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Review

Just-in-time approach in healthcare inventory management: Does it really work?



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ABSTRACT

Healthcare organizations need to efficiently use their available resources, improve their productivity, reduce operating costs, and provide high-quality services. Just in time (JIT) is an approach that has benefited the healthcare industry in these regards, improving patient outcomes by reducing waste and non-value-adding activities. As such, our main purpose in this study was to discuss the use of JIT systems in healthcare inventory management and highlight their importance, as well as explore the advantages and limitations of JIT systems in healthcare management systems. We also explored supply chain issues in healthcare during the COVID-19 pandemic and provide strategies and recommendations for improvement.

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1. Background

The healthcare industry has faced many challenges in improving quality of care and patient satisfaction while reducing costs (Moons et al., 2019). Inventory accounts for a large proportion of the costs of healthcare organizations (HCOs) (Kelle et al., 2012). Approximately USD 83 billion is spent in the U.S. on hospital supplies such as disposable gloves and gowns every year (Scanlin 1997, Kua-Walker 2010). Furthermore, the amount spent on inventory-related activities such as handling, storage, transport, and restocking inventories is extremely high, accounting for more than one-third of hospital budgets (Dennison et al., 1994, Kua-Walker 2010). Additionally, U.S. hospitals waste approximately USD 25.4 billion each year on unnecessary supply chain spending (NAVIGANT 2018).

Healthcare institutions are responsible for planning, purchasing, managing, handling, tracking, and transporting stock (e.g., medications, medical equipment, and supplies). These activities are critical for their operations. Inventory and supply chain management primarily focuses on improving efficiency, controlling costs, and receiving and distributing the needed supplies on time to provide improved patient care (De Vries 2011). Supply chain management is key for organizing workflow and tracking inventory, purchases, orders, and payments. Supply chain management in healthcare settings requires skills in managing costs, inventory forecasting, and space management, while inventory management involves in-depth knowledge of logistics and financial aspects of stock (Dwivedi and Kothiyal 2012). These management systems help to protect organizations from both material and financial losses by maintaining an efficient and accurate record of items and supplies.

Inappropriate inventory management results in substantial losses for healthcare organizations and negatively impacts the quality of patient care (Brandon-Jones et al., 2014). Inadequate management can potentially lead to overstocking, meaning that extra assets are retained in inventory, thereby restricting cash flow and the development of the organization. Conversely, understocking leads to shortages and disturbs the stability of the services provided by the organization (Moons et al., 2019). Poor inventory management is one of the largest causes of inefficiency in healthcare, and efficient supply chain management can help hospitals to reduce costs and optimize their operations.

Reducing costs while improving the quality of care is essential in the healthcare industry. Hence, many HCOs are looking for innovative tools that will allow more efficient supply chain practices, helping to reduce costs without affecting the quality of their services (Lee et al., 2011, Mathur et al., 2018). Many inventory management systems applying just-in-time (JIT) approaches were working well prior to the COVID-19 pandemic; however, the pandemic created unprecedented challenges for these systems. Healthcare supply chains were negatively impacted and there were considerable disruptions to the supply of essential health items such as personal protective equipment (PPE) and ventilators, along with many medications (Chowdhury et al., 2021).

2. Objective

Our aim in this study was to provide an overview of techniques that can be used to improve healthcare operations by implementing JIT systems and to discuss their benefits to the healthcare industry. Our findings provide insight into supply chain management by reviewing the relevant literature and exploring the integration of JIT concepts and practices into healthcare systems as a potential cost-saving strategy for healthcare organizations and systems as a whole. Additionally, we describe the use of JIT

approaches during the pandemic and the benefits and risks associated with using this method. We outline future implications for JIT systems along with future research directions.

3. JIT systems

JIT is an innovative stock management strategy: a supply–demand system encouraging flow-type production that attempts to precisely match the demand for care with supply (Baum 2006). The concept of JIT was originally developed by Toyota Motor Company in Japan, and was then applied in a variety of industries worldwide, including healthcare. JIT systems can quickly respond to demand without the need for excess inventory. In JIT systems, suppliers deliver small quantities of supplies to HCOs as they are needed, which avoids the problem of overstocked inventory and eventually lowers operational costs. JIT is a comprehensive inventory management technique that reduces waste and eliminates non-value-added items (Li 2015).

JIT systems restock inventory and place a reorder for future resources when a preset minimum value is reached, using an indicator when more stock is needed to meet the current demand (Karkowski et al., 2017). For each supply category, the order volume is determined to avoid a lack of stock during the time between orders. Differences in demand between different types of supplies are expected, and must be determined using robust software. Some items that must be prioritized, such as life-saving medical and surgical items and other essential items; these are defined, while the items to which JIT can be applied are identified (Kester et al., 2001). Therefore, JIT requires the establishment of a monitoring and evaluating system that is able to detect and determine minimal acceptable inventory levels.

In JIT, healthcare organizations and suppliers work together to deliver inventory on time. To successfully run a JIT system, a close relationship must be built between the HCOs and suppliers (Karkowski et al., 2017). Without excessive inventory, healthcare organizations will depend on their suppliers. JIT is demanding on suppliers, so having reliable suppliers is an important factor in building the relationship between the HCOs and suppliers. Hospital workflows will be facilitated as HCOs better understand the supplier's capabilities, and suppliers better understand the HCO's needs (Kua-Walker 2010).

4. Benefits and risks of JIT systems

4.1. Benefits of JIT systems

JIT systems work well in normal settings, providing solutions to many issues faced by other inventory systems as well as many long-term benefits. Overstocking results in waste and lost and damaged items (Neil 2004, Baum 2006). The several benefits of using JIT in healthcare organizations include increased quality and efficiency, and savings in healthcare resources. Applying this method creates a stabilized work schedule and increases productivity (Siddiqui 2022). Therefore, the adoption of JIT by healthcare facilities has been widespread. The most common benefit of using JIT is cost reduction; In United State JIT has resulted in annual savings of approximately USD \$3–11 million per hospital, which is around 10 %–17 % in savings (Scanlin 1997, Baum 2006).

In a JIT system, stock is delivered by suppliers when needed, which reduces inventory costs by reducing unused inventory, freeing up money for HCOs to use for other care activities and care facilities (Aptel and Pourjalali 2001). JIT provides HCOs with an opportunity to minimize warehouse space, thus reducing inventory holding costs and investment in stock (Baum 2006). Other cost reductions include the labor costs required to move and manage

supplies; the number of workers can be reduced and some warehouse processes can be automated (NAVIGANT 2018). This can also result in improved productivity as employees are able to focus on tasks related to patient care instead of unnecessarily handling inventory (Neil 2004, Kua-Walker 2010).

JIT helps to increase inventory turnover ratios, leading to higher efficiency by preventing products from staying in storage for long periods. In addition, applying JIT saves time; with a smaller inventory, the time spent on ordering, purchasing and managing stock is lowered, which can improve productivity and services. Monitoring and management of inventory can also be improved because of the low number of items in the inventory (Kaswan et al., 2019). Close management of smaller stocks reduces the chance of wasting inventory items. Another advantage of the JIT approach includes improved work and operation flows, enhancing overall HCO productivity. (Canel et al., 2000) JIT can also improve service quality, leading to increased customer satisfaction (Jackson 2017). The JIT approach has several benefits for inventory management in HCOs, but some concerns have been raised due to the nature of the healthcare industry.

4.2. Risks of JIT systems

One of the major concerns with JIT systems is the uncertainty and unpredictability of the volume of hospital work (Neil 2004), which can pose a serious risk to hospital operations when the demand unexpectedly increases and the current inventory is insufficient. This may lead to zero stock, which can seriously affect patient care (Baum 2006). This is the top reason why HCOs hesitate to use JIT systems. Another issue regards suppliers, particularly for vendors that import items from overseas and may experience disruptions in shipments. To address these issues, stock levels need to be closely monitored and managed.

One solution is to keep a buffer inventory to avoid stock running out. However, this buffer or emergency inventory needs to be balanced to avoid holding a large amount of stock, which would conflict with the main goal of a JIT system, or holding too little stock, which would not resolve the issues or address the risk of shortages.

A second solution is to use JIT systems only for general suppliers items that do not directly impact patient care or affect emergency situations like labels, swap, pads, linens, etc (Doughty et al., 2020), (Kua-Walker 2010). This helps to ensure that inventory costs remain low without risking patient safety. The improvement of cash flow and cost saving are mainly coming from reduction inventory holding, minimize storage area, utilities, personnel and damage items. (Lai and Cheng 2016, Raj et al., 2022). Moreover, companies and manufacturers could not have the ability to bring the raw materials during the lockdown and even after restriction were lifted so for the critical items such as ventilators and intensive care unit items, its highly important to be on set without interruption (Raj et al., 2022). **A third** solution is to establish a contingency response plan with the supplier or with other healthcare institutions as well as considering a rapid communication between all sectors in timely manner to reduce the delaying of delivery and avoiding overstocking and shortages (mutual aid) ((Cheng and Podolsky 1996, Lai and Cheng 2016, Peng and Pang 2019, Okeagu et al., 2021). This type of effective and timely manner agreement should include essential supplies and priority medicines was very useful to overcome JIT limitation and maintaining resilience supply chain during health crisis like COVID-19. (Doughty et al., 2020).

JIT systems are difficult to operate and require the close monitoring of supply consumption. The supply forecast needs to be calculated using statistical tools and techniques to ensure accurate forecasting (Li 2015), as JIT relies on accurate data describing the

consumption of the resources. Thus, JIT may not be ideal for every institution and often requires extensive preliminary planning to ensure that the system can work appropriately. Each institution needs to assess their situation and ability to establish a JIT system by weighing the costs and benefits of such a system.

Another issue related to JIT is transportation and delivery costs, which tend to be high. The cost mainly depends on the transport type and vehicle used, and the distance traveled. The system is designed to decrease inventory and order stock when needed, relying on the certainty of on-time delivery. This may mean frequent deliveries, which decreases efficiency and increases delivery-associated costs, which is an additional cost factor that needs to be considered and discussed with suppliers (Kim and Rifai 1992).

5. JIT systems during COVID-19: increases in demand

The COVID-19 pandemic has substantially impacted global supply chains and extensively disrupted the flow of supplies, increasing demand for key materials (Leite et al., 2020). These supply chain disruptions had serious consequences that placed health workers and patients at risk. During the pandemic, the high demands for PPE, medications, and equipment such as ventilators exposed the instabilities in healthcare supply chain frameworks, many of which relied on JIT systems (Chunning and Kumar 2000). Accordingly, many HCOs faced major issues with their supply chains and experienced shortages and understocking of many of important supplies. Additionally, the supplies of active pharmaceutical ingredients (APIs) from China and India, vaccines, and essential medical supplies were limited, delaying global supply amidst surges in demand. The world is still suffering from disruptions in its supply chains (Chowdhury et al., 2021).

To protect local supplies, some countries in Asia and Europe terminated the export of PPE, leading to a continued reduction in global stockpiles. Thus, countries that mainly depended on imported supplies experienced serious PPE shortages; the pandemic exposed their fragility and dependency on the current supply chain system. The shortages during the pandemic were directly related to the use of JIT systems which failed to meet the unexpectedly high demand, placing many HCOs at risk of having insufficient supplies. The challenges that arose during the pandemic showed why the JIT method should be used with caution in healthcare systems, proving that HCOs need extra supplies to mitigate the risks of present and future delays and disruptions. (Andaneswari and Rohmadiena, Gereffi 2020).

The experience obtained from the pandemic has highlighted the importance of proactive supply chain management in healthcare. During the pandemic, JIT systems created havoc for healthcare organizations, driving up the costs of supplies and placing extra pressure on already taxed healthcare budgets and systems that were trying to provide life-saving care. Thus, under JIT systems, due to lack of sustainable inventory for such these items, if inventory is unavailable during a pandemic, HCOs may experience widespread stock shortage. Many medications necessary for mechanical ventilation (sedatives, vasopressors, and paralytics) were in limited supply.

6. Recommendations to overcome current challenges

6.1. Digitize and automate supply chain processes

Globally, supply chain systems have faced many challenges, especially during the pandemic, indicating that a new strategy is warranted to address the shortcomings of the current system. To minimize inefficiencies and build robust systems, we recommend building an integrated supply chain framework using tools such

as big data, the Internet of Things (IOT), blockchain, cloud computing, and artificial intelligence (AI) to directly link HCOs to suppliers and facilitate HCO purchasing processes. These tools can help HCOs to accurately predict their demand and visually track their consumption (Dash et al., 2019, Wang et al., 2019). This transition from traditional operators to a more automated system that enables AI and machine learning will require a secure, transparent, and trustworthy platform to exchange information among all stakeholders as an efficient inventory management tool. This integrated supply chain system will improve inventory levels, rationalize processes, streamline purchasing, and help to build better relationships with suppliers. The supplier–HCO relationship is key to improving hospital supply chain systems, as these systems are built on the trust between hospitals and suppliers (Gurtu and Johny 2021).

6.2. Positive behavior strategies

JIT can benefit healthcare organizations by helping them to operate more efficiently, minimize operation costs, and increase productivity. However, these systems need special considerations to run successfully: positive attitudes and behavior toward the new methods must be developed, and the capacity and readiness of the current system for a major change must be assessed. Moreover, estimations of consumption patterns must be accurate, so tools are needed to calculate and predict which items are associated with higher (e.g., lifesaving items) and lower risk if out of stock. The long-term impacts of the pandemic have shown many healthcare systems the benefit of direct relationships with suppliers. This emphasizes the importance of cooperation and trust between HCOs and suppliers. Hospitals being directly connected to suppliers, without an intermediary distributor, will facilitate the supply process and will determine whether a given supply chain is cost-effective or needs modification. Applying a supplier relationship management strategy can be used as a tool to create a better supplier relationship system by closely measure supplier processes and build a more efficient and positive relationship. Institution that adapt such strategy demonstrated a substantial benefit in term of reduction of inventory, sustainability, and efficiency process even for centralized procurement. (Ezzahra et al., 2018, Amoako-Gyampah et al., 2019) Once a system is working, employees need to be aware of its value and be trained on how to use it properly. After implementation, the system will require continuous evaluation and monitoring to inform necessary adjustments which is essential for a success of JIT system. (Okeagu et al., 2021).

6.3. Strategic sourcing

Despite the financial and nonfinancial benefits of JIT systems, such a system may not be the right choice for all HCOs; for some, JIT may not optimize the healthcare supply chain. Ensuring the maintenance of an emergency inventory is the best and safest choice for the healthcare industry during pandemics (Leaven et al., 2017). Adopting a direct sourcing model can both ensure that an organization receives the products it needs at a sustainable cost and that supplies will be sufficient during disruptions. Additionally, diversification by having multiple suppliers will mitigate future shortages, as having a single supplier may put an organization at risk of running out of stock.

6.4. National stockpiles

A regional stockpiling infrastructure is one method of overcoming JIT inventory issues. Strategic national stockpiles (SNSs) help a whole region to secure healthcare services by maintaining strate-

gic quantities of all medical and surgical items. These stockpiled supplies are vital for supporting national health security during pandemics and other crises. Supplies from these stockpiles can be delivered to HCOs within hours (Branson 2021). Countries that used their SNSs during the pandemic were able to meet the surge in demand and overcome the medical shortages to some extent, especially at the beginning of the pandemic. However, the stockpile system was ultimately unable to equip various regions with necessary healthcare items to ensure the safe and effective management of the pandemic (Rule 2021). These SNSs were deficient, so a more substantial and well-maintained stockpile approach is needed to provide a more robust response to any unexpected surges in demand and to anticipate future needs (Gerberding 2020). The pandemic has highlighted the importance of strengthening the domestic healthcare supply chain system and enhancing communication at all levels between government and private entities to enable sharing of information regarding supply and needs, especially during crises (Huang and Varmus 2021).

6.5. Just-in-case systems

Healthcare leaders have learned many lessons during the pandemic, so they will hopefully be prepared for future challenges. The COVID 19 pandemic has forced leaders to rethink and consider just-in-case (JIC) instead of JIT systems, which focus on lean management by reducing inefficiencies and waste through the supply chain and lowering investments. JIC is a type of demand-based supply chain system. The key to JIC is focusing more on the continuity of work and operations. Creating an inventory buffer through JIC systems is one way to mitigate supply chain disruptions and prevent HCOs running out of supplies (Swierczek and Szozda 2019). During purchasing planning, the planner creates a 10 % inventory buffer, particularly for life-saving and essential items, in case of high demand caused by an influx of patients. Thus, some HCOs might consider moving from JIT to JIC systems, maintaining sufficient inventories to minimize uncertainties in supply and demand, and focusing on balancing efficiency with a flexible and reliable supply chain, and using “Par” level for each item when it becomes in a very low level and even an one item is a backbone of JIC process (Coslett 2022). It could be organized by using such inventory software connecting to each item by barcode would track each one. if the attention is not paid from warehouse, HCOs would confront shortages. However, JIC systems require increased stock to address potential delivery delays, which increases costs for the organization, which is opposite of the intent of JIT approaches. In a JIC system, an emergency plan must be considered, and higher costs and longer delivery times must be expected. Thus, caution is required in the assessment of the risks and benefits of these systems to ensure that the inventory buffer costs less than the risks it would offset (Chopra and Sodhi 2004). Nonetheless, both benefits cannot be simultaneously obtained. JIC overcomes the limitations of JIT and satisfies customer demands, but at higher cost. Thus, a balance should be reached between JIT and JIC approaches to achieve a balanced and resilient system (Kerr and Houghton 2010).

6.6. Supply chain risk management systems (SCRMs)

During pandemics, demand may surge, exceeding the ability of the supply chain to quickly respond. Unanticipated surges can disturb the normal inventory plan and may compromise both public and national health security during pandemics and other emergencies. A vital task in healthcare decision making is to recognize and address critical risks in any supply chain system. Thus, supply chain risk management systems (SCRMs) are implemented to identify areas where surges in demand may occur so plans can be accordingly designed (Swierczek and Szozda 2019). The overall

aim of an SCRM is to ensure that supply chains perform well, with smooth and continuous flows of supplies, and to promote supply chain resilience and robustness. SCRMs should consider all aspects of supply chains and their associated stakeholders, including individuals and organizations, and examine the impact of stakeholders on supply chain resilience. In healthcare supply chains, several strategies can be implemented to mitigate risk and maintain supply-and-demand stability. Inventory can be managed by shifting toward a supply chain that minimizes disruption and leverages technology to manage increasingly complex processes and supplier relationships that require real-time monitoring, such as forming a surplus supply of critical inventory; securing critical assets; using highly accurate forecasting that depends on high-quality information and fast decision making; creating an optimal and standardized fulfillment processes, which will require centralized visibility using an online portal; measuring and monitoring stock consumption using predictive analytics tools; and tracking the trends in orders and usage volumes to support prediction (Monczka et al., 2015, Wang et al., 2019).

We recommend using a risk management approach to sort multiple suppliers into tiers of revenue impact and suggest using tier-specific tactics, such as continual supply monitoring and buying insurance. Additionally, an express delivery system can be implemented by contracting a third-party source with experience in this field. To ensure functionality during a pandemic or disaster, items can be directly purchased from vendors using cash within one or two days. Collaboration with clinicians and prioritization of patient outcomes are needed, along with decisions about how space is used in provider facilities (Croom 2001).

6.7. Using analytical models

Analytical models are other tools that can be used to optimize decision making within supply chain processes. One of the main challenges in ensuring resilience in supply chains is mitigating the ripple effect, which is the propagation of supply chain disruptions that impact the chain's resilience and performance. At the beginning of the pandemic, several ripple effects were reported due to supplier disruptions in some countries, which then spread downstream in the supply chain, leading to shortages. Several approaches to controlling supply chain resilience have been explored using analytical models such as Bayesian networks, which are powerful analytical tools for risk management and uncertainty assessments. Application of this technique in the supply chain field is relatively new and requires further studies. Bayesian networks can be used to identify causal risk factors associated with supply chain processes; therefore, they can be integrated with machine learning algorithms using big data to overcome many uncertainties and logistical issues (Hosseini and Ivanov 2020).

6.8. Future supply chain frameworks

With the future development of new technologies, a hybrid system using the JIT approach may become easier and less costly to implement, and may overcome the limitations of current JIT systems. The system should be able to monitor the average consumption rates of supplies and support projections for future inventory management. Using a barcode system for supplies can provide up-to-date and accurate assessments of stock use and identify any unused inventory (Scanlin 1997). Stock can be categorized into different classes according to turnover rate, emergency and urgent use, or price.

A more comprehensive digital supply chain system will be able to estimate use patterns to enable proactive supply management approaches and inform decisions on product distribution. The formation of digital systems will enable a more data-driven supply

chain strategy, including data modeling to assess different scenarios. This will allow decision makers to more proactively approach planning for future events (Snowdon and Saunders 2022). Another technique that may be used is the integration of a networking system that connects HCOs with their suppliers. This could simplify and increase the accuracy of the ordering process by eliminating the need for intermediaries. This will necessitate the use of comprehensive dashboards that are able to track items from production through shipment to end-user consumption. Data gathered from this dashboard can be used to guide decision making. These technologies will reduce the number of employees required for managing inventory, which in turn will reduce errors and costs. Moreover, monitoring must be performed using a predefined indicator to continuously evaluate the function of the supply chain and benchmark performance against its peers. The system should also be able to identify alternative products and supplies, which would mitigate the effects of any crisis by avoiding dependency on certain pipelines and disruptions related to critical products and services (Kua-Walker 2010).

In recent years, HCOs have been moving toward leaner and increased integration strategies in their supply chains. The benefits of this approach are minimized inventory and reduced costs, but this approach poses potential risks (El Baz and Ruel 2021). Thus, a trade-off exists between a lean strategy (cost-saving approach) and resilience (robustness), which must be balanced. This is called a “leagile” supply chain, which balances efficiency and resilience through supply chain risk management, taking advantage of both strategies (Ahmed and Huma 2021).

In reference of lean process that helps organizations for dealing and managing their supply chain, particularly the critical items, it suggests. First, implementing the lean process in each administrative department. Those departments including warehouse, purchasing, finance, and human resources. Innovation by focusing on quality and productivity with elimination of non-value added activities for each department and section is the cornerstone for implementing the lean process. Then, starting for using map process by considering each steps that are presentation, consultation as in Kiezen Approach, prioritization, Pilot team and methodology application respectively. Second, using such kind of advance system like Med-Approve which can contain all hospitals information with addresses and vendor as well. Each hospital has special code number to use to identify each entity with an icon for meeting agenda to discuss each item for getting approvals as a stock item for all hospitals especially for medical and surgical items. Finally, the benefits of applying lean process is to improve workers performance and the quality with confidence which creates a good environment in each entity (Monteiro et al., 2015, Rossiti et al., 2016).

7. Conclusions

In conclusion, JIT is a lean methodology that can provide financial and operational benefits. However, caution is needed in specific situations to prevent the breakdown of the system, which would compromise the ability of healthcare systems to deliver care. JIT works properly when the organization has reliable and accurate demand forecasting and works with reliable suppliers, especially if the suppliers use local manufacturers, which considerably impacts the supply chain process. Above all, to be ready for any future emergencies, lessons must be learned from the response to the current COVID-19 pandemic and used to improve overall supply chain systems; HCOs must identify several suppliers and ensure a sustainable stockpile, particularly in areas with many tertiary hospitals. In the future, researchers should evaluate the practicability of the JIT approach by performing evaluations from

different perspectives, including costs, efficiencies, benefits, and risks.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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