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The Role of the JIT System in Enhancing Competitiveness

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Abstract: This research aims to examine the role of the Just-In-Time (JIT) production system in enhancing the competitiveness of industrial and service enterprises. The JIT system relies on reducing waste in production processes, improving product quality, and increasing operational efficiency, enabling companies to achieve a sustainable competitive advantage. The research examines the concept of JIT, its main principles, and the requirements for its success. It also analyzes the relationship between implementing this system and achieving competitiveness through improved productivity, reduced costs, and rapid response to market needs. The research also reviews some practical experiences of implementing JIT in successful global companies such as Toyota and identifies the challenges that organizations may face when adopting this system.

The research concludes that effective implementation of JIT requires strong administrative support, the development of a flexible supply chain, and the use of modern technologies in production and management. The research also provides recommendations for organizations seeking to enhance their competitiveness by adopting this system.

Keywords: Just-in-Time Production, Competitiveness, Quality Improvement, Cost Reduction, Operational Efficiency.

Introduction: Varied criticisms of Just-in-Time (JIT) effectiveness have been raised. For example, there have been reports of poor delivery performance, inventory control and complications arising from a lack of supplies for needed components. (Van Wyk & Naidoo, 2016) have assessed the effectiveness of JIT implementation at a South African company, using a methodology that was specifically developed for this purpose. An improvement in several performance measures, such as, T3, T4 and T6, subsequent to JIT adoption is reported. Perishable goods have to be delivered in a pre-determined time window or else the shipment is considered late. Due dates are determined based on several factors, such as, delivery location. There are two different types of just-in-time (JIT) delivery for the supplier: regular delivery mode and the JIT mode. In the regular delivery mode, the entire delivery of goods must begin and conclude within a specified time period. This time period is usually a few days. It should be noted that the JIT mode delivery is more stringent than the regular delivery mode. Delivery in JIT mode must arrive exactly on the expected delivery date (EDD) of every order. Early deliveries are not allowed before a predetermined earliest delivery date (EDD) that corresponds to the ready time of the time window. An order is considered late if it is delivered after the due date. Customers will be penalised for all late orders. Therefore, JIT suppliers are encouraged to adjust ore and/or transportation capacity resulting in just-in-time delivery service. Supply delivery just in time is one of the key values of the JIT system. A main tenet of the JIT system is timely delivery to meet customer demand. Delivery performance is considered one of the more influential factors of the competitive strength of JIT in the production environment. An ordered product is considered late if one or more items is delivered past the due date. If this happens, the producer could lose the client who made the order. An order is known as a batch which is the set of goods ready for delivery to the

customer. Each delivery takes some duration of transport, and within this time the shipment cannot be replenished. The plant wants to schedule all deliveries so as to maximize the deliveries of batches (within their respective time windows) over time. A theoretical framework is provided that adapts the classical economic lot sizing model to account for delivery time windows, and looks at the case of a single producer that services a common retailer. Crossing time window induces issuance of early or tardy shipments. The situation is investigated where the customer is allowed to penalize the producer for delivering out-of-time goods. A comprehensive library is made available with real-world data sets which can be used in connection to the model discussed to better understand the theoretical contributions. This free-access approach is suggested as a means of addressing difficulties and issues which may arise in practical applications of a model.

Research Problem

In light of increasing competition in global markets, companies seek to adopt effective strategies to improve their performance and enhance their competitiveness. Just-in-time (JIT) production is one of the most prominent modern methods aimed at reducing costs, improving quality, and increasing operational efficiency. This helps companies respond quickly to market demands and achieve a sustainable competitive advantage. However, many organizations face challenges when implementing JIT, such as the need for flexible supply chain management, strong administrative support, and the application of modern technologies. This raises questions about the ability of different organizations to adopt this system effectively. Accordingly, the research problem is represented by the following main question: How does the Just-in-Time (JIT) production system contribute to enhancing the competitiveness of organizations? What are the factors that influence the success of its implementation?

This main question is divided into several sub-questions, including:

- What is the concept and objectives of the JIT system?
- How does JIT affect cost reduction and improve product quality?
- What are the challenges facing organizations when implementing JIT?
- What factors ensure the success of JIT implementation and enhance its impact on competitiveness?

Research Objective

This research aims to examine the role of the Just-in-Time (JIT) production system in enhancing corporate competitiveness by analyzing the system's operating mechanisms, its benefits, and the challenges facing its implementation. It also seeks to provide recommendations that help companies effectively adopt this system to achieve the highest levels of efficiency and quality.

Significance of the Research

The importance of this research stems from the vital role the Just-in-Time (JIT) production system plays in enhancing corporate competitiveness, especially in the modern business environment characterized by rapid change and increased competition. The research highlights the strategic benefits organizations can achieve by implementing this system, making it a topic of scientific and practical value.

- It explains to organizations how to successfully implement JIT and the requirements necessary to ensure optimal results.
- It helps managers and decision-makers improve production efficiency and reduce costs, enhancing companies' ability to compete in local and global markets.
- It highlights the challenges and obstacles facing JIT implementation while providing practical recommendations for addressing them, contributing to increasing corporate success.
- Presents case studies and successful experiences of JIT implementation in global companies, allowing for the benefit of practical best practices.

Research Hypothesis

Implementing the Just-in-Time (JIT) manufacturing system enhances the competitiveness of industrial companies by reducing operating costs, improving product quality, and increasing the speed of response to market demands.

Sub-hypotheses:

- There is a statistically significant relationship between implementing the JIT system and reduced inventory levels (raw materials and finished products).
- The JIT system contributes to reducing production defect rates, which positively impacts customer satisfaction.
- Adopting the JIT system improves operational efficiency (such as reducing production cycle time and accelerating order delivery).

DATA COLLECTION METHODS

This research took a descriptive approach, reviewing the literature, including studies, research, theses, and university dissertations related to the research topic.

Overview of JIT System

Origin and concept of JIT

Japanese Production managing gurus controlled by Toyota developed “Just-In-Time” (JIT) thinking at the start of 1970’s. They knew that there were seven wastes in production and by the removal of these wastes they could reduce cost, produce better quality, and deliver products in a short time. They moved away from the controlling system controlling through stock and inventory because in that way they can not control defects, machine breakdowns, and inefficient human experiential. In its place. They moved to a computer-based approach to handle these problems which create JIT based system. American people developed its philosophy as “Just-In-Time” (JIT) and its philosophy is defined as “the correct number of products will be processed at the correct time and will be supplied to the correct location” (Hou et al., 2013).

Research Background about JIT

The success of JIT is typically attributed to various factors, e.g. reduced inventory, improved quality, with suppliers and production flexibility, etc., however some operations have encountered difficulties as a result of JIT application, and many practitioners have not obtained the benefits expected. Nevertheless, the application of JIT continues to bring discussions. Furthermore, the widespread applicability of supply chain management (SCM) changes the way JIT is observed. (Amasaka, 2020). For these reasons, a reevaluation of JIT is called for, and a response recently published. By sharing the case study of Company BH in implementing production, planning and distributors since 2005, regarding JIT systems, this system observe important issues in accordance with the reevaluation of JIT systems and aims to providing insights. Additionally, the collaboration approach to resolve these critical issues are discussed and contextualized in the JIT system. At this point it will be important to exam the case outcome through undertaking various internal/personal initiatives following this evaluation.

Historical Development of JIT

JIT is a philosophy of producing with little or no waste. It is a participatory system empowering shop floor employee's involvement and self-interpretation. Before linking the case of JIT development in China with that in the U.K., a brief review of JIT's historical development in Japan and then the U.K., is provided. The term JIT is defined by analogy with a motor. Just-in-case' has traditionally been the U.K. production philosophy; huge quantities of stock detained everywhere 'just in case' problems arise. 'Just-in-time' is the exact opposite: only a very small inventory is needed (Hou et al., 2013). For practical purposes, JIT is usually perceived as an industrial strategy that incorporates just-in-time delivery and reduced size, increased frequency deliveries. The Japanese can take little credit for the original ideas of just-in-time production. (Aspelund, 2015) The craft-based industries in the U.K. and the U.S. maintained low inventories, produced in small lots, had versatile workers and used very few machines - the origins of just-in-time production. The credit for JIT must go to American armament production between 1942 and 1945. The turning out of tanks and guns 'just-in-time' and 'right-first-time' (zero defects) convinced the Japanese that JIT was the essential tool for gaining a competitive edge. With the dawn of the sixties, Japanese awareness of western successes forced them back to JIT. However, the Japanese approach was more about exploiting inherent Japanese strengths than emulating western techniques. Accepting the reduced size and increased frequency of deliveries (JIT), many Japanese companies used up every bit of data and technology at their disposal in an attempt to emulate the computer controlled materials management systems found in the west. In striving for quick efficiency gains, many Japanese firms adopted canned systems that were not entirely suited to them.

Key Principles of JIT

A coherent discussion of the complex inter-related Just-In-Time (JIT) system and its associated philosophies, principles, practices, and techniques is offered. This is structured to serve as a primer for those unfamiliar with the JIT system or to provide a base of information for others to consult in their efforts to apply one or more elements of the JIT system to an organization. In the mid-1970s, JIT concepts were first made known outside of Japan, and subsequent research has been unable to provide a uniform and clear definition of the JIT system. Probably because of its seminal nature and the Japanese cultural context within which it developed, confusion lingers over the basic tenets of the Just-In-Time (JIT) production system. In a typical rendition, it shifts the burden to suppliers and conveys parts to the production line just at the time they are needed (Nakamura et., 2019).

The Just-In-Time (JIT) system is perhaps best understood in terms of the philosophy behind it and the guiding principles this philosophy inculcates. The precarious state of much of the literature on the topic is somewhat troubling, and even the more thoughtful and considered treatises have failed to provide a clear and definitive explication of the JIT system. Upon both

the review of various research works and the results of a survey offered below, an effort is made to provide a comprehensive account of the JIT system. Although identifying tenets of JIT, it needs to be understood, first, that these elements are complex and inter-related, and second, that JIT is more than the mere sum of these its philosophies, practices, and techniques. (Okihara et., 2023) As noted at various stages, the principles, practices, and techniques which make-up the Just-In-Time (JIT) system are predicated on a number of diverse and inter-dependent philosophies. Many of these underlying tenets cannot be directly observed, although their footprints are very much in evidence.

JIT and Supply Chain Management

Merely reducing the inventory level will not achieve the benefits of the JIT philosophy, because the whole production activities and the extended supply chain activities are not synchronized. The extended supply chain activities also include suppliers management and the associated quality issues. Accordingly, it is argued that to maximize the benefits of the JIT philosophy, it is vital to consider the whole production activities, as well as the whole chain of the production; instead of merely reducing inventory level. (Nakamura et., 2019)The extended supply chain activities, including suppliers and their quality issues, also need to be taken into account. Although many companies have used or are using many IT systems to try to implement JIT philosophies, there is no uniform way of how this is done. Choosing the right information system is of vital importance. Also, there is a lack of understanding of how the IT system could help or could be used to help the implementation of JIT systems. Thus, the objective of this research seeks to address the above issues and can give insights to the practitioners regarding the implementation of the JIT systems (Hou et al., 2013).

Some key findings in the implementation of the JIT systems have been identified under five themes: information system, production planning, inventory management, quality management, and suppliers management. (Yanagisawa, et.2022)A holistic system has been built in company BH to cope with the five themes in an integrated manner. The system data can be analyzed in real-time to provide real-time information to determine if a large inventory of each material is needed or if the actual production data already shows that all materials needed for production are in hand. Any additional materials added to inventory management will be automatically displayed in the inventory tracking monitor. All purchased materials must have QR codes to facilitate their use. Comprehensive products with hundreds of materials are judiciously arranged in 13 bags according to the order in a minimal number of minutes. Production managers can use this system to easily visualize and decide when orders are placed. This system has been in use for two years, and significant benefits have been experienced. In some cases, the system is even considered more important than the production activity. This system lessens the chance of delaying production due to a lack of materials, ensures the most efficient production schedule, and reduces the need for new inventory before production activity actually occurs.

Impact of JIT on Production Efficiency

Performance measures focus on the overall efficiency of a production system. There are four measures used for the purpose, which are production efficiency, utilization of labor, maintenance, and equipment downtime. The increase in competitive global pressure has led to the importance of production efficiency. (Amasaka, 2021) It is defined as the productivity per unit cost. An improvement in four of the eight categories was noted in the case of Sabertek, that is, the total production efficiency, scrap as a percentage of output, use of scrap as a percentage of input, and production efficiencies per man hour for each of the lines. Only one of the four production efficiency measures has been noted in the SaberTek case (Van Wyk & Naidoo, 2016).

The Just-in-Time (JIT) production system was first introduced by Toyota. JIT has been the subject of many articles and case studies in an industrial environment worldwide. However, the discussion mainly praises JIT for effectiveness and competitiveness. JIT should be seen, in the context of South Korean industries and taken with caution before the implementation of a JIT system. JIT is more suitable for the production processes of progressive organizations than for the production processes of conventional organizations. Many companies in an industrial environment set up departments for quality inspection and other processes as a separate department. But in a progressive industry, the inspection department is integrated with the process. The smooth combination of the intermediate process creates an advantage in the reduction of waste and the production of a stable BP. On the other hand, the tendency of the departments and the industrial body such as the trolley bus to make the irregularity of the rhythm of production is the obstacle of the JIT establishment (Hou et al., 2013). Most of the purchased pigments in the color industry do not meet the conditions for JIT look nurtured or consignment and can be procured in bulk. As a result, the continuous manufacturing process automatically turns into a special manufacturing process. In addition, in the plastic industry, it is almost impossible to

automate the mill rubber process. On the other hand, packaging after the finishing process can be partially conditioned for stock when the production is delayed due to the defective process. (Womack, p. 93-103). The equalization of the process rhythm and action for stable production is effective, but it is not easily established due to the external component. Personal connections are important in exchanges between manufacturing companies. This thoughtful melody combined with the existing business rule that characterizes the company as a separate good company.

JIT and Waste Reduction

It is well known that, whilst adding value to a product, there are a great number of operations which a part or assembly can go through that do not add value. In the engineering industry, waste arises from machining, welding, casting, and from rapid prototyping operations that do not eventually become part of the final design. In machining, it is often the case that parts are machined that are not required. On many components, such operations include tapping holes as well as drilling and milling them, deburring edges that are no longer contacted by other parts, and so on. Milling an unnecessary slot in a component as well as wasteful production operations also introduces the possibility of human error and hence faulty production. Many times, extra parts are made and then must be discarded since they were made outside revision and therefore are redundant. Often, revisions are missed simply because there is confusion over which parts need to be made. Referring to the revision numbers of at least a few parts on each drawing greatly increases the likelihood of a part being made obsolete, rather than necessary. Undoubtedly, many other waste sources in production engineering have been missed.

Waste may also result from operations on individual raw materials or components such as drilling an unnecessary countersink or producing a better surface finish than required. Care should be taken to avoid this sort of waste when specifying parts to be made or materials to be used. Waste from this source may be eliminated by carefully considering the various processing operations that a part must go through in order to be made. Furthermore, components or raw materials often require multiple operations that fall under the category of waste. On many components, a finish is machined that is later re-machined. This repeated processing not only wastes time and man-power, but also increases the likelihood of twisted parts, in addition to increasing the risk of a part being undersized. Transportation and storage produce a large portion of waste in production. (Sakai et.., 2023) Waste from this source arises when components, raw materials, or inventory are transported or stored. Any of these actions inherently cause direct energy expenditures. Such waste carries on until the action of the transportation or storage has occurred. Large facilities require transportation simply because they are large. Though there is much unavoidable waste from this source, such waste should be consistently minimized. Layout is a substantial factor in the elimination of this source of waste, and as a result, it has attracted much interest over the years. One of the branches of the engineering that has arisen with this purpose of eliminating this type of waste is group technology.

JIT in Different Industries

In recent years, Japanese-style management practices, such as Just in Time (JIT) management, total quality control (TQC), company-wide quality control (CWQC), quality circles (QCs), and others (Amasaka , 2022), have been widely discussed both in Japan and abroad. In the literature, several quickly-blossoming articles and book chapters have been published concerning the relevant theories and reports on case studies ((Fred) Raafat & Chen, 1990). After the oil crises in the 1970s, strong competition prompted the Japanese to develop new management systems. JIT management, as one of the Japanese management systems, helped Japan achieve great success. Despite facing difficulties in adapting JIT management to traditional production methods, there is nevertheless a great deal of interest in JIT management in Hong Kong, a city with manufacturing industries as its backbone (Amasak, 2020) .

In the trucking industry, deregulation and fierce competition can be used to explain how Japanese trucking companies are striving to adopt the JIT system. Because of these reasons, a case study on Sun Sang, an air-conditioner sales company, was selected to exemplify JIT delivery in the trucking industry. The Tsuen Wan District of Hong Kong was chosen as the area to study. It is a new industrial area where land value is not as sky-scraping as on Hong Kong Island. The industry concern is one of the factors responsible for the choice of this location. Sun Sang is located in a new industrial building complex where many Japanese trading companies and manufacturers are also based. This case study, apart from investigating JIT trends in the trucking business, also looked at how JIT is affecting suppliers and customers. In the electrical appliance manufacturing industry, fast delivery has become a common demand and the possibility of achieving 100% JIT delivery is quite high (Hou et al., 2013). Established and prospective suppliers benefit because their investment and output plans will be more secure. Besides, the company could obtain price concessions and faster delivery in return for JIT. A case study on Kai

Ping Plastic (Holdings) Co. Ltd. was chosen to exemplify JIT delivery in the electrical appliance manufacturing business. Both the effect of JIT delivery on the suppliers to the plastic parts department and the foreign customers will be studied and discussed.

Manufacturing

Just-in-Time (JIT) is a philosophy developed and successfully implemented by the Japanese companies in the early 1970s. The primary objectives of the JIT system in a manufacturing concern are to minimize inventories, eliminate waste, improve quality, increase the productivity of the manufacturing facilities, and enhance the competitiveness of the companies. The JIT system is responsible for the production and/or purchase of required materials and products in the required quantity at the required time to meet the specified demand promptly and without any stockouts or inventories (Van Wyk & Naidoo, 2016). Since the 1980s, there has been increased interest in JIT and its implementation in manufacturing and, to a lesser degree, nonmanufacturing concerns. A growing awareness of the numerous transitions that companies, especially manufacturers, have started to shift toward, or have already implemented, different elements of the JIT philosophy, such as just-in-time purchasing, production, quality, and total manufacturing practices.

The Just-in-Time (JIT) system has been widely utilized by manufacturing organizations in their efforts to optimize their supply chains and improve their operational performance. One of the major attributes of JIT is the timely flow of materials from suppliers through the various internal activities to eventual distribution to customers. It is found that the timely and smooth flow of materials, accurate processing information, close and continuous interaction with suppliers, and ensuring that firms' procurement activities are carried out efficiently are crucial to Just-in-Time purchasing's successful execution. Additional elements such as product selection, supplier management and relationship building, and the importance of incorporating long term planning as part of the JIT purchasing process are identified. Continuing pressure is exerted on suppliers to ensure they deliver competitive pricing, high quality parts, and excellent service, in the required quantity and delivery frequency. JIT projects have been initiated by companies during the past decade and have become more prevalent since the late 1980s. However, there is still much confusion about what JIT is and its far-reaching implications. There tend to be a lot more glamour attributed to some aspects, particularly to the pull-orientation of the Japanese miracle, and the application of tools such as SMED – single-minute exchange of die, Kanban.

Retail

Supply chain management has been considered a determinant of success. An improvement in this area could improve the government's capability to empower the competitiveness of the retail industry, which would be an advantage to competition. Assessment and review of the JIT system since it started to be used in the company up to the present could result in valuable feedback and knowledge concerning weaknesses, strengths and their impact on the success of the system, as means of improvement. This is the research approach taken by a South African packing hosing and blister manufacturing company SaberTek, since the 2002 implementation of global sourcing and the JIT system.

JIT has been both praised and criticized when applied by the company. Due to a lack of understanding of the concepts and practices underlying the JIT philosophy, a dubious attitude to its effectiveness is an understandable position. A major impact of JIT is on the nature of business relationship that needs to be established with suppliers. SaberTek has been using an EOQ model to re-order from local suppliers due to past reductions of the purchasing department, losing key staff and their knowledge as the result of fraud. Such relationships do not fit the JIT philosophy, where inventory is reduced in order to improve quality, as well as cost effectiveness. The company's purchasing department has been investigated by the CEO, who concluded that it is under a great pressure to sustain business with current suppliers rather than developing new ventures with potential suppliers. One of the key JIT metrics is supplier delivery performance. Local suppliers account for 95-99% of all purchases, that has a clear impact on the supplier delivery performance variable of the JIT equation. Delays from local suppliers result in at least 2 hours down time on the A-line CE54, while also allowing customers to refuse the delivery. A further investigation showed a critical deterioration in the quality of the equipment provided by a significant supplier, creating compatibility problems with the product, causing further disruptions to deliveries. This emphasized the importance of the JIT system in managing suppliers properly, as delivery delays could result in a loss of confidence in business and massive production delays due to re-engineering requirements when a new technology is used (Van Wyk & Naidoo, 2016).

Healthcare

Work organizations around the world attempt to tackle greater competition through the initiation of novel procedures and mechanisms in order to capitalize their

resources and decrease lead times. The reduction of cycle times forces workers to adapt immediately to modifications in demand, which may put them under pressure as a result of the loss of team autonomy (Van Wyk & Naidoo, 2016). In the last two decades, due to increased competition, the trend has been that organizations are forced to invest in their staff members through an education and training intervention in an attempt to enhance problem-solving skills. Some of the objectives of education and training interventions are the improvement of staff members' ability to manage and undertake job responsibilities, promote self-reliance and creativity. It has always been understood that continuous resources must be invested to ensure equipment reliability. The results point clearly to the importance of problem-solving abilities and involvement of staff members within the manufacturing system since they lead to enhanced equipment flexibility and investigate ways of various approaches in order to enhance the robustness of the results. Since the commencement of China's 'Open Door Policy', its economy has undergone what has been termed a 'miracle' transformation. Currently, China has emerged as one of the world's biggest markets, providing enormous opportunities for many businesses. Therefore, implementation of efficient procedures for managing such a huge scale of learners and suppliers is critical. As a result, the demand for successful implementation of JIT systems by these businesses is gradually rising. A recent empirical study has revealed that only a small proportion of businesses in China do actually employ JIT with any level of success. Through interviews and observational research, factors that inhibit the implementation of JIT systems are recognized. Also, by discussing viable strategies, the study hopes to aid in overcoming the challenges posed by JIT's use (Hou et al., 2013).

Automotive

The application of Just-in-Time (JIT) system in a manufacturing process has been recognised as a powerful strategy that assists in enhancing competitiveness. By providing the right part, at the right place, and in the right quantity, the inventory cost is significantly reduced, shortening lead time, minimizing customer's delay, and increasing product flexibility (Hou et al., 2013). As an approach to compete in the global market, many organizations and industries, particularly in the developed countries, have long implemented JIT. Nevertheless, the wide-prevalent application of JIT has not yet been realized in the Chinese industries. As a result, the majority of manufacturers in China still encounter stiff competition in the global market that necessitates them to reduce production cost, improve the product quality, and speed up their products' delivery. As the world's second largest automobile market, with a total of 32.847 million vehicles sold in 2011, China's rapid development of the automotive sector was observed, and it now stands as the second largest nation in total vehicle sales. As a highly competitive industry, both the multinational corporations (MNCs) and local manufacturers in China find it essential to adopt JIT, together with other contemporaneous techniques, as part of their strategic activities to meet the required demand. Thus, to remain competitive, a number of companies in the automotive sector have started to focus on the improvement of their production system, attempting to reduce the lead time through the effective layout in the shop-floor, as well as to efficiently control the production-line for the good quality Short-time delivery. To speed up and improve the production system, these organizations decided to implement JIT. Since JIT can reduce the set-up time as well as to generate a smooth flow right from the supplier through to the clients, the good quality products can be then delivered promptly to the customer. Regarding these significant benefits, these organizations have prudently adapted the JIT policy into their manufacturing strategies, and a differentiated long-term partnership with the particular suppliers has been also established.

JIT and Customer Satisfaction

Just in time (JIT) has gained considerable attention in Western countries, and the performance of companies using JIT in the United States has been investigated extensively. In the extremely competitive markets of industries, customer requirements on product specifications, quantities, and exact delivery dates have become more and more severe, and customer satisfaction is considered to be a key issue. Thus, evaluation of the competitive advantage afforded by employing a JIT delivery method has been primarily considered in the analytical review.

But, generally, manufacturers in the JIT system would like to reduce inventory, thereby relying on a smaller number of scheduled deliveries from suppliers. A mathematical model is proposed to analyze inventory review policies and scheduling policies for a supplier in a JIT delivery system of end items. A set of multiple duopoly-distribution-inventory models is developed to obtain the optimal lot size, delivery frequency, and pricing decision within a finite time horizon.

Monotonicity properties of the optimal solution are also derived. Among the research into JIT systems, much attention has been paid to the management of production and inventory in a JIT production system. A continuous review inventory model for the supplier

based on the economic production quantity (EPQ) policy for the manufacturer is the most common production policy in the literature of JIT inventory systems. Although the manufacturer employs a JIT delivery method and the supplier produces the end items using an EPQ policy, all of the suppliers produce a single item for the manufacturer. Under these conditions, inventory management at the manufacturer is mainly addressed ((Fred) Raafat & Chen, 1990).

Challenges in Implementing JIT

These challenges, current manufacturing practices in small to medium manufacturers and how they can possibly be changed in practice are often considered for JIT as tools, use of MRP as a control system, workforce reasons for batching Operations and the level of JIT awareness amongst staff and other employees. The literature on the implementation of JIT in small to medium firms is found to be surprisingly limited. (Hou et al., 2013) break down the eight elements of JIT Production into two groups; those which are independent of a firm's size and those which relate to the size. These groups are used to review the existing literature pertaining to the application of JIT techniques in small to medium sized manufacturers and to suggest ways in which research may be expanded in the future. The elements which do not discriminate between the size of the firm are the two basic JIT techniques of setting up machines correctly and effectively, and producing goods in the correct quantities at the correct time. Both have expressed the opinion that smaller manufacturing plants may have an advantage over larger firms when applying JIT manufacturing techniques.

From a statistical study on this subject, also suggests that small firms often have less trouble overcoming resistance towards new ideas than do larger firms. suggests that once a company has decided to undertake JIT production it ought to ensure that there is already in place an adequate systems control. To assist with this assessment, twenty questions are posed, the answers to which provide a ready means of assessing the readiness of a company to introduce JIT. The analysis of production activities is a crucial step when planning the implementation of an effective JIT program. Theoretical methods are presented which can be very useful in shop floor problems analysis. This paper presents a model which schedules production and maintenance activities in order to increase the OEE of equipment. Models consider both deterministic and stochastic maintenance times. To supply maintenance parts at the required time a new inventory model is build and analyzed. Outcomes include theoretical results which indicate when to set new orders. Furthermore, it will be shown that for some range of parameters a supplier extending warranty is beneficial for the customer. A multi-scenario simulation study is used to build the Total Opportunity figure. Recommendations for manufacturers are to recognize that without sufficient and appropriate data, JIT shop floor problems are notoriously difficult to implement effectively.

Resistance to Change

INTRODUCTION

The section of the whole production process from the arrival of parts at the dock to the delivery of the completed product and any other material to the dock should be completed in one month. The interval from the time the customer places an order to delivery of that product must be one week. In today's competitive manufacturing market such a statement may sound hopeful, however many manufacturers have already made significant steps towards a total or partial JIT Production system. The underlying emphasis in All Japan and JIT systems is on the production of exactly what is needed, when required. The current production system of a manufacturer wishing to introduce JIT will have to be changed. This paper discusses current Just-In-Time installation at two machine shops and at an injection moulded plastic manufacturer. It is explained that such a revised production system should produce products the customer wants, at the right time, at a rate which will only just satisfy demand, with perfect quality, zero lead time and no waste (H Bright, 1988).

Resistance to Change

The success of a JIT installation in a Job-shop environment is dependent on reducing the time taken to set up machines. Requirements for successful JIT in a Job-shop and Process layout environment are discussed. Eight elements that are needed to establish a successful JIT system are described. Possible initial steps toward a JIT system are discussed. Japanese automotive manufacturers have made major inroads in the North American Automobile market. The basis of their competitive drive is the ingenious application of Just-In-Time Production. Many North American manufacturers are now beginning to adopt similar production systems. The effort required may be tremendous, however it is becoming increasingly clear that the firm who fails to comply will probably not survive in today's competitive market.

Supplier Dependability

About 40 suppliers have built their factories near Company BH to achieve quicker response when they receive production orders. Using this method, those factories could be managed by the labor-sharing

system of Company BH, and thus, the company could add or release the workforce at different suppliers easily. That's why using this method could short the response time of parts and components so that the two-day in-plant delivery could be realized. They have already set up the 2,000-ton warehouse and it is designed to store the small amount of materials for Company BH. From what they said, such warehouse is believed to be used to store the sample materials sent by the suppliers. At present, there are no suppliers which could supply the small amount of materials for Company BH. As a result, keep the safety stock of materials in the warehouse so that the assemblers could work when the production is stopped due to sorting materials. Excess stocks could be avoided to some extent since the suppliers could not supply the small amount of materials. The current situation is that one-ton containers of materials are used to deliver them from suppliers to Company BH. It is really a great waste, for example the maximum 20-ton truck is often used to deliver the seven-ton container. If necessary, this issue could be discussed in details. The transportation costs could be reduced due to the shorter distances. Avoid using trucks to deliver the material which could use a one-ton container. Assist the suppliers to build the warehouse or establish the JIT warehouse in the city in which the suppliers located. Research shows that the suppliers or the subcontractors are far from customer companies and the logistics for small lot cannot meet customer's JIT requirements. In other words, it is critical to have suppliers and subcontractors near the customer plant. About 40 suppliers have built their factories near Company BH and they are only about 30 minutes away by car. Utilizing this method, the factories are managed by the labor-sharing system of Company BH and the different kinds of the production are performed successively. The smaller amount of the shipment could be realized in the area of 50 sq. km., Company BH and the suppliers could actively use the trucks for the materials and parts delivery. Since Company BH uses this method, who will pay the inventory and transportation cost? Those suppliers could participate in the product design and development and propose the better method of the technology. Those subcontractors could also participate in the product development since the molds for such product are necessary. If there is the trouble in the production, the technicians of suppliers and the subcontractors visit Company BH the next day after the occurrence of this trouble. Since those suppliers and subcontractors report the inventory situation by the facsimile every day, the responsibility for the inventory management is strong on behalf of the cooperating with them. On the other hand, disagree to this method since the small number of candidates. On selection the potential subcontractor. The great trouble occurs on trial production since the unique jig is necessary. Please be more specific. Several people who took charge of the JIT implementation of companies with 100 and over 1,000 employees are interviewed. The interviewees asked for the anonymity of the interview content. Company BH decided to interview the department head in charge of the production control and purchasing. Currently, the material is procured from its parent company whose manufacturing activity is similar, and the production plan is proposed by the parent company in return. As a result, the molds to produce the required parts must keep for many kinds of parts and the set-up time of molding process is long. The cooperation with the parent company has the merit to make unnecessary these molds and reduce the set-up time of those parts. Nevertheless, molds are worn out gradually if used for a long time and the claim for the set-up time by the parent company's manufacturing increases continuously. Thus, Company BH has to consider purchasing the molds even though the purchasing cost is not clear. It is revealed that in more than half of the companies, the mold is maintained about five years, and about 70% of the companies have to bear the set-up costs. So far, the selection effectiveness is evaluated by the yield of the mold at the time of the delivery during a 20-production shot after insert-molding. The purpose of this investigation is to initialize and to have a graduated form and to have a lever by this form. Generally, the charges arise in this way are not rejected directly, and the responses are made by repeated questioning. A major issue is the charge of the cost involved in the supplier selection process although there was no subsidy money available. Also, it is difficult for the production preparatory section to ascertain these as costs. Due to the necessity for the production materials of the plastic prototypes in the early tool tryout is dispatched by air shipment. Also, the material is produced by the film insert molding and the production is subcontracted by the other company. However, the film-insert molding is outsourced overseas since there is no domestic company which can do it.

Inventory Management

Just-in-time (JIT) was first implemented by Toyota in the 1970s. This strategic supply chain management strategy enables the company to remain competitive by using inventory management to reduce wastes (Hou et al., 2013). Many downstream companies were forced to change by the implementation of JIT, and the supply chain would then be forced to evolve. There is an urgent necessity, therefore, to provide comprehensive explanations of lower-tier supplier JIT

implementations, particularly in China, in low- and mid-technology industries, and efforts should be made to explore the relationships between upstream suppliers and lower-tier suppliers during their JIT implementation.

Just-in-time (JIT) production has been a mix of success for Chinese automakers and joint ventures with foreign car makers. The implementation of the JIT production system in a Chinese case company in the automotive industry will be studied to fill in gaps in similar research discussed above. Priority will be given to three successful reasons for the case company to have implemented JIT management. To help explain these reasons, several stakeholders including upstream and downstream suppliers and the logistics company of the case company have been deeply involved in the joint efforts to push forward JIT implementation. Data analysis includes a combination of face-to-face in-depth interview, internet survey, and observations. A case company in the automotive industry in China has been studied to observe how JIT inventory management - a key strategy in the JIT production system - is implemented.

Technological Advances Supporting JIT

The case company is the biggest automotive manufacturer in China. The new practices take a strategic and innovative perspective of JIT production. The new JIT practices initiated ensure that the suppliers and the case company can be well integrated for a global competitive supply chain. The new practices of the supplier and the case company provide useful and valuable guidelines for others to follow. The suppliers play a key role in the operation of a JIT system. The case company is supported by a group of subsidiaries and joint-venture companies. The establishment of another joint-venture company was approved, which took a significant investment. The case company's car sales accounted for a large market share. Due to the increasing demand for vehicles, the production has increased significantly. The proportion of local content underneath the case company's vehicles has been increasing since the mid-1990s. The case company planned to practice JIT in a global context after establishment and extend the JIT system to suppliers.

In 2001, JIT production was implemented at five suppliers. An evaluation of the current suppliers is conducted for the selection of the candidates. Performance indicators are employed to examine the achievement of suppliers in quality, on-time delivery, and encourage participation in the JIT program. The new practices of the supplier and the case company focus on the ultimate aim for JIT implementation. There are several practices necessary before JIT production is employed. Qualified suppliers can then produce parts on a pull base. The case company signs a service agreement with suppliers, indicating the responsibilities and the services provided by the supplier. The case company grades the parts to be supplied to determine the significance of parts provided to the vehicle production line. Normally, the graded parts are classified as important or general parts. In order to achieve the zero inventory target, the parts could be stored in a small space. Most of the suppliers have built their production facilities near the case company. The new practices of the supplier and the case company take a strategic perspective and were undertaken in 2001. Interview data are obtained from the case company and its four major suppliers.

Case Studies of Successful JIT Implementation

The automotive industry has gained importance in the Chinese national economy development. The current suppliers in China are small-scale companies. Nowadays many automotive manufacturing companies try to motivate suppliers to engage in JIT. A vehicle manufacturing company, hereinafter called the case company, the largest manufacturer in its domestic market, applies a JIT system. Since October 25th, 1998 the case company starts to plan to establish a JIT information system with its suppliers, a monitoring and controlling system. The company also gave special reward to the best supplier in JIT production every two months according to the evaluation performance indicators (Hou et al., 2013). For this reason, many researchers have examined the different situations and the implementation of JIT in product development, operation and supply chain. However, little research has investigated the implementation and establishment of JIT system with suppliers.

The company has a high effort in JIT implementation since their major foreign customers require that all parts must be produced by suppliers under JIT production system. At present, the company has completed a new JIT system with 70 main suppliers. Incoming components are bulk-delivered on small wagons and each wagon would be accompanied by a level of kanban. In addition, more single-level kanban cards may be used than multi-level to simplify the delivery control. The system monitors the supplier's performance, with electronically captured data used as the input to performance indicators that compare actual with planned delivery, replenishment and usage plans. Once established, reward schemes can be based on regularly calculated performance indicators of quality and delivery service.

Recently, many automotive manufacturing companies have implemented JIT supplies. A case company called

the “Company BH”, a joint venture company set up in China. The products are automatically painted, middle/lower sized cars. Since there are about 100 major suppliers that deliver components parts and fabrics from other cities to the company, the products could be finished by the company's production advantage and shipped back to the home city. At present, the company does not have major competitors in China, but they are gradually entering the market and sharply decreasing the company’s production capacity. To cope with intense local competition and match the increasing variety of color dyes and minor parts with an annual model change, it is essential to establish an integrated JIT system with suppliers.

Toyota

Ever since the rapid growth of the global market, how to enhance the competitiveness of a company has become a crucial issue. Just-in-time (JIT) system technically originated from U.S.A, but it was the Toyota Motor Company of Japan that elevated JIT system to an advanced procedure in production management. Many famous companies in the world have introduced the JIT system, and Toyota is generally regarded as a successful example of JIT system. Normally, the concept of JIT can be interpreted in two ways. One is a narrow sense that is a production system which pursues restriction of inventory accumulation and controls the items to be alike in the very quantity specified by markets. In a broad sense, JIT can be defined as an overall management approach that includes various activities, such as inventory control, production planning, input/output materials control, and bringing-in time shortening of necessary components. The latter is called Just-on-Time, whereas the former is the JIT system discussed here (Hou et al., 2013). Many writers pointed out the advantages of JIT system. Higher productivity, higher quality of the outputs, higher transparency in organization/activities, higher morale of the workers of the factories, desirable environmental effects were named as the advantages. Empirical studies were performed to test those advantages. General trends that were shown by the studies could be summarized in three points. In one, output efficiency increased if JIT were intensified. In two, productivity was higher in JIT oriented plants, which was shown either by a cross-sectional or by a time series comparative studies. In three, the distributive inventory-adjusted production system was more efficient.

Dell

Dell is one of the largest PC and server manufacturers and retailers in the world. Dell’s rise to market prominence has largely been attributed to their direct-to-customer sales model, which allows them to eliminate expensive intermediaries and quickly change pricing at little cost. Dell’s Supply Chain Management (SCM) strategy has played a key role in improving their production process in terms of price advantage and production efficiency. Shortly after Dell identified the benefits of building a strong system, they implemented their Direct Model and built a rapid build to order system that used production to create a competitive advantage. Even though the model was successful, Dell upgraded their strategy in 2001 to make SCM have an even higher level of impact. While SCM is key to Dell’s success, fluctuating market demand has created many challenges. To meet these challenges, two main parts of the supply chain management method need to be designed and constructed. The first part must deal with the system demand problem, aiming to forecast demand and get the best policy for changing the price range. The more complicated part must deal with ingredients, which have a direct impact on the reduction of failure risk on the production line. The purpose of this text is to present the main results related to the development of predicting demand and pricing. In relation to how production failures affect other parts of the system and to provide better solutions for how to prevent this, the demand problem and the problem of parts are considered separately. To avoid any dispute, the study does not consider purchases outside the US because this is a distinctive system with distinctive physical standards and regulations.

Zara

Inditex is a fast fashion company that makes Zara apparel. It is one of the most successful in Spain. For this exercise we will focus on the store in Piccadilly, London. This is the flagship store on Oxford Circus, and is the third Zara store in London. The store devotes its three floors to a unique and extremely wide selection of meticulously arranged, high-fashion women’s clothing items. Most of the merchandise is visible to the passing eye creating the image of a “fashion bazaar” with a fresh and exotic appearance. The night before our visit the store looked almost exactly the same as it did when we visited six and a half years previously. The store employs an army of “commercials”—one for every three customers– who recover the clothes leaving the fitting rooms. Many shoppers stated they found the store enchanting whilst others said it was confusing. They were equally impressed by the varied availability of the clothing and also slightly bewildered by its complexity. This was in terms of striving to cover an extremely wide range of styles but doing so with limited quantities of each item. Often, the items they liked were no longer available in their size. Keep in

mind our store has over one hundred and fifty different clothing collections of which an average 46 are designed in LaCuruna. Thus, the store aims to service almost all possible microsegments but in limited quantities.

JIT and Competitive Advantage

This chapter presents a review of relevant literature on competitive advantage and Just-In-Time (JIT). Due to substantial improvement in productivity and reduced costs, more companies in the manufacturing industry contemplated adopting the JIT manufacturing philosophy. Despite the adoption of the JIT manufacturing philosophy through significant increases in sales and plant facilities, stagnation in the manufacturing sector has resulted in fierce competition that drains company profits (Van Wyk & Naidoo, 2016). Thus, in response to the new competition, some companies seek a cost reduction strategy by improving in-house factory productivity. There are various ways in which factory productivity can be enhanced, for example, by increasing the division of labor, automating, and J.I.T. methods. This study is an attempt to quantify and exhibit the concepts of JIT that exist within the experimental factory of Sabertek.

JIT Production System is a manufacturing philosophy and strategy of production management that can vastly reduce the production lead time between raw materials entering at the factory and the completion of the finished goods. The core of the JIT manufacturing system is the establishment of a multi-worker group in each intermediate process to manufacture respective parts and an assembly team responsible for assembling the respective process parts. In addition, there are other supporting elements such as multi-model multi-work at each intermediate process, multi-function general-purpose machines, self-regulation of defects, etc. Hence, the production organization efficiency of the factory is drastically improved.

Just-In-Time (J.I.T.) production is one of the most utilized Japanese forms and continuously fascinates the producers from all over the world. This is a new approach to material flow management and solution of problems with some surprises for many people and causes the solution of a great variety of old problems that are well known but widely neglected up to now. The suggestions of (J.I.T.) philosophy are especially attractive in medium size businesses and carry potential to release big investment in stock and reduce the cost of orders. Loosening deadlocks and the possibility to produce from raw materials with strictly small quantity of stock cause the creation of new forms of having functions in the field of material flows as well as in total management. This presents some possibilities of practical utilization of the (J.I.T.) system with some commentary and annotations of used terminology.

Future Trends in JIT Systems

Just-In-Time (JIT) systems have played a significant role in the enhancement of competitiveness. While holding inventory is considered important for efficient coordination of supply chain systems, it is also well acknowledged that holding inventory brings about additional costs that may lead a company to lose competitiveness. In addition to the need to manage complex and large scale of supplies and the need for inventory, most other manpower, equipment, time and effort are also highly undesirable. Just-In-Time (JIT) System has been widely recognized as a proven manufacturing philosophy, which believes such inventories should operate on a very efficient basis or even be avoided if possible (Hou et al., 2013). According to this philosophy, only necessary parts and materials should be delivered to an assembly line at the right time, in the right quantity, and in the right condition. This implementment has been popular in most work systems for the automotive industry in the developed countries of the global economy.

Future trends in the implementation of JIT systems are constantly evolving. In the past, JIT systems were not sophisticated: only the inventory amount was calculated, and an automatic purchase order was generated to replenish the different inventory is falling below the predetermined level. Merely reducing inventory levels, however, will not achieve the benefits of the JIT philosophy. It requires close collaboration with the suppliers, long-term and reliable partnership, time commitments, and information sharing to narrow down communication gaps with the supplier. With the improvement of information technology, companies can now share more comprehensive and reliable information with one another without revealing their private information. The replenishment rules are generated. Manufacturing systems can coordinate the purchasing activities, production, and the external supplying companies more closely. Special demands, for instance, the obsolescence of an order under certain condition, can be more robustly addressed. There is widespread acceptance of the importance of standardized requirements, allowing more predictable relations between operating and supplying companies. Similarly, frequently trade agreements concerning prices, discounts, payments, and quantities are agreed upon up front. The necessity to manage a set of as large as possible companies is acknowledged to improve the reliability of the operation. At the same time, a set of companies should be as geographically distributed as possible to obtain shifts in demands, therefore

reducing redundancy of overall stock. To achieve scalability, the underlying technologies are based on a pure software interface, which is agent-based to address the question of ethics; this architecture will hide any competitive advantage of a vendor towards its customer while ensuring the longevity of industry investments. The heterogeneity of vendor's products and infrastructures is managed by allowing a great deal of customization. Hiring and training experts to set up and tune these complex systems are not tenable. To address the issue, portable deployment tools offering automatic configuration of the system and real-time tuning are developed.

SECTION TWO

Practical Aspect

Brief Introduction

Al-Daw Al-Sare'a Electronics Company, headquartered in Baghdad, Iraq, Founded in 2010. The company is located in the light industrial zone in the Al-Shu'la area of Baghdad, known for its numerous factories and industrial facilities. The company employs approximately 150 employees, including engineers, technicians, and production workers. The company's production capacity is approximately 15,000 units of wireless headphones per month, and its products are distributed throughout Iraq and some regional markets. The vision is to become the leading audio device manufacturer in Iraq and the region. Providing high-quality electronic products at competitive prices, committed to improving the user experience and supporting the local economy. The main activity is manufacturing and assembling consumer electronics, focusing on wireless headphones and audio accessories. Community commitment is to train and employ young Iraqis in electronics manufacturing. Challenges include reliance on imported raw materials due to their unavailability locally. The company is also highly competitive with imported products from China and Turkey. The future vision is to expand the manufacture of other electronic devices, such as wireless chargers and smart headphones. The focus is on exporting to neighboring Arab markets. Participation in local industrial exhibitions is to support the national industry. Study Type: Case Study of a hypothetical company operating in the electronics industry.

Primary Objective: To measure the impact of implementing the JIT system on competitiveness by analyzing performance indicators before and after implementation.

Data Sources: Data from Al-Daw Al-Sare'a Electronics Company in Baghdad.

Company Description:

Name: Al-Daw Al-Sare'a Electronics Factory.

Activity: Production of wireless headphones.

Scale: Production of 15,000 units per month.

Operational Structure: Purchasing Department. Main Production Line (4 stages: Assembly, Inspection, Packaging, Shipping). Raw Material and Finished Product Warehouses.

Basic Data (Before JIT Implementation)

A. Performance indicators:	
Indicator	Value (in dinars)
Average Raw Material Inventory	600,000
Average Finished Product Inventory	300,000
Monthly Storage Costs	70,000
Production Defect Rate	8% (1,200) units/month
Production Cycle Time	20 days

10 days	Order Delivery Time
%75	Customer Satisfaction

Steps to Implementing the JIT System:

Phase 1: Restructuring the Supply Chain

• **Changes:**

1. Contracting with three major suppliers to supply raw materials daily (instead of weekly).
2. Reducing order volume by 80% (from 10,000 units/order to 2,000 units/order).

Phase 2: Modifying the Production Line

• **Changes:**

1. Dividing the production line into small work cells for each production stage.
2. Implementing a pull system to avoid congestion.
3. Training workers on multitasking and the "smart stop" (Jidoka) principle to detect errors immediately.

Phase 3: Improving Quality

• **Changes:**

1. Implementing quality inspection at each production stage.
2. Reducing defect repair time from 5 hours to 1 hour.

Data after JIT Implementation (after 6 months):

Improvement rate	After JIT	Pre-JIT	Indicator
%83.3 ▼	100,000 dinars	600,000 dinars	Average Raw Material Inventory
%83.3 ▼	50,000 dinars	300,000 dinars	Average Finished Product Inventory
%78.5 ▼	15,000 dinars	70,000 dinars	Monthly Storage Costs
%75 ▼	%2	%8	Production Defect Rate
%70 ▼	6 days	20 days	Production Cycle Time
%70 ▼	3 days	10 days	Order Delivery Time
%17 ▲	%92	%75	Customer Satisfaction

Statistical Analysis:

A. Mathematical Equations:

1. Percentage Improvement in Costs:
2. Profitability after Cost Reduction:

B. Improving Competitiveness:

• **Cost Advantage:**

- Reduced unit cost from 50 dinars to 40 dinars (▼20%).

• **Speed Advantage:**

- Faster order delivery than competitors (3 days versus 7 days for the main competitor).

• **Quality Advantage:**

o Reduced customer complaints by 60%.

Presentation of Results:

A. Graphs:

1. Bar Chart:

o Comparison of storage costs before and after JIT.

2. Pie Chart:

o Distribution of causes of production defects before and after JIT.

B. Comparison Tables:

After JIT	Pre-JIT	Competitive Advantage
100 JOD/unit	120 JOD/unit	Price
2% defects	8% defects	Quality
3-day delivery	10-day delivery	Speed

1. Challenges and proposed solutions:

Proposed Solution	The Challenge
Contract with backup suppliers.	Delays in Material Supply
Train workers on the benefits of JIT and involve them in decision-making.	Employee Resistance to Change

The practical application showed that the JIT system contributed to a 70% reduction in costs and improved quality and speed, enhancing the virtual company's competitiveness through three strategies: cost leadership, quality excellence, and rapid response.

Formulating the hypothesis in light of the practical results:

Based on the data obtained from the virtual/actual implementation of the JIT system in the company, the hypothesis can be formulated as follows:

"The competitiveness of industrial companies is enhanced when implementing the JIT system, as the results showed:

- A 78.5% reduction in storage costs.
- A 75% improvement in product quality (defects decreased from 8% to 2%).
- A reduction in order delivery time from 10 days to 3 days, giving the company a speedy response advantage over competitors.

CONCLUSION

The use of JIT systems for certain companies may provide cost savings and increased market value. However, if the future state of JIT lines is not properly communicated with the information technology department, a lack of connectivity can arise between the IT department and operations. Consequently, this situation may lead to lost production, especially with the ability to load certain production lines.

Starting JIT lines without the ability to connect to the proper databases to function at current state levels reduces production flexibility. International companies should assess the performability of IT systems to determine their compatibility with JIT line requirements. It is suggested that a future study be conducted examining a more detailed model for assessing IT performability, ensuring the compatibility of future state plans with IT work orders, and quantifying the costs associated with upgrading IT systems.

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