

STUDY ON PRACTICALITY OF JUST-IN-TIME INVENTORY MANAGEMENT IN A CONSTRUCTION PROJECT

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Abstract: Indian construction environment has changed drastically over the span of last three decades. All the departments in construction industry need to cope up with the change occurring in the industry over time. Inventory management aims at optimization of inventory investment to ensure increased efficiency within the construction process.

In our traditional system, unfortunately, inventory plays a role of asset whereas it is most expensive liability. It is important to bring new practices into implementation so as to stay alive in the competition. Just in Time technique (JIT) is one such initiative that can enhance inventory management without large investments.

JIT is a lean concept which increases efficiency and decreases waste by receiving raw materials only as needed for production process thus reducing inventory cost. It is best suited to small and large scale projects as it does not require major financial investment. This project covers a case study where the proposed system is implemented and compared with conventional approach of inventory management on a Residential building (Kamela Rehab Kondhwa, Pune) to demonstrate the usefulness of JIT in terms of cost, and to increase its base of application in Indian construction industry. The conventional material procurement procedure will be studied thoroughly and the JIT philosophy will be used to reduce the cost of project efficiently.

Keywords: Inventory management, Just in Time, Cost Reduction.

1. INTRODUCTION

1.1 General

India is a developing country and construction industry plays a vital role in its economy. The competition in this field is at its peak. The construction environment has changed drastically over the span of last three decades. All the departments in construction industry also need to cope up with the change. Inventory management is the soul of Material Management department which aims at optimization of inventory investment to ensure continuity in availability of materials. In our traditional system, unfortunately, inventory plays a role of asset whereas it is most expensive liability. The conventional methods of inventory management have been in use for many years. It is important to bring new practices into implementation so as to stay alive in the competition. Just in Time technique is one such initiative concerning inventory management [14]. Today construction industry needs to minimize cost in addition to improve quality and on-time delivery. According to lean manufacturing, "inventory" is important factor of any construction firm that increases cost, reduces profitability and requires more working capital without adding any value to the customer and organization. This fact was discovered by Toyota Motor Corporation and they developed a unique "Just-In-Time" technique to reduce inventory to the minimum possible degree. Just-in-time (JIT) is a stock control strategy used to increase efficiency and decrease waste thereby lowering inventory prices [19].

This inventory strategy increases efficiency and decreases waste by receiving raw materials only as needed for production process thus reducing inventory cost and acquiring high quality. The planning and performing activities in construction industry have got new directions because of JIT. Conceptually, JIT as an approach works towards objectives of achieving delivery dependability, less space requirement for material storing, high quality and low cost [6].

JIT is used for continuous improvement in which on value adding activities are identified and reduced in order to minimize costs, improve material quality, and improve work efficiency, improve material delivery, add production flexibility and stimulate new technique in work place. JIT as an approach to increasing improvement in construction environment based on successfully reduction of waste and continuous improvement in productivity, continuous monitoring of processes with the goal of eliminating all forms of waste is a key point in understanding JIT.

1.2 Objectives

1. To understand the JIT philosophy in detail for Construction Industry in India.
2. To review the issues in currently used inventory management by examining the process on the considered project through questionnaire

3. To develop a plan to implement JIT on site under consideration so as to increase the organization's ability to compete with others and remain competitive over the long run because of optimal process of material management.
4. To carry out comparative analysis between conventional approach and JIT approach for inventory management.

1.3 Literature survey

MohdArifMarhani et al. Lean construction (LC) is excellent in managing the construction process and achieving the project goals by eliminating waste. The objectives of this report are to provide with fundamental knowledge of LC and highlight the barriers of its implementation. The literature reviews has been conducted through relevant databases. It was found that there is a need for more holistic approaches to be adopted in LC implementation such as health and safety, and six sigma. A systematic training and research are also found vital to provide good interaction and collaboration with the stakeholders. LC is also capable to enhance sustainability in construction thus the quality of life for future Malaysian construction industry.

N.B. Kasim et al. A key factor adversely affecting project performance is the improper handling and management of materials on site. Materials management is particularly problematic on fast-track projects where design and procurement decisions are made concurrently with construction activities. This report reports on the early stages of research which is developing a new ICT-based approach to managing materials on fast-track schemes. As a precursor to this work, the report reviews current material management practices on fast-track construction projects and explores the ICT tools and techniques currently being employed on such projects. The findings reveal the need for more sophisticated materials management solutions which accord with the needs of fast-track schemes. The report concludes by presenting a research framework for developing such a system in the future.

UsamaHamedIssa et al. The construction projects involve various risk factors which have various impacts on time objective that may lead to time-overrun. This study suggests and applies a new technique for minimizing risk factors effect on time using lean construction principles. The lean construction is implemented in this study using the last planner system through execution of an industrial project in Egypt. Evaluating the effect of using the new tool is described in terms of two measurements: Percent Expected Time-overrun (PET) and Percent Plan Completed (PPC).

Glenn Ballard et al. The acronym JIT has been highly visible since the late 1980's, as manufacturing attempted to meet competitive challenges by adopting newly emerging management theories and techniques, referred to by some as Lean Production (1). What is JIT? What is its relevance for the development and implementation of Lean Construction theory and practice (2)? Manufacturing JIT is a method of pulling work forward from one process to the next "just-in-time"; i.e. when the successor process needs it, ultimately producing throughput. One benefit of manufacturing JIT is reducing work-in-process inventory, and thus working capital. An even greater benefit is reducing production cycle times, since materials spend less time sitting in queues waiting to be processed. However, the greatest benefit of manufacturing JIT is forcing reduction in flow variation, thus contributing to continuous, ongoing improvement. Can this approach be applied to construction? What is "Construction JIT"?

M. Muya1 et al. Materials supply logistics plays a significant part in meeting the project delivery goals of cost, quality and time. Customer service is the key element that holds together all supply logistics activities, thus, the effectiveness in selecting suppliers should begin with evaluating characteristics that are deemed necessary for a supplier to provide a pre-requisite level of customer service. Such factors, or enablers, provide indications as to whether a given supplier will be able to meet key materials delivery objectives.

Ricardo Antunes et al. The building construction industry faces challenges, such as increasing project complexity and scope requirements, but shorter deadlines. Additionally, economic uncertainty and rising business competition with a subsequent decrease in profit margins for the industry demands the development of new approaches to construction management. However, the building construction sector relies on practices based on intuition and experience, overlooking the dynamics of its production system. Furthermore, researchers maintain that the construction industry has no history of the application of mathematical approaches to model and manage production.

SVEN BERTELSEN et al. normally building materials are transported to the building site as a part of the purchase, and the price quoted is 'as delivered in whole truckloads'. This tempts the purchase organization to save a few cents, which are easily lost by an unsuitably form of delivery. Studies of logistics show that a substantial increase in productivity can be obtained by delivering building materials on conditions laid down by the construction site, i.e 'just in time' and 'packed for the work process'. The additional cost by this approach can easily be covered by the savings gained on the construction site.

Manlian R.A Simanjuntak et al. Just In Time (JIT) is a construction system that is designed to increase productivity, get quality, reduce costs, and achieve delivery time as efficiently as possible by eliminating all types of waste contained in the construction process so that companies are able to submit their projects according to the will of consumers in a timely , Timely production systems (Just in Time Production System) was originally developed and promoted by Toyota Motor Corporation in Japan, Many studies in various countries have attempted to introduce the JIT in construction projects especially in the field of oil and gas industry to reap the same benefits.

Low Sui Pheng et al. The Just-in-Time (JIT) philosophy originated from the Toyota Production System (TPS) and has been used in the manufacturing industry for many decades. It has helped to increase the productivity of the industry and has also increased the quality of its products. In recent years, numerous studies in developed countries have endeavored to introduce JIT in the construction industry

to reap similar benefits. This study focused on applying JIT to the Chinese Construction industry with the goal of improving its performance and thus its competitiveness. This report discusses the current state of the Chinese construction industry; presents the potential impediments to implementing JIT; and proposes a framework for JIT implementation in the areas of design, procurement, construction and inspection. The results of this study suggest that government and educational institutions should play a key role in spearheading the application of JIT in the construction industry in China.

Singhvi S et al. The experience of implementing JIT concept in an Indian automobile company was thoroughly studied, which did cast light on how critical the 'employee involvement' is for implementation of JIT. This research has come to the conclusion that JIT implementation is not very difficult; large investments are not required. JIT's implementation comes with a wide range of benefits thus being a great opportunity for Indian industries.

V. Vijaya Lakshmi and Prof. G. V. Chalan et al. The study has covered the objectives, elements as well as the limitations of JIT. Factors which are required for implementation of JIT in Indian industries are studied briefly. The research concludes with the statement that JIT is indeed a productivity ethics that might lift the construction company's economy by generating enormous savings. But, some specific time bound training programs should be organized for the work force only after studying their behavior patterns, personal traits, attitude and social values.

Dr. A. K. Gupta et al. This paper reviews literature on Just in Time in Indian context and studies its aspects of implementation. Factors hindering implementation of Just in Time are categorized and explained in brief; namely management, workers, process and suppliers. Improper understanding can also be a major setback. Thus the misconceptions about JIT philosophy are brought to light.

The results of this study state that JIT technique can be very helpful in improving performance of Indian industries implied that proper training and management is carried out. The author suggests that some survey and case studies must be conducted in Indian industries as it will demonstrate the usefulness of JIT in Indian service sector.

2. MATERIAL AND METHODS

2.1 Scope

In this project, the emphasis is given on small and medium scale construction projects which usually face cost overruns due to inefficient inventory management and need upgradation in their process. A Case study is undertaken to compare conventional approach and JIT approach after developing and implementing JIT philosophy on a Slum Rehabilitation project, 2P+11 residential building: Kamela located at Kondhwa, Pune, India. Different parameters on same site will be analyzed and reviewed to see whether JIT approach is better over conventional approach for inventory management in Construction Industry in terms of duration and cost.

2.2 Examination of inventory management process

2.2.1 Procedure of material procurement presently being used

Below listed out is the procedure of material procurement followed on the site under consideration.

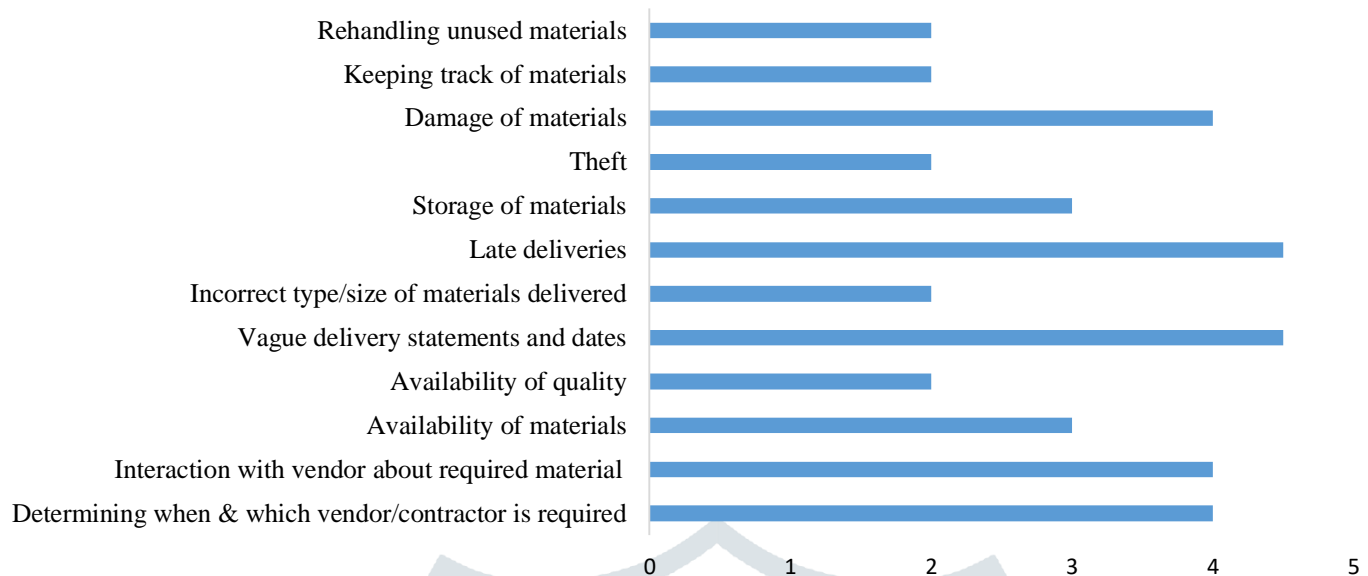
1. Construction material need generated from site
2. Check availability from the store
Inform procurement department, issue slip will be created and material supplied to the site
3. If material not available in store, the procurement department will check availability from local suppliers
4. Intent generated by selecting vendor from approved list
5. Inspection of the received stock is done
6. Store is updated with received material
7. The requested materials are supplied to the site

2.2.2 Stores maintained on the site are

1. Consumable (main) store
2. Cement godown, jointing mortar, admixtures
3. Steel yard
4. Diesel, oil and lubricants

2.2.3 Problems in conventional inventory management process adopted

A questionnaire was developed to be filled by project in-charge. Graph below shows the level of problems arising in the presently adopted process.



Graph 1. Rating of problems occurring in conventional inventory management

2.2.4 Procedure for implementing JIT approach

1. Examine the presently used conventional approach and understand the problems in that process
2. Study the schedule and list out upcoming activities for the period of 30 days.
3. List out the materials required along with their quantities for this activities.
4. Prepare a schedule for implementing JIT.
5. Coordinate with the finalized vendors by providing them with the JIT implementation schedule according to which the materials are to be delivered.
6. In case vendor is not finalized for the upcoming work, refer and follow the vendor/contractor finalization schedule to avoid any delay in project.

3. RESULTS AND ANALYSIS

3.1 Implementing JIT approach

3.1.1 Upcoming activities during the period of 1st Feb to 1st March

In this project, activities awarded to contractor with labour rate are considered. Table below gives out schedule of activities which are considered for JIT implementation.

Table 1. Schedule of upcoming activities considered for JIT implementation

Task Name	Start Date	Finish Date
Kamela Rehab - Building		
Masonry		
10th Floor	Tue 12-02-19	Sat 23-02-19
11th Floor	Tue 26-02-19	Sat 09-03-19
Toilet Waterproofing		
6th Floor	Sun 10-02-19	Thu 21-02-19
7th Floor	Fri 22-02-19	Tue 05-03-19
Dado (Toilet and Kitchen)		
5th Floor	Wed 06-02-19	Wed 13-02-19
6th Floor	Wed 13-02-19	Thu 21-02-19
7th Floor	Thu 21-02-19	Thu 28-02-19
8th Floor	Thu 28-02-19	Fri 08-03-19

Flooring and Tiling		
3rd Floor	Wed 20-02-19	Sun 03-03-19
4th Floor	Sun 03-03-19	Thu 14-03-19
Door Frames		
5th Floor	Mon 04-02-19	Mon 11-02-19
6th Floor	Mon 18-02-19	Mon 25-02-19
7th Floor	Mon 04-03-19	Tue 12-03-19

3.1.2 Material required for considered activities

ABC analysis is done to select the materials for implementation of JIT amongst all material. Class A items have high consumption value and require tight inventory control. Inventory cost can be saved with proper management of these materials.

Table 2. Material details for JIT implementation

Items	Estimated quantity	Units required	Total cost in rupees
AAC block	2470 Sqm	20582 Nos.	14,61,322
Bricks	140 Sqm	8234 Nos.	69,989
Dado tiles	1441.09 Sqm	16763 Nos.	6,97,488
Flooring tiles	935.8 Sqm	2730 Nos.	6,04,527

3.1.3 Schedule for material procurement

The material procurement plan is made considering materials required for period constraint of 6 days. The materials delivered are unloaded directly on the location of activity. (Near lift to carry material directly to the floor where work is in progress). It will help reduce the carrying cost of materials.

Table 3. Schedule for material procurement

Item	Quantity	Date	Time
AAC blocks	5140 Nos.	12-02-19	9:00 AM
	5140 Nos.	18-02-19	6:00 PM
	5140 Nos.	26-02-19	9:00 AM
	5162 Nos.	31-02-19	6:00 PM
Bricks	4117 Nos.	10-02-19	9:00 AM
	4117 Nos.	21-02-19	6:00 PM
	4190 Nos.	06-02-19	9:00 AM
Dado tiles	4195 Nos.	13-02-19	9:00 AM
	4190 Nos.	21-02-19	9:00 AM
	4188 Nos.	28-02-19	9:00 AM
	1365 Nos.	20-02-19	9:00 AM
Floor tiles	1365 Nos.	03-03-19	9:00 AM

3.2 Comparative analysis of conventional approach and JIT approach

3.2.1 Conventional approach

While performing analysis for conventional approach actual ordering cost is evaluated and inventory carrying cost is assumed to be 18% for all materials with reference of examination during practical execution procedure of construction. Inventory carrying cost is incurred for inventory maintenance, storage cost, insurance taxes, deterioration & obsolescence.

Table 4. Analysis of cost by conventional approach

Sr. No.	Material	Material cost	Ordering cost	Inventory cost	Total cost
1	AAC block	1461322	14613	263038	1738973
2	Bricks	69989	700	12598	83287
3	Dado tiles	697488	6975	125548	830010
4	Flooring tiles	604527	6045	108815	719387
	Total cost				3371657

3.2.2 JIT approach

Whereas in JIT approach, the ordering cost is evaluated on the basis of frequency of orders.

Number of orders = Quantity demanded/ Volume per order

Ordering cost = Number of orders x Fixed cost

5% of wastage is considered for tiling work.

Table 5. Analysis of cost by JIT approach

Sr. No.	Material	Material cost	Frequency of ordering	Ordering cost	Total cost
1	AAC block	1461322	4	29226.44	1490548
2	Bricks	69989	2	1399.78	71389
3	Dado tiles	697487.56	4	162265.8	859753
4	Flooring tiles	604526.8	2	35271.6	639798
	Total cost				3061489

Cost saved by using JIT approach over Conventional approach =

$$33,71,657 - 30,61,489 = 3,10,168$$

3.3 Recommendation for contractor finalization

To avoid any delay or uncertainty in material procurement it is advisable that a contractor and/or vendor finalization schedule is brought into practice. This schedule will be entirely dependent on base schedule of projects. A buffer of 45 days is set before start date of any activity.

This schedule needs to get updated after every quarter to keep it in loop with actual project status.

Below table is a sample of contractor finalization schedule made with inputs from tracked schedule.

Task Name	Start	Finish	Vendor selection/contractor finalization schedule
Excavation & RCC	31-03-18	02-07-18	15-02-18
Masonry	04-10-18	02-05-19	20-08-18
Plaster works	17-11-18	18-05-19	02-10-18
Waterproofing	07-12-18	20-04-19	22-10-18
Flooring	13-12-18	20-07-19	29-10-18
Plumbing	11-12-18	24-09-19	27-10-18
Electrical	20-08-18	14-08-19	05-07-18
Fabrication	17-10-18	10-08-19	02-09-18
Painting	05-11-18	19-09-19	0-09-18
Lift Installation	01-01-19	27-04-19	15-11-18
Fire fighting system	01-01-19	27-04-19	15-11-18
STP	24-05-19	19-08-19	09-04-19

Table 5. Analysis of cost by JIT approach

4. CONCLUSION

1. After examining the inventory control process on the considered site certain problems like uncertainty in determining when & which vendor/contractor is required, failure in interaction with vendor about required material, vague delivery statements and dates, incorrect type/size of materials delivered, late deliveries came into light.. Just in time being an inventory management philosophy covers these grey areas to have a smooth procedure and avoid delay in project completion.
2. As the schedule for vendor selection/ contractor finalization is ready, delay in this section is eliminated completely
3. JIT approach saves 9% of cost for the activities considered over the conventional approach

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