this growth has posed a challenge to clinical trial sponsors who must ensure that the correct drug is delivered to the correct place at the right temperature while upholding the correct standards with the complexities in supply chains complexity and management, is a task easier said than done. There is a risk of failing to step up to the challenge that would put both the patient and profits at risk, a risk the sponsors cannot afford to take [14]. With the existence of several manufacturing and supply chain strategies set up to deal with this new-era challenges with a much better degree of control and flexibility the rate of adoption has been unable to keep up mostly due to a lack of understanding, with reliance on less than prime methods of Managing production Packaging Labeling and distribution of Study drugs Which introduces unnecessary Cost and risk.

In this sector of drug development JITM can be defined as the customization of clinical trial kits to full at a late stage, where they can be used either in isolation or as part of a wider LEAN initiative, this is a systematic and strategic approach that maximizes value by minimizing waste or removing it in totality from the process. It makes it possible for materials that are in stock like bottles, wallet cards, vials, ampules, and pre-filled syringes, to be packed and labeled just prior to shipment in order to meet varying global needs effectively immediately demand is known.

JITM provides a solution for sponsors looking to maintain operational efficiency, reduce risk and optimize costs while running large-scale complex personalized studies. JITM Has come as an alternative to standard batch manufacturing, a technique where drugs are packaged and labeled before being added to inventory over several workstations to produce set demands Which has been the basic setting for sponsors, this is due to its ability to easily accommodate less certain demands common with clinical trials as compared to commercial drug production that are beneficiaries of continuous manufacturing strategy. The challenge with batch manufacturing in clinical trials is that while dealing with biologics for example, the short shelf life of readily assembled kits exposes them to the risk of surpassing expiration dates as they wait to fulfill the notoriously unpredictable demands of enrollment from clinical sites and the sponsors having to deal with limited supply of very expensive products makes batch manufacturing a very risky endeavor for biologics based clinical trials.

Studies that involve oncology, gene therapy, immunotherapy, rare or orphan diseases usually use very expensive products, studies that involve drugs with short stability and a need for frequent retesting, studies that are patient centered that require specific patient labelling and configuration of the kit, for studies that operate a pooled supply strategy, just in time manufacturing can be an ideal fit.

There is still a fear to pick up JITM as it is still considered a new concept in the clinical trial field and the fear of the unknown is a major driving factor in its opposition with a common misconception being that it is the most expensive method of ensuring supply to sites and patients, with critics using the fact that sponsors are required to run small operations more frequently as compared to fewer much larger batch manufacturing operations, with many assuming this removes the advantage of economies of scale. An on demand approach to clinical supply chain, depending on the design of the study this false economy is dependent on the selection of the default setting during the preparation of the study, the preparation stage, JITM initial overhead may be higher as compared to standard batch manufacturing but once the cost saving measure that come with reduction in wastage, reduced time of study, far fewer returns and minimized overage JITM becomes the more favorable option. There is also significant savings in courier costs, administration cost and the cost of transporting and physically burning products when sites are done with their clinical trials which are usually supplied by clinical supplies that are customized and delivered to fulfill a precise and immediate need.

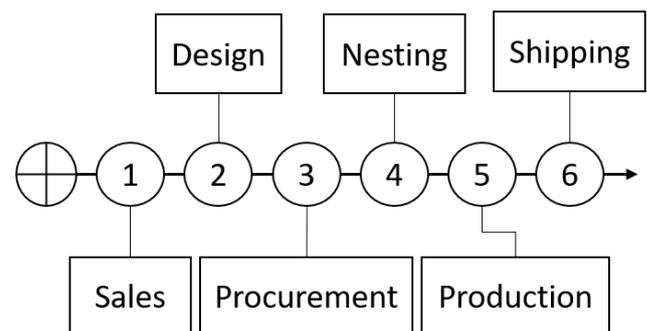


Figure 2: Just in Time Stages

VI. APPLICATIONS OF JUST IN TIME

In conclusion, just in time is a process that plays a key role in the industry. Its role has been applied in different sectors such as construction, retail sector, food industry, technology, fashion industry, automotive industry and other sectors. JIT system has helped the manufacturer and supplier to coordinate effectively by ensuring that raw materials can only be made available at the stage whereby they are needed to be used, hence helping to reduce certain costs such as the transportation costs and waste that may occur as a result of the materials being delivered at in appropriate time. On the other hand, just in time also reduces the response time between the customer and the supplier [15].

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