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Proposing a Model for Effective Construction Site Logistics Management in Pune Region

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***Abstract*: The construction industry is often slower to adopt new technologies than other industries. Yet the construction industry shall embrace these technologies sufficiently in order to keep up with advances in other trades. One of the most crucial elements in construction management is productivity. During the project we studied and analysed the data to investigate and improve the logistic situation at a construction sites situated in Pune. During the study we found that there is a lack of general knowledge regarding material and site logistics in construction projects in Pune. As a result, there are many unnecessary movements on site interrupting overall output on site and displacing direct value-added activities. Therefore, the purpose of this paper is by practical observations and site interviews, earlier studies, to investigate the existing logistic approach on the construction site, as well as to provide proper logistic strategy for improving construction process. Major effort of this study has been put on material deliveries within the construction site. In this paper, we propose to develop a new model/ platform to utilize modern advance technologies in the construction sector.**

Hence, the main objective of this paper is to introduce new systematic model that will improve construction productivity by enhancing construction site logistics management practices. The use of this model will not only help in increasing productiveness of the construction projects but also it will make this sector more competitive with other industries. In order to achieve the main goal of the paper, different building construction sites have been selected from which the data collect data using direct observation and study. This will help to improve the communications between various project participants as Managers, contactors, subcontractors and suppliers is another expected result.

***Keywords*: Construction, engineering, equipment, logistics management, material management, project, site, transportation.**

1. Introduction

Completing any construction project in a time with their numerous constrains requires the skillful integration of many aspects. One of these aspects, which plays a crucial role in ensuring that construction projects are completed successfully, is labor productivity. Construction project sites are impacted by several factors that affect the efficiency of a workforce by reducing their overall productivity. Such a loss of efficiency interferes with the performance of an entire project, and reduces management's chances of meeting project quality, budget, and time objectives. Conversely, by increasing overall productivity through improving labor force productivity, construction companies would reap many more benefits from their projects. One of the most common reasons of loss of productivity of a project is the poor management of materials, equipment, and tools or "logistics management". Hence, construction logistics may be defined as "the management of the flow of materials, tools, and equipment and any related object from the point of discharge/depart to its point of use or installation.

The previous investigation showed that in any construction project, the material costs generally occupies the engineering project construction cost 65%-70%, whereas the delivery of these generally accounts about 17%, i.e., the physical distribution expenditure will approximately contribute the Construction Project cost about 10%-11% [2]. The Construction Site Logistics mainly comprises of two major Factors- Material Logistics & Supply Chain Management [2].

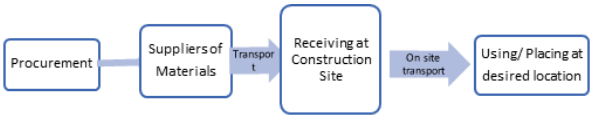

Fig. 1. Logistics Process of Construction Project

A. Problem Statement

Enhancing Construction is a dynamic, competitive, ever changing and challenging industry. There are large number of reasons which causes the delay in any Construction project. There are various point of views by which we can compare the conventional site logistic system, The construction Site Logistics process in Pune has the following basic characteristics:

1) The distribution of logistics process

It includes the gathering physical distribution, all materials and the equipment's are transported finally to construction site to completes the project using these materials. The owner or the investor are consumers, usually before the construction process starts, it is required to determine, the construction completed through the various quality testing department and so on examination, is considered qualified, considered the project to be completed. This creates the contrast with the Industrial enterprise's production physical distribution process. Generally Industrial enterprise's production physical distribution process not only includes the inflow of material, but also includes the product outflow, every product by the plant production, assigns

for many consumers or the producer. Some also have the characteristics of recycling physical distribution, thus, the physical distribution process circulation continues.

2) Major uncertainty and non-Uniformity

There is huge non uniformity in construction project production process and the transportation process, which results in frequent various project changes, causes the resources demand and supplies non-uniformity. There is high uncertainty in any construction logistic system, the perfect material forecast demand changes the plan with difficulty frequents, which causes the material demand uncertainty in huge amount, the very difficult traditional enterprise such to form the accurate material detailed list, simultaneously, is also not easy to control and maintained the stock accordingly. Thus these physical distribution plans frequently need to revise due to such influences.

3) Flexible, complex and more diverse system

Any Construction project requires wide range of diverse materials. Some bulk materials include steel, cement, sand, etc. requires large-scale logistics facilities and equipment to complete loading and unloading and need more space storage at site. Whereas, some materials require special packaging, loading, transport, unloading and storage systems at site. These factors have huge impact on any construction logistics. Packaging of materials, its transportation, warehousing and other technical requirements, increases the difficulty and makes the logistics system to make it more complex and diverse.

4) Storage /High costing issues

The storage space constrain is the main issue in almost all construction projects. The high land and operating cost, are also some important factors to look for, especially in urban areas such as Pune. In case of Industrial projects or the Warehouse construction projects, it is generally temporary structure which get removed after the completion of the said project which make on-site storage costs particularly high.

2. Need of Project

According to previous research done by the various authors, the need for better logistics solutions in construction projects is necessary. Poor logistics not only results in delaying the projects but also represents a poor image of the construction sector. At present, the material procurement process for construction projects in Pune is only connected or linked with contracts that being purchased at cheaper price with certain specified standard specifications. Many a times the supplier or manufacturer is being asked to deliver these kinds of materials at lower rates. We found no motivation to work in developer's interest. Some advantages for individual firms in the supply chain comprises of:

1. Reduced real costs, with margins maintenance.
2. Incentive to remove waste from the process.
3. Greater certainty of out-turn costs.
4. Delivery of better underlying value to the client.
5. More repeat business with key clients.

We believe that our work will help the construction companies in Pune region to look on the logistics issue from another angle and realize the possibilities for further improvement within the field of material and Site logistics. This will probably contribute to more effective logistics solutions characteristics.

3. Scope of Project

The Study mainly focus on the studying the Construction Logistics Process and Investigate the Current Logistic Situation in Construction Industries in India. As well as we shall Analyze and Optimize the Material Flow and Site Transport. It has observed that most of the construction projects suffers from unnecessary activities on site which leads to wastages of resources. This indicates the need for improving construction logistics. Thus, the research questions that have been studied are:

1. How does construction logistics of an apartment building project work in practice?
2. How much time do construction workers spend on material handling?
3. How does the current logistics solution affect the construction process?
4. How to improve construction logistics in order to reduce the time workers spend on material handling?
5. To Propose/ Develop a systematic model for efficient logistic system.

4. Aim and Objective

Aim of the study is to identify, rank and recommend the major causes of cost overrun and escalation in the construction projects. The certain main objectives of this study includes:

1. To study construction logistics process as well as to analyze and optimize the material flow and site transport.
2. To investigate the current logistic situation in construction industries.
3. To develop a model for Improvement in the site logistics

5. Data Collection

The focus of our study is material deliveries, their storage and Logistics at Site. We have regularly visited the construction sites and did observations and documentations of all bigger deliveries to the site. This helped us in investigating how material deliveries are handled when received at site. We have also measured how long time does it take for workers to pick right material and move it to the right place.

Information comes from site observations where we, for the period of 6 months, chose to observe each bigger delivery to the construction site. We also followed workers who handled material deliveries. The actual time that it took for construction labours to carry/ handle materials on site has been recorded. Observations have been done during the execution of the project. During our study, interviews have been conducted with

people involved in the project, both with workers, supervisors and managers.

Table 1
Project information

Project	1	2
Name of Project	Parkland	K11 La Vida
Location	Ghorpadi	Balewadi
Developer	YashVastu Developers	Kakkad Properties
Total B/u Area	9,47,000 Sqft	5,50,000 Sqft
Number of Buildings	Ph1 – 4 no's and Ph2 – 4 nos	2 nos with Commercial
Number of Floors	3P + 12 and 3P + 20	3P + 298
Number of tenements	700 nos	298 nos
Construction Period	June 2016 to Feb 2022	Aug 2018 to Dec 2020

A. Data Analysis

To study and examine the existing logistic process at above sites, following one sample study is considered. In this study, the complete analysis of construction material from procurement phase to using it at site was observed and recorded.

Table 2
Sample Data Observation

S. No.	Material	Project A	Project B
1	Type of Material	AAC Blocks	AAC Blocks
2	Quantity Required	2000 Nos	2500 Nos
3	Procured Quantity	2000 Nos	1500 Nos
4	Lead time required	7 Days	5 Days
5	Unit Price per Block	Basic Price – Rs 70 per Block Transport – Rs 0.30 per Block	Basic Price – Rs 69 per Block Transport – Rs 0.45 per Block
6	Time Taken to Deliver at site	9 Days	6 Days
7	Working Hrs. incurred for Unloading at site	8 Hrs.	6 Hrs.
8	Location of Unloading/ Storage	Unloaded at multiple locations as per its utilization	Unloaded at Ground Floor
9	Location where it is being used	At multiple points	At 10th Floor
10	Extra manpower incurred to shift material from store to the point of use	0 hrs/day	6 hrs/day for 2days
11	Extra Cost incurred for shifting	00	Rs 1200/day

1) The summery of the observations/ current situation follows below

a) Project A:

1. The site logistics were planned in initial stage of project and somehow being maintained at site. But still some flows are there.
2. Materials are sometimes placed in the suitable place making accessibility to the working place. Also the amount of stored material is so well arranged that it possible to put it somewhere else easily. The outcome from that is that Fitters/carpenters spend no extra time on moving materials from one place to another.
3. Cement and steel rods be ordered with needed length while ordering in advance. The steel rods are being of full-length rods (i.e.12m length) and for staking it, dia wise steel racks of 12m length has been prepared. During the unloading, it gets stacked dia wise so as to reduce the time for sorting it at later stage.
4. Separate shuttering yard is also being maintained to stack the shuttering /formwork material separately.
5. Lorries with materials come twice per week. Such as for Aggregates, Cement and Fly Ash Brick etc. One small vehicle and one Excavator is kept at site to transport/ shift the materials/ fabricated steel from casting yard to actual site location.

b) Project B:

1. No site logistics were planned in initial stage of project and no any planning is there for material handling and storing.
2. Materials are sometimes placed in the unsuitable place making less accessibility to the working place. Also the amount of stored material is so huge that it is not possible to put it somewhere else easily. The outcome from that is that Fitters/carpenters spend extra time on moving materials from one place to another.
3. Access to the site and within the premises is not being maintained and need to be improved.
4. Huge amount of materials being ordered at initial stage irrespective of the requirement which causes the extra burden on logistics and increases the cost of project.
5. Shifting of the materials from fabrication yard to the actual site location is also being hampered sometimes as the logistic process is not being monitored well.

6. New Model Development for Effective Logistic System

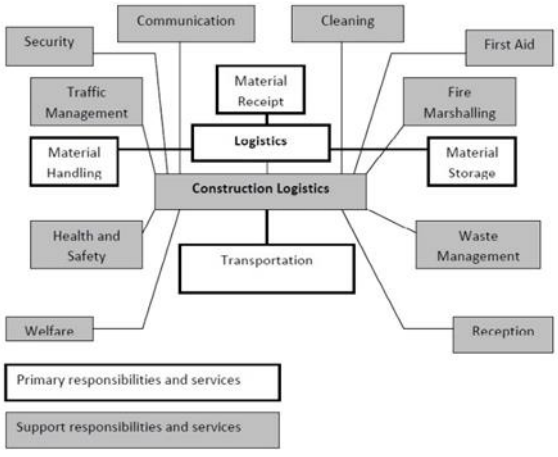

Fig. 2. Primary and Support Logistics Functions and Services

During the data collection and analysis, we observed that the current process was inefficient with respect to logistics management. There is no any tracking system for procurement of materials, their transportation and stacking at site. The

initiation of Purchase orders, keeping track of all its implications during transport and receiving at site, keeping everybody involved well informed about order progress, and simplifying access to information were the major issues.

Therefore, we feel need to simplify and facilitate the communication process on construction sites and among the project participants such as Clients, Supplier, Managers, Contractors etc. Therefore, we are introducing a conceptualized logistics framework that will allow supply chain that plans, implements, and controls the efficient, effective flow and storage of goods, services and related data from the point of its origin to the point of its consumption/ placing in order to meet customers' requirements.

A. Site Layout Planning

Site layout is a part and parcel of materials management which determines the location of off-loading, location of the storage spaces, protection of the materials and movement of materials to construction areas. The aim of this phase is to select the optimum path for material routing by proper analysis of site facilities, space and safety within the construction site. Many researchers have pointed to the importance of site layout in increasing site productivity, minimizing the travelling time and maximizing the space utilization.

This phase is divided in three stages i.e. site initialization; site modelling and site optimization. Site

initialization is the process of planning site facilities (vehicles, building components, temporary facilities etc.) on the site. Initial site layout constructed using CAD data. CAD package is used in developing the geometry of the site layout.

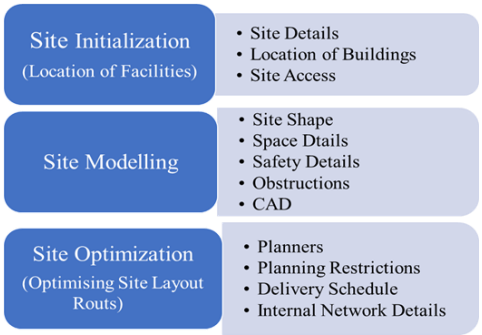

Fig. 3. Factors for Site Layout Planning

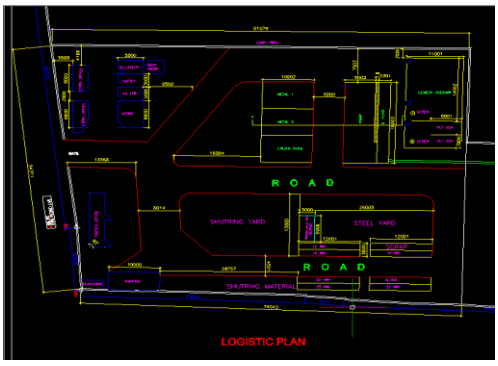

Fig. 4. Site Layout Planned for Project A

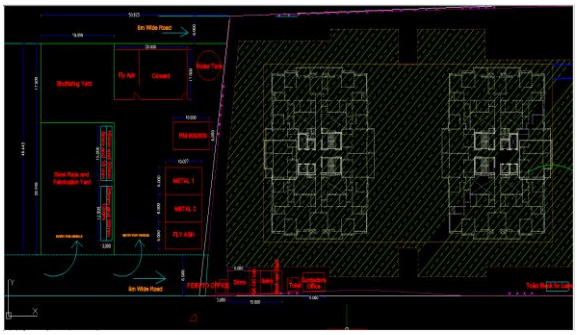

Fig. 5. Site Layout Planned for Project B

B. Construction site resource planning

In reality, many of the construction projects generally suffer from various delays like; Bad weather, unsuitable ground conditions, client change orders, etc. These uncertainties will ultimately increase the project execution time. Proposing that the material management system shall be integrated with project planning and project scheduling.

The aim of this phase is to integrate the detail Work Plan requirements (based on Last Planner Methodology) with external logistics and site layout system to have an integrated dynamic logistics system to combat site requirements.

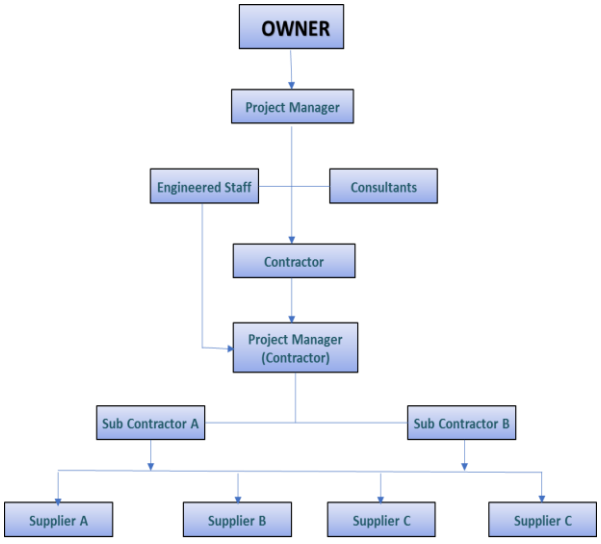

Fig. 6. Simplified model for information sharing along construction supply chain

7. Result and Discussion

The findings from the above discussions/results (i.e. Proposed model) were then implemented on both the sites (i.e. Project A and Project B). The changes in material supply chain process has been incorporated as per fig 6 above. And the site layout designed for Project B, is being implementing there as per the fig. 4.

Further, after implementing the proposed developed model at both the constructions sites, a delay analysis for slab castings done at both the projects and the results were then compared

with the earlier analysis. Same is computed below,

Table 3
Delay analysis of a slab casting at both projects after implementing proposed model

S. No.	Delaying Factors	Project A	Project B
1	Target completion period	26 Days	22 Days
2	Actual Days consumed	33 Days	35 Days
3	Delay due to material Delivery	0 days	1 day
4	Unavailability of Skill labours	0 day	0 day
5	Lack of communication and Coordination	1 days	0 days
6	Delay due to Material shifting/ Handling	0 Day	0 Days
7	Delay due to unavailability of plants and equipment	0.5 day	1 days
8	Delay due to plant breakdown	0 days	0 days

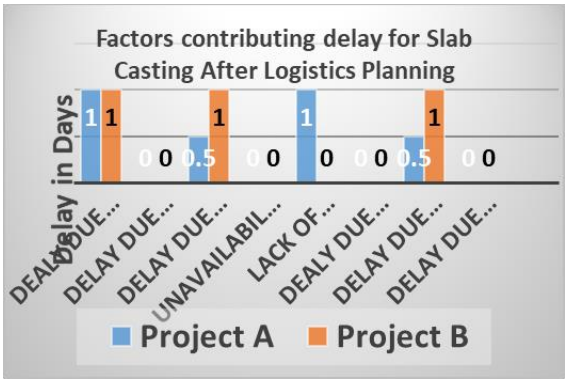

Figure 7: Graphical comparison of delay analysis after implementing the model

Fig. 8. Comparison of Delay before and after implementing the model – Project A

Fig. 9. Comparison of Delay before and after implementing the model – Project B

8. Conclusion

The purpose of this study is to examine the current scenario of construction logistic processes in Pune area and to identify the factors required to make it more effective. During the study we observed that the construction logistics is somehow underestimated by construction companies and that can impact many factors including Overall Cost and time consumption, material wastages, environment production, production time etc. of the project.

Thus, this paper has described the basic integrated dynamic logistics concept and development of a conceptual logistics framework to manage movement of materials from manufacturer to the construction site. The advance planning and design aspect of construction projects are generally insufficient. So, we felt that the construction industry requires a well-defined efficient and integrated logistics system that will help logistics planners in improving the productivity and sustainability in the building processes. A well-organized loading/ unloading times will lead to lower indirect costs, reduce site congestion and will tend to improve the site space utilization. It is anticipated that an integrated logistics system will improve delivery efficiency and reliability; reduced fuel and delivery costs; a reduction in inventory levels via just in time deliveries.

9. Future Research Activities

In addition to the ongoing process of collecting wide range of site constraint parameters affecting a logistics system of projects, this research will also include to develop a computer-based system using computer-aided design to select the best available route, which will have reduced the overall Cost and Time parameters associated with material handling at any construction project.

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