

## **The Experiments of the Application of Just in Time (JIT) Systems in Industry and Services**

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**Abstract:** This study aimed at shedding the light on the most important pioneering experiments in applying Just in Time (JIT) systems in industry and services. Also, benefits achieved by these systems, the most important learned lessons from them and finding out the reasons of the differences of the application results in each of them separately. The study relied on the descriptive approach to achieve the objectives of the study. The relevant literatures have been reviewed which dealt with these experiences researches, studies, theses and books. The study concluded that there is a difference in the achieved results in companies that applied JIT systems. In addition, applying these systems may take a long time which could be up to 20 years and there is a Keeness from companies not to publish their experiences, fearing of coping or participation in competitive advantages. Companies dealt with study such as Toyota motors, Dell, Green Gear, Nigerian companies, Seattle Children's Hospital and International Changi Airport in Singapore achieved a lot of advantages because of applying JIT systems. Some companies faced many obstacles that monitored by the study. These systems focus on process rather than product, so the health sector benefited from applying JIT systems as industrial companies.

**Key words:** JIT systems, industry, services, pioneering, experiments

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### **INTRODUCTION**

In recent years, many corporations exerted concentrated efforts in order to apply JIT systems. Because of variation surrounding the institutions and corporations that have implemented such systems in terms of conditions and factors in which they operate and organizational cultures by which are characterized, the matter requires the study of those factors and conditions. Furthermore, reviewing the fundamental features of some successful experiments in implicating JIT systems which can be guided by them and benefit from them in knowing the benefits of the application of these systems and also identification obstacles and problems that accompanied and faced some experiments. It was necessary also to reviewed and analyze those experiments and practices of foreign, local or regional corporations working in the fields of industry or services, whether corporations that have implemented such systems in whole or in part.

Few foreign literatures focused on those experiments and practices. However, Arabic literatures were limited or rather rare as far as knowledge of the researcher. The available information in both was not sufficient and detailed except the recent studies about the significance and benefits of systems which requires great efforts and

more time to reach those experiments by analyzing several specialized researches and studies to investigate these experiments as well as it has been found that some corporations were eager for not to publish their experiments in the application and benefits resulting from it because they fear of imitation them or they share in competitive corporations (Adeyemi, 2010). Also, they fear of failures or disadvantages that may be appeared by these studies and researches in application or in working systems.

**Research problem:** Most companies in industry and services field face many challenges that affect their ability to compete such as inventory accumulation, obsolescence of production lines, shortage of capital and investment and rising production costs. JIT systems are facing these problems where they do not rely on the foundations of traditional systems. These systems work to reduce production costs, get rid of damaged and defective production, reduce inventory to a minimum and eliminate waiting and lead times. Many companies made intensive efforts to apply JIT systems. Due to the difference of the environments surrounding companies that applied these systems, there is a difference in results achieved by these companies and the advantages gained

from applying these systems which requires studying these experiences to benefit from them. Therefore, the research problem could be formulated through the following questions:

- What are the most important pioneering experiments in applying JIT systems in industry?
- What are the most important pioneering experiments in applying JIT systems in services?
- What are the main benefits and advantages achieved by the companies applying these systems? And there is a difference in the achieved results?
- What are the main lessons learned from the experiences of companies that have applied JIT systems?

**Study importance:** The importance of the study stems from advantages that achieved by the companies that adopted the application of JIT systems and from the different experiments which help companies that want to apply these systems to achieve satisfactory results. In addition, analyzing these experiences and extracting the learned lessons will benefit the companies that want to apply these systems especially literatures dealt with different experiences are relatively few. Therefore, this study is important. It will work to enrich knowledge in the field of JIT systems.

**Study objectives:** This study aims at the following:

- Shedding the light on the most pioneering experiments in applying JIT systems in industry and services and the achieved benefits
- Identifying the reasons of difference in the results achieved in companies that have implemented JIT systems
- Identifying the most learned lessons from companies experiences that have implemented JIT systems

**Literature review:** Previous literature showed the following: The study of which has been applied to 400 producers and distributors of cement in Pakistan, showed that JIT systems application leads to reduce inventory to a minimum and thus reduce the waste and the cost of inventory and production as a whole. Also, it showed that the design of the production process by integration with JIT systems has a positive impact on the product. While the study of which has been applied to 130 of Iran's top managers, concluded that the application of JIT systems led to an increased improving of the financial performance. Also, it showed that there is a positive relationship between JIT systems and growing

the performance of companies and increasing their efficiency and profitability by reducing production costs, improving the quality of products, reducing the ratio of the waste and achieving the competitive superiority. The study of which was applied to 360 of Majorus companies, including Dell company and other companies in the automotive and aircraft manufacturing and others, showed that the application of JIT systems led to increase the ratio of production, reduce costs, reduce direct inventory costs, reduce inventory spaces, reduce insurance costs and reduce the total costs of the product. While, the Japanese companies which applied JIT systems, reduced inventory rates. Therefore, the total annual turnover became much higher than the American companies. For example, Toyota company recorded the ratios of total annual turnover from 41-63 while the American corresponding companies recorded the ratios of the total annual turnover from 5-8 (Javadian *et al.*, 2013). Also, Dell company reduced its prices by 10-15% from its competitors. It assembles >180.00 computers devices every 24 h. There is no >2 h of inventory in its plants and 72 h as a maximum over the entire process. While Cessna Aircraft company in the United States reduced, through applying JIT systems, all kinds of inventory and spaces related to it. The average of storage period of raw materials amounted to 3 weeks. Productivity increased from 40-60%. With regard to services field, especially the health services, the study of (Iswanto, 2015) saw that the application of JIT systems i Seattle Children's Hospital in area of inventory control using Kanban system took 18 month. This system saved >23.000 work hours from doctor's time annually, achieved a return on investment amounted to \$2.5 million in the 1st year and reduced supply costs by 5%. While the elements of applying JIT systems at International Changi Airport in Singapore helped it to eliminate the waste in the airport and reduce the repetitive and routine procedures (Pheng *et al.*, 2011).

## MATERIALS AND METHODS

The study relied on the descriptive approach by the analytical review of scientific references (books, studies, researches and periodicals related to the subject of the study.

**Sources of data collection:** The study relied on the secondary sources in collecting data from theses researches, studies, periodicals and books.

**First: the applications of JIT systems in industrial corporations**

**The experiment of Toyota motor corporation:** JIT was developed by the Toyota motor company in Japan. It is

generally attributed to the work of two employees, Ohno and Shingo. Ohno developed the production process operating, planning and control systems. He introduced a control method known as a two-card Kanban system. Toyota Corporation learned operations and techniques of production processes from Ford Motors company. On this basis, the corporation has developed the assembly process which was called in the beginning "Toyota Production System" (TPS). This system gradually evolved in a manner that during 1980 Toyota company has manufactured a very quality product, compared to their American competitors. Also, this product was at a low cost. As such, Japanese are very sensitive towards waste and re-working or repetitive work. They consider inventory as evil that consumes space and resources. Therefore, Toyota company described inventory as water covering the rocks which refer to the problems of production system. Also the rate of water reveals the rocks and reducing inventory reveals hidden problems. Therefore, many Japanese companies reduced inventory rates to the point where the ratio of the total annual turnover is much higher than US companies. For example, Toyota company's the total ratios of turnover ranged from 41-63 while the corresponding companies in United States ranged from 5-8. Toyota company realized that JIT system will only be successful if the following matters occurred.

- Involving everyone in the organization and his commitment to it
- The arrangement of the factory and the production processes to achieve maximizing outputs, effectiveness and efficiency
- Scheduling quality and production programs to achieve orders more accurately

Toyota company has been present in the market for provision of cars according to customer demand with a minimum of waiting. It has spent 6 year in re-arrangement of organizing, manufacturing and delivery. Its goal was to reduce the average of time between the demand of the seller and delivery in the company's factories in North America to become 14 day, instead 70. The goal of the achievement is not to make the customer happy but to reduce the costs of the seller's stores. In order to reduce the average of the delivery time, the company developed its programs that connect between the seller and the factories and between the factories and the suppliers. By achieving the integration between the supply chain, a supply order became comes from the seller to the company through those programs that is capable on the availability of parts in any places close to the customer.

As for the application of the system, shingo, the Known engineer in the company, said that the corporation took 20 years to implement JIT system (Temesgen, 2004). Some studies pointed to 25 years (Benton, 2007). Also, most other countries took 10 years to get similar results. The basic elements of "Toyota Production System" are eliminating waste, Minimum inventory, small lot size, reducing set-up time, stable production schedule, focused factory, group technology, preventive maintenance, multi-skills works, Kanabn system, Just-in time purchasing, scheduling without overload capacity and problems solving. The study will explore, in the following section, the experiment of one of Toyota company's factories for producing cars located in the United States.

**Toyota factory experiment in Long Beach city, the United States:** This plant was established in 1972 which held on an area of 300,000 square feet. Production space includes 14 building. It is located in Long Beach city, Florida. It manufactures four models of light transport vehicles. The number of factory's workers is 375. Its annual production exceeds 150,000 units. The factory began in the application of JIT systems gradually where it began the application in the assembly unit and go to the other units. A group of managers had certain responsibilities with regard to the application. By an introductory model and planning the details of application, these systems were applied to the factory.

**Kanban system:** Kanabn system is the primary source of control over the productive system although, it was working beside the system of Material Requirements Planning (MRP). The factory uses Kanban system with single card which uses the order moving and production. The cycle of production in the factory uses from 400-500 card a day. The colors of these cards are codec to illustrate the different phases of manufacturing and raw materials. Production schedules in this factory are characterized by rigor, consistency, in addition to allowing a small amount of safety. Main production schedule is used to count Kanban cards that rely on visual control system that contains colors, lights panel and hooks panel on which cards put.

**Relationship with suppliers:** a limited number of suppliers have been chosen for >2 years with establishing good relations with them.

**Control over production:** the factory also uses the visual censorship in selection and shipping department, in addition to buzzer is used to indicate that there is out of

order machine and need to fix it. Furthermore, the factory uses computer panel in the assembly department which contains colored lights to clarify the status of machines and orders and also provide workers with information on production schedules in return for the actual production and the reasons of differences in order to assist them in taking corrective procedures

## **RESULTS AND DISCUSSION**

**Dell company experiment:** It is an American company, based in Round Rock, Texas. It is specialized in computer and technology field. It develops, manufactures, sales and supports the personal computers and related products and services. By 2008, Dell employed >88, 000 people around the world. It evolved during the eighties and nineties of the 20th century. In 2008, it ranked second in sales of computers among computer manufacturers, after Hewlett-Packard company, known as HP. Dell sells currently personal computers, servers, data storage devices, network switch, software, computer peripherals, printers, mp3 players and electronics built by other manufacturers (Wikipedia site). In January 1998, Compaq company was the biggest seller of personal computers, according to Forbes magazine. After Dell company applied JIT systems to its inventory, Compaq company lost \$2 million that caused the resignation of its chief executive. It did not respond quickly enough to this dramatic change but it integrated eventually with Hewlett-Packard company. Both companies lost a large share of the computer market for the benefit of Dell because the structure of cost followed by Dell makes it difficult to compete with it by other competitive companies. Low-cost production system which is one of the advantages of Dell, made it able to be fewer prices than its competitors by 10-15%. Dell company is the only company in its field that uses JIT systems effectively. It caused revolution in selling personal computers. It adopts the policy of strategic focus to reduce inventory allowed it to keep just 5 day of inventory which is a smaller amount of inventory of any company in this industry. Gory Mike said that most companies in the field of computer store between 20-25 days. The limited amount of inventory held by Dell created a value for its customers. By integration the entire value chain (innovation, development, design, production, logistic services, service, delivery and sales) a vision has been created that allows the company to invest in what customers want rather than guess what they want in addition to creating strong relationships between the company and its customers and suppliers. The minimum inventory provides the company an economic advantage

because computer's components value and manufacturing declines by 1% in the week, making Gory Mike said in answering about question in April 7, 1997, if he thought that Dell need to change the process of its inventory, he told that: "computers devices value decreases at a very high rate. Also, keeping inventory loses computer amount of its values the longer the period of its storage, sooner to deteriorate while Kevin Dollins, company's chief executive, said that: "13 years ago, Dells inventories amounted to 20-25 days of inventory in a sprawling network of warehouses. Today, although Dell gathered >80,000 computers every 24 h, it has no >2 h of inventory in their plants and a maximum of 72 h across the entire process.

### **The obstacles and benefits of the application of JIT systems in Dell company (www.Ukessays.com)**

**First: obstacles:** The company must do an accurate study to ensure that the storage process is working according to what is hoped from it. The matter needs, before implementing, a very long period and balance between risks which may face the company's business. In addition to that this matter was very difficult and costly because it may have initial costs which may disrupt some works. However, despite these difficulties, Dell company faced them. It realized that it will obtain many benefits in the long term which would make it more profitable and will allow it the continuous improvement within its business practices.

**Second: the benefits:** The company has enjoyed many advantages and benefits gained from the application of these systems. These advantages are: a reduction of spent capital on inventory which could be spent on other areas such as advertising and marketing. Furthermore, these systems have positive results on the financial figures of business which achieved a cash conversion cycle by applying those systems and this allowed to the company a huge flow of funds in its business which has had the encouraging effect on its profitability. The company achieved other benefits. For example, it reduced the cost by reduction of used resources in production of computer devices which helped the company to get rid of waste on the basis that JIT systems cancel the costs of storage and warehouses space. Also, this matter allows it to inject liquidity into the company's other parts.

### **Experiment of Green Gear company in the United States:**

Green Gear cycling, Inc, of Eugene oregon, designs and manufactures a high-performance travel bicycle, known as Bike Friday. It is the best-selling of the world. It suits the narrow storage space or the place in which bags put on

the plane as usual baggage where it can be folded inside handbag, (www.bikefriday.com). Green gear's goal, from its inception in 1992 has been to produce a high-quality, rapid and economical bike. This goal suggested a mass customization strategy requiring fast throughput, low inventory, work cells and elimination of machine setups. It also meant adopting the best practices in operations management with a major focus on Just-in-Time (JIT) and supply-chain management. Green gear has carefully integrated just-in-time manufacturing and continuous improvement into its culture and processes. Green gear's processes are very puzzling like its product. It is a relatively small company, its sales amounted to \$3 million, its employees are 30 and its space reached to 17,000 square feet of production area. It uses the principles of advanced manufacturing. It took these principles from Toyota Motor Corporation and other companies associated naturally with the larger factories. It divided management between Alan Scholz who undertakes the business side and his younger brother, Hanz, product designer and development director. Due to the uniqueness of its products, the company will be able to control the higher price of these products as well as control the customer and make him pay in advance. The list of bike Friday passengers contain inspector of nuclear weapons who requested a bike to see if there are weapons of mass destruction in Iraq or not as well as David Robinson in San Antonio Spurs center, NBA player, Dick Smothers, Comedian actor, Tour Ole Frane winning with Greg Lemond (Stevenson, 2002).

Trough collaboration with suppliers, Green Gear company has been able to develop and implement JIT shipments which helped to reduce inventory levels. By inventory classification at the point of use and the development of internal systems that support small quantities that re-ordered and re-organized, the company became able to reduce inventory and raise quality. This success is due to the use of JIT system. It is an effective system because it allowed the company to reduce inventory and raise quality. These systems known as Kanban systems. And often use a simple signal such as the card instead of using the formal request so as to refer to the need for more parts.

In order to achieve competitiveness and efficiency, managers in Gear company wanted to maintain the overall productivity from raw pipes to the final shape of the bike in less than one day. Manufacturing layout with high production capacity require processing or removing set-up processes. This leads to two stages of flow lines which are: dual bikes stage and single bikes stage. Seven work cells related to the two lines are spare components from three supportive cells which provide

secondary assemblies and coating powder for the cover and wheels. They receive orders via Kanban cards. Productivity time for each cell is to be balanced to fit with others. Work cells that are well-designed in this way contribute to the rapid production in Green Gear company, while working in-process is reduced.

Each bike has been manufactured according to its size and then it is immediately shipped when it was done. Therefore, JIT system, in which industrialization is done according to order, requires few materials, a few inventory from working in-process and zero inventory from the finished goods. The cooperation of suppliers, effective work cells and the removal of set-up processes contribute to reduced inventory and help Green Gear company in its continuous quest for manufacturing bikes rapidly (Heizer and Barry, 2006).

**Experiment of the application JIT systems in the Nigerian companies:** Since the launch of the National day of productivity in 1991 by the Federal Government of Nigeria, there was awareness to improve productivity in the public and private sectors. Attempts and efforts were needed to mobilize the local initiatives to reduce inefficiency and lost time in the production process for improving processes and quality in production and quality concerning product and service. Nigerian government and specialists interested in improving productivity. The goal lies in promoting the concept of JIT systems on a large scale through workshops and seminars. There are only a few Nigerian companies that apply JIT systems while there are many companies, especially small ones, are still not aware of JIT systems. Although there is a fear of failures, few companies applied this system successfully.

First, the obstacles of application of JIT systems in the Nigerian companies. The factors hindering the application of JIT systems in Nigerian companies pertain to suppliers, product, production, human factors and other ones.

**Suppliers:** Factors pertaining to suppliers are: the lack of control over the timing of shipping external suppliers. This matter is one of the problems facing the Nigerian companies that apply JIT systems or that have not applied them because Nigeria is not rich in natural resources and relies on the outside. Also, the shortage of trusted suppliers (quality or cost) that could cause the stoppage of production lines, in addition to not predict the amount of the required supply per shipment which creates problems towards the application of JIT system. This matter leads to keep large amounts of a safety stock.

**Employees:** Factors relating to employees are: lack of commitment by administration which is the most dangerous factor. Therefore, factory must be re-designed and re-planned and workers must be educated concerning the added value activities. Those of the most important reasons why few companies in Nigeria apply JIT systems and educate top management about the benefits of these systems and the ways of applying them successfully. The second of those obstacles with regard to workers is the conflicts between common interest administrations. Also, there is resistance by employees concerning applying these systems and the lack of commitment and knowledge of those systems.

**Product:** High product mix is the most important factors pertaining to product as wells as the irregular demand. Therefore, the Nigerian companies resorted to unify parts and depended on flexible manufacturing systems.

**Production factors:** Low production volume is the most common problem, in addition to the problem of factory re-design which is one of the requirements of JIT application.

Nigerian companies ways to overcome the obstacles they faced when application: Most Nigerian companies which applied JIT systems, claimed that the key of success is to overcome employee's obstacles in the first place and that administration must be fully committed and that JIT systems philosophy does not require less than a new way of thinking and a cultural change led by administration to convince subordinates of application of these systems on condition that managers themselves to be ready and committed to the application. Companies that implemented JIT systems take 3-6 months in search of the importance of application. They had 4-5 individuals in the team of JIT project. Other companies had >9 individuals.

The objectives JIT project's team were analyzing the philosophy of these systems and benefits and obstacles of their application. Also, if those systems can be applied or not. There is an agreement between the companies implemented JIT systems that learning JIT systems is a significant tool for the success of the application. And they need to manage processes change by learning JIT in the first place. Benefits achieved by Nigerian companies that have implemented JIT systems. Despite, the immense benefits and advantages achieved by Nigerian companies, they have not been published. Furthermore, there is a scarcity of local researches and documentation of these results. These companies, also did not want to declare their achievements because that matter means sharing the

Table 1: Benefits JIT systems application in the Nigerian companies

Benefits JIT systems application	Repetition	Percentage
Decline inventory investments	11	69
Significant saving in space	11	69
Increased flexibility	8	50
Worker's high morale	7	44
Low supply time	7	44
Improving productivity	5	31
Reduction in customer complaints	5	31
Reduction in defects	4	25
Reduction in machines breakdown	4	25
Reduction in set up time	4	25

competitive advantage. Benefits achieved by Nigerian companies after application of JIT systems are as follows (Table 1).

**Second: JIT systems applications in services industry:** Improving the operating methods and reducing waste of each stage is not acceptable only in manufacturing companies but it has also a huge capacity in other sectors. The international competition forced service sectors in India, for example, to use innovative technologies to meet the challenges and problems that are imposed on those sectors. JIT systems are a vital matter for manufacturing and services industry because they focus on the process and not the product. The matter will be seen through the experiences of some service sectors such as health care and how they benefited from JIT system to minimize waste and reduce inventory to the lowest level and control it tightly as well as other sectors will be displayed in this section. Due to the increased importance of the services industry that have become a profitable sector for companies and governments and due to the need for developing these services by our societies, this section has been allocated to display the experiments of service sectors benefited from JIT application. The other service sectors can benefit from these experiments.

**JIT systems in health services sector:** Although, the idea of using JIT systems in managing hospitals inventory in 1980 has many benefits, it is still not acceptable on a large scale. This is attributed to the relatively few and available researches that dealt with the application of JIT systems in hospitals, compared to many researches dealt with the application of such systems in the industrial sector. Most case studies dealt with the application of such systems do not give a guarantee that such systems will work well in hospitals. They have not given further assurances that these systems will be beneficial for them.

The doption of JIT systems brings financial and non-financial benefits. Despite those benefits, some hospitals believe that JIT system is not the right option for them. There are concerns about a lack of inventory

that may jeopardize the lives of their patients. Therefore, some studies suggested that safety inventory is to be maintained to avoid dispensing completely with inventory. However, if the quantity of safety inventory was very large, it would be a problem which is inconsistent with the objectives of JIT systems. Furthermore, the application of this system requires a long period of commitment. In the case of non-hospital satisfaction of this system, it will be hard to go back to the original system. The application JIT systems, is not a computer program that hospitals can buy it but the matter requires a radical change in inventory management. Also, hospitals staff need to know those systems, concepts and functions and then provide enough time to adapt quickly the new system. Hospitals must balance between the costs of implementing those systems and the benefits expected to be achieved before making a decision of the application. Moreover the gradual application will relieve hospital's anxiety and fear (Walker, 2010).

Eventually, hospitals are constantly looking for innovative ways to contain costs without sacrificing quality and meeting the needs of patients. There is a consensus among researchers that JIT systems is useful to reduce costs and improve quality and it can be applied also to service sectors such as health care services because it employs processes that add value to the basic inputs used the final product. Therefore, the successful application of JIT systems is a vital matter for manufacturing and services industry because it focuses on process not on product (Aradhya and Kallurkar, 2014). JIT systems can help health care services to be the most advanced and efficient.

#### **The application of JIT systems in health care**

**Flexibility:** The health services characterized by supply and demand fluctuations. Therefore, health care institutions must be able to achieve a balance between supply and demand. The labor force is determined often by flexibility and the ability to do >1 job. This concept can be applied to nursing where hospitals can re-organize the nursing units according to the concept of intensive health care. Medical facilities should enjoy flexibility through filling prescriptions, making testing and patient's treatment without moving them from one building to another. The concept of flexibility includes using workers with multiple skills which reduce dealing patients with new employees throughout a day.

**Technology:** JIT systems support the use of technology such as implementing assembly processes. There is a high control in the shadow of using mechanism. Health care processes depend mainly on medical specialists but

the use of technology can improve the quality of health services to a large extent because specialist doctors are more dependent on advanced and sophisticated machines.

**Set-up and design:** The sound set-up plays a key role in providing the good health services. Health care institutions must remove communication barriers facilitate effective continuity and providing effective communication means. Bottlenecks and congestion during the delivery of health care services can be devastating to the quality and success of the organization in the delivery of health care.

**Simplification:** One of the benefits of JIT systems is to reduce set-up time. Efforts should be exerted to reduce set-up time beginning from the entry of orders and determining the planned schedules.

**Standardization:** Other areas can be concentrated by the unification of work, procedures and resources. The unification of activities reduce time and the high cost of staff training, thereby productivity will be greatly affected.

**Quality:** Total quality management is one of the most important prerequisites for the success of JIT systems. Doctors, specialists, nurses and paramedics must do their jobs properly and rightly from the first time which requires adequate learning and training.

**Purchase in light of JIT systems:** A lot of papers suggested the concept of purchase according to JIT systems and inventory reducing programs. Purchase systems under JIT systems characterized by dealing with a small group of suppliers closed to the organization, supply is frequent, forming partnerships on the long term with purchase companies under such operating conditions where relationship with suppliers has been established depending on mutual trust, openness, exchange of information and selection of suppliers at the highest level of quality and reliability of delivery. This is what must be applied to the purchase processes of health care institutions.

**Intensive labor:** Health care processes with intensive labor and competition were an incentive to dismiss incompetent workers. The providers of health care services must not commit the same mistakes of manufacturing companies to reduce costs because cost cutting in this way makes health care providers more efficient in the short term but it will not be able to competition on the long term.

**Damage:** It refers to the concept that health care services cannot be saved or stored such as doctor's leisure times and the loss of that opportunity which may cause the waiting of patient.

**Procedures:** Both wait and doctor's interests are two important factors in patient's satisfaction. The interview of doctor's closely relates to their duties and functions. Procedures under JIT systems improve procedures that accelerate these processes which help doctors to focus more on their works and leads to patient's satisfaction.

**Training:** Employees training play a key role in implementing JIT concepts in health care processes. The employees of the hospital's proper training and empowerment provide a great deal of flexibility to meet fluctuations of demand and the proper use of the hospital staff. Training will help to raise the employee's ability to identify and solve problems and points of operational weaknesses that hinder the organizational effectiveness and efficiency.

**Continuous improvement:** The concepts of continuous improvement and total quality control in JIT systems embody in employee's participation and reducing inventory. Due to the nature of the intensive work of health care processes and the need for scheduling employees to provide services, all employees in the hospital must be allowed to participate in the process. Thus, it is necessary to help employees to get a chance to offer suggestions and improvements and get the awards. With respect to services, focus must be put on the work rather than capital (Gupta, 2012).

**The experience of Seattle Children's Hospital:** Seattle hospital is located in Seattle, the United States. It specialized, for >100 years, in meeting the physical, emotional and developmental needs of children from infancy to adulthood ([www.seattlechildrens.org](http://www.seattlechildrens.org)). Application of JIT systems in the hospital ([www.hfma.org](http://www.hfma.org)).

The main hospital contains 250 beds and receives 300 thousand visitors from internal and external patients annually. The cost of storage in the hospital was high because of redundancy and the shortage in some supplies and medical materials. The excess and stored supplies throughout the hospital were obsolete. The inadequacy of some materials led to prompt order moving which was very costly and in large quantities because it was outside of contracts with the hospital's suppliers.

The hospital adopted JIT systems and the method of inventory control (Kanabn system) in order to determine

optimal inventory quantities for supplies. The hospital has analyzed the historical data to know the average of consumption and the patterns of usage for each class. And then, the hospital and key suppliers set Kanabn system with binary boxes for most of its supplies. Kanabn system's function is to create visual signals to monitor the need for more than a particular item. Employees have been appointed to examine boxes (from 5-6 h) and examine the empty boxes to refill them.

The arrival of new supplies usually come in a few hours beginning from order time so as to reequip the empty boxes (at the same time, doctors are using the supplies of the second boxes). This system (Binary boxes) ensures uninterrupted supplies and excess inventory. Purchases department's chief and his deputy believe that such system is very simple and easy for medical teams to follow it. The clarity of vision that appears on the main control screen panel is the key to achieve success in this system because of the speed of stock movement which can be easily monitored and the amount of the order that can be easily adjusted according to actual needs. Although, this system took 18 month, it saved >23,000 h of doctor's time annually and achieved a return on investments of \$2.5 million in the 1st year. Also, the costs of supply has been reduced (amounted to 5%) and the total cost reached \$200,000.

**The application of JIT principles on the Changi International Airport (Pheng et al., 2011):** This airport has a long history dating back to when terminal (Adeyemi, 2010) first commenced operations. Currently, there are three terminals which operating in the airports. Since its opening in 1981, the airport has made its mark in the aviation industry as a benchmark for service quality excellence. It won over 340 awards, including 19 awards as the best airport in 2007. Being described repeatedly as one of the best airports globally for its high efficiency, terminal 2 started operations in 1990, followed by an extension project in 1996. Deploying a Linear form that runs parallel to the runways, It is located adjacent to terminal (Adeyemi, 2010) toward the South. Also, terminal 2 inaugurated Sky-train system that links the tow terminals. It occupies an area of 358.000 m<sup>2</sup> and is able to handle 23 million passengers every year. Terminal (Benton, 2007) was opened in 2008. Its cost amounted to \$1.75 Billion. Its space is 380.000 m<sup>2</sup>, that is located directly opposite terminal (Aradhya and Kallurkar, 2014). It is the largest among the three terminals. The terminal itself has seven floors with three levels of basements and four levels above ground.

**Application of JIT principles:** There are seven principles according to JIT concept which are: elimination of waste,



Kanabn/Pull system, uninterrupted work flow, total quality control, top management commitment and employee's involvement, supplier relations and continuous improvement.

**Elimination of waste in the airport :** It refers to eliminating all unnecessary inventory and reducing or minimizing wastage. In the context of the airport terminal, it can be referred to the minimizing of waste as applied to the airport layout and its work processes. The reasons of waste are waste from over-production, inventory waste, waste from product defects, transportation waste and processing waste, waste of waiting time, waste of motion and waste of space and energy.

**Kanban or pull system in the airport :** Under the Kanban system, the service does not need to be produced and stored but it will be supplied when the need arises. Some airports use push system and produce more than they need in order to maintain quality standards which is not desirable. Unlike manufacturing, the demand for certain things, especially services, cannot be predicted such as the trolleys used in the airport terminal. It appears difficult to determine whether a passenger will pick up a trolley to use or not because this action is dependent on the passenger's preference and the amount of baggage carried. To provide good quality services, excess trolleys must be provided because the airport management cannot have less than what is necessary for the passengers.

**Uninterrupted work flow in the airport:** The airport terminal can use the design of simplification and automation technique to install the easiest route for any passenger to go through without difficulty and without the help of signage. In addition, it has been proven to be strategically useful in the changi International Airport. The technique of reduction of set-up time process does not appear to be relevant in the airport. This is because airport processes are not concerned with the manufacturing of products which would involve the tooling of machines.

**Total quality control in the airport :** Quality control in the airport means that responsibility is delegated to all the employees to ensure excellent work quality. The employees play an important part in exploring ways, through their brainstorming sessions and discussions, to achieve excellent work standards through quality control circles.

**Top management commitment and employees involvement in the airport:** Employees at all levels must be involved to

achieve the most benefits from a good spatial layout in the airport. Airport leaders and top management must believe in consulting widely and appreciate the need to work closely together with employees and customers to ensure the best possible operating structure for the airport.

**Supplier relations in the airport:** The quality provided by suppliers ensures the service excellent in the airport. Any external party who provides the airport with a service can be considered as a supplier. The JIT concept requires the suppliers to provide consistency and high quality in their performance or service. The suppliers should be producing quality products in the right quantities at the right time to suit the customer's needs.

**Continuous improvement in the airport :** The aim of this principle is to improve productivity through the layout of the terminal. In the context of the Changi International Airport, lessons learnt from terminal (Aradhye and Kallurkar, 2014) were examined and used for improvements in terminal (Benton, 2007). The airport always takes steps to achieve continuous improvement in it. Therefore, the airport has been able to maintain its status as a world-class airport for many years.

**The learned lessons from these experiences:** There are learned lessons from these experiences by analyzing the experiences of companies adopted JIT systems and the most important of which: the study of the experiences of companies that adopted JIT systems and identifying the advantages gained from the application process and the challenges and problems encountered during application can be useful for companies wishing to adopt the application of these systems, especially after studying the circumstances that accompanied the application process. There is a difference in the results achieved by the companies applied to JIT systems due to a variety of reasons that have been referred to them in the results of the study. So, the companies desiring the application of these systems must look for the effective application requirements and applying all elements of these systems to achieve the best desired results. Applying this system requires patience where the application process and the desired results take a long time. For example, Toyota company took 20 years in the application process and then most other companies took 10 years. Applying these systems must be gradual to avoid risks that may result from the comprehensive application or failure in the application. It is important to start with an experimental project away from the existing productive system, then applying to a part of the existing productive system

until getting to the comprehensive application. The 5-deploying the experiences and benefits of the application by the companies applied these systems may help the other companies in reducing risks accompanying the application process and reducing failure rates in the application process. JIT systems can be applied to industry and services alike. However, there are elements of the system are not compatible with the nature of the service. These systems are comprehensive philosophy to eliminate waste, improve productivity and maximize competitiveness in all various kinds of companies and organizations. Belief in the importance and benefits of these systems mad a company as Dell bears high costs and faces risks accompanied the application process, making it more profitable in long run and occupied an advanced position in the sale of computers and surpasses its competitors like Compaq company which lost a large share from its share in the market. This is due to the low production costs enjoyed by Dell company and the strategic focus on reducing inventory and simplifying the delivery process.

The health sector, by applying Kanban systems in inventory was able to benefit from the advantages of these systems such as reducing waste, minimizing inventory to its lowest level, monitoring inventory and achieving flexibility. The previous matters encourage the other health sectors to adopt these systems. Despite the high cost incurred by the Seattle children's Hospital, USA, due to applying these systems which amounted to \$200.000 and the period of the application process which amounted to 18 months, it was able to achieve a return on investment of \$2.5 million in the 1st year, saving 23.000 h from doctor's time and reducing supply costs to reach 5%. Success and speed in application reduce, to some extent, the credibility of the doubts of hospitals which did not applied these systems. It is difficult to predict the demand of services due to the nature of work at airports, it is difficult to predict the demand of services provided within the airport such as carry bags trolleys and other services. In addition, all elements of these systems are not suitable for application in the airport. However, International Changi Airport in Singapore was able to apply some elements of JIT systems that helped to eliminate the waste in the airport by reducing the repetitive and routine procedures.

There are benefits as a result of applying JIT systems in companies covered by the study which are: improving productivity, increasing organization's flexibility, rising employee's morale, achieving and supporting the competitive advantages, reducing set-up, lead and machines breakdown times, reducing customer's complaints, saving in the factory spaces and eliminating inventory. There are obstacles and challenges can face

the companies wishing to adopt these systems which are: the lack of the trusted suppliers, the lack of commitment and supporting of top management, re-designing the factory, the high cost of the application process, length of time spent in the transportation, loading and unloading and the difficulty of customs procedures. These constraints may prevent the application of these systems. The study concluded the following: there is a difference concerning results achieved by companies that have implemented JIT systems. This is due to many factors, including the nature of the internal and external environment, the extent of benefiting from the successful companies experiments, the extent of content of the advantages of these systems, the degree of employee's supporting and conviction of these systems.

Applying these systems may take a long time. Therefore, we need to patience to achieve the desired results. For example, Toyota Motors Corporation took 20 years to apply these systems. Most other companies take 10 years.

There is a Keeness by some companies concerning not to publish their experiences for fear of coping these systems, sharing in the competitive advantages in the application or work system. Many Japanese countries reduced inventory rates where the ratio of total annual turnover became much higher than the American companies. Toyota motors company's total turnover recorded from 41-63 while the corresponding companies in the United States recorded from 5-8 of total turnover. Dell company was to be able to reduce the costs of production after applying JIT systems and that made it able to be less than its competitors by 10-15% because it adopted a strategy to reduce inventory and simplify the delivery process. This matter made it maintains only 5 days of inventory. There were obstacles faced Dell company when it applied JIT systems which are: The very long period needed by the application process, the costs of application and risks associated with the application process. However, it became more profitable as a result of applying JIT systems.

Green gear bikes company was able to reduce inventory rates, raise its quality level. It produces bikes according the demand and shipped them immediately upon completion, making the producing of bikes rapid. This was due to applying JIT systems. There are few Nigerian companies that applied JIT systems while there are many companies, especially small ones, don not apply them. This is due to the fact that these companies do not know these systems. There are obstacles faced the Nigerian companies when applied JIT systems. These obstacles are: the lack of the trusted suppliers, not to

control the timing of the shipment of the external suppliers, the lack of commitment of the administration, the existence of conflicts between common interest administrations, the existence of resistance by workers, the problem of re-designing the factory and raising the mix of products. On the other side, companies that applied JIT systems reaped many benefits such as reducing set-up and lead times, reducing machines breakdown, reducing the complaints of customers, raising employee's morale, improving productivity, increasing flexibility, saving a lot of space and reducing money which were invested in inventory.

The services sector achieved satisfactory results by applying JIT systems such as the industry sector because these systems focus on process and not product. The idea of using JIT systems in the management of hospital's inventory began in 1980. Despite their benefits, these systems have not received a great acceptance because of concerns that have not been studied enough. Most companies want to be reassured when adopting these systems. These systems need a long time, the fear of depletion of inventory, jeopardizing patient's lives and the matter requires enough time to adopt the workers with these systems.

Applying JIT systems in Seattle children's hospital take 18 months. However, these systems saved >23.000 h from doctor's time annually and achieved a return on investment of \$2.5 million in the 1st year of its application as well as reduced the costs of supply by 5%. The total cost of application amounted to \$200.000. The principles of JIT systems have been applied to International Changi Airport in Singapore. These principles are: eliminating the waste, Kanban system, Uninterrupted work flow, total quality control, the commitment of top management, the participation of employees, relations with suppliers and continuous improvement which proves that the principles of these systems can be applied to services and industry and achieve satisfactory results.

### **CONCLUSION**

The research acknowledges that there is a difference between results achieved by the companies applying JIT systems. This is due to several reasons. The extent of the company's professionalism in managing the transition to JIT systems. Also, the ability of the company to prepare and encourage employees and patience on results. The extent of the company's gains from the successful companies' experiments applied JIT systems. In addition, studying the obstacles and challenges facing these companies and how they overcome them. Companies have benefited from the

experiences of other companies before applying these systems have achieved better results than other ones.

The nature of external and internal environment of the company such as the prevailing organizational culture, the extent of encouraging and supporting top management and its conviction with these systems, participating and supporting employees, the extent of the availability of the required financial resources for applying these systems, the extent of customs procedures facility in the case of importing from abroad, the extent of suitability of energy prices and its availability, the extent of the ease of loading and unloading, the speed of transport and the availability of suppliers who accept working under JIT systems.

The extent of the company's application for all JIT elements where it is known that the application of all elements of these systems together achieves satisfactory results. The study of the company's effective implementation requirements and the study of the steps of applying these systems in companies adopted these systems, all these matters helped the company to achieve better results from companies that did not do so.

### **RECOMMENDATIONS**

It is necessary to benefit from the experiences of successful companies in applying in JIT systems. Also, understanding circumstance and challenges they faced and how they overcome these challenges and problems. It is important to encourage companies that implemented JIT systems to spread their experiences in the application in order to benefit the other. Patience on the desired results from the application process must be a necessity where companies take a long time to achieve the desired results. For example, Toyota company took 20 years while most other countries take 10 year to achieve similar results.

It is necessary to overcome the costs of the application process and facing risks that accompany the application process because companies will obtain many benefits on the long run such as Dell company. By graduation in application, these problems and challenges can be faced. It is necessary, also, to study obstacles that faced companies applied JIT systems such as Dell company and Nigerian Companies that the study dealt with them. Furthermore, it is important to benefit from strategies through which these problems have been faced in order to ensure the effective application.

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