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Material flow in construction sites – a case study.

Flujo de materiales en sitios de construcción: un estudio de caso

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ABSTRACT

The efficient movement of materials at sites in fair quantity at fair time without any interruption is called material flow. Operation and flow of these materials is a challenge experienced in sites today due to material scarcity, delivery delays, inadequate transportation facilities, loss and wastage, insufficient storage space etc. Data on material flows and inventory levels is intended to promote circular economy and resource efficiency in the construction sector. This paper presents a case study in Kerala, India with the purpose to quantify the flow of materials and stocks in the construction site. A questionnaire survey was conducted to find out the main factors that can affect the flow of materials in the building industry. Out of 65 respondents labour, equipment, material, time and cost are identified as the main factors which can contribute towards material flow. Based on the identified parameters, a material flow pathway is developed for the case study. It demonstrates the management of logistics and factors influencing the movement of materials on work sites. It therefore helps in the analysis of factors concerning the efficient use of materials in infrastructure projects.

Keywords-material flow, logistics management, material scarcity, infrastructure projects.

RESUMEN

El movimiento eficiente de materiales en los sitios en cantidad justa en el momento justo sin ninguna interrupción se denomina flujo de material. La operación y el flujo de estos materiales es un desafío experimentado en los sitios hoy en día debido a la escasez de material, retrasos en la entrega, instalaciones de transporte inadecuadas, pérdida y desperdicio, espacio de almacenamiento insuficiente, etc. Los datos sobre los flujos de materiales y los niveles de inventario están destinados a promover la economía circular y

la eficiencia de los recursos. en el sector de la construcción. Este documento presenta un estudio de caso en Kerala, India, con el propósito de cuantificar el flujo de materiales y existencias en el sitio de construcción. Se realizó una encuesta por cuestionario para conocer los principales factores que pueden afectar el flujo de materiales en la industria de la construcción. De 65 encuestados, la mano de obra, el equipo, el material, el tiempo y el costo se identifican como los principales factores que pueden contribuir al flujo de materiales. Sobre la base de los parámetros identificados, se desarrolla una ruta de flujo de materiales para el estudio de caso. Demuestra la gestión de la logística y los factores que influyen en el movimiento de materiales en los sitios de trabajo. Por lo tanto, ayuda en el análisis de factores relacionados con el uso eficiente de materiales en proyectos de infraestructura.

Palabras clave: flujo de materiales, gestión logística, escasez de materiales, proyectos de infraestructura.

INTRODUCTION

Construction materials are the primary movements occurring in the sites after water consumption. In relation to completing projects at the required time, effective material flow is one of the most significant factors in the construction industry. Poor materials and equipment due to improper handling, transportation etc can affect the material flow up to a great extent. The main goal of materials flow is to ensure that the adequate quality of materials is available when needed. There are several factors affecting material flow. It leads to increased cost and wastage. Various scholars had proposed numerous ways to quantify the material flow. Identification of the factors is the key step to materials flow. Following improper steps during construction to complete the work on time can cause site risks, including the shortage of materials, delay of materials on time etc. It can thus hamper the project performance.

LITERATURE REVIEW

Material handling practices in the construction projects of residences were reviewed. The research illustrates the strategies for efficient material management, factors that optimize generation of waste in building projects and issues associated with material management by undertaking a questionnaire survey. In the questionnaire study, members with a task such as project manager, site manager and contractor are chiefly selected. Data collected from survey questionnaires was validated with experimental data. According to this report, current material management activities in regional building projects required rigorous and efficient supervision. Nearly all regional building projects also have specific aspects related to material management, including preparing and scheduling of supplies, procurement, use, storage, excess supply, and waste management (Aye Mya Cho et.al, 2014).

A review was carried out to figure out the reason caused by improper use of material management of building projects. The objectives of this research was to calculate the estimated and existing cost of building materials with the S Curve analysis, recognize the issues that may arise in scheduling, sourcing, procurement and also suggest remedies. Few variations that occurred were due to lack of material planning and experience, storage limitations, uneven geographical conditions etc. Generally, a project's expense is attributed to the inventory facilities, staff, subcontractor, operating cost etc. It can be accomplished primarily by adopting mitigation strategies towards ways to solve cost differentiation. The author thus established simple understandings of flow of material and its quantitative analysis (Tunji-Olayeni et.al, 2018).

The factors influencing successful management of materials in Construction schemes for homes were listed out. As per the analysis, the factors influencing the management of materials were divided into three categories, such as small, medium and large enterprises. A research paper of nine separate small, large & medium-sized companies in Maharashtra has been investigated. In order to remove a few of these concerns, it was proposed that enterprises should integrate materials management into the global approach of the companies by analyzing all the data factors gathered. Ultimately, the absence of material management would result in job delays, overrun in capital expenditure, reductions in worker productivity and wastage of materials (Rohit Sharma et.al, 2017).

A research was carried out to determine the most influential indicators, types of factors affecting cost overruns and price inflation in infrastructure projects, and to classify the sort of issues posed by cost escalation transactions in India's government contracts. On that framework, a questionnaire was established to assess the degree of importance of the factors that may cause cost overruns. This provided the necessary material control and flow for quality project execution within the specified period, thereby ensuring timely completion of the project and cost savings (Rajaprabha R et.al2016).

CASESTUDY

Construction projects are composed of numerous interrelated tasks. A continuously updated reliable work plan is essential to co-ordinate the various aspects of the tasks and maintain high productivity and also complete the work on estimated time. Proper material flow can be implemented to effectively improve work flow reliability for construction projects. Percent Plan Complete helps to measure the accurate work flow reliability as well as the flow of materials in each work. A case study was conducted to understand how each factor affect material flow reliability.

The project involved in the construction of bus stand in Kunnamkulam in Thissur district in Kerala, India. The construction began on April 2019 and was completed on October 2019. This study covers 167 workdays. The field was excavated and made ready for the construction of the new bus stand. Piling was done since the soil was loose in nature. 53 piles were casted which included casting of 2 pile per day. Crew size varied between 8 to 12 workers on each week depending on the amount of available work in each area. According to the project manager, crowding was not an issue for any of the working areas, all of which were outdoors. On the other hand, weather was a significant factor affecting major work progress since major portion of work was conducted in monsoon season. The work had become lag due to COVID-19 and lockdown related issues, there was also an issue due to scarcity of labour and material at that time. The main factors that affect material flow were found to be labour, equipment, material, time and cost. All these factors have an impact on the material flow in the construction of bus stand.

METHODOLOGY

The site was inspected in detailed nature to understand the flow of materials and work in general. Also the site engineer was interviewed in order to understand the major factors of material flow experienced in sites, impacts due to improper material flow and to know their opinion regarding control measures that can be employed in site to reduce wastage and improper handling. Accordingly a questionnaire survey was conducted to find out the main factors. Out of the 65 respondents, labour, equipment, material, time and cost are identified as the main factors which contribute towards material flow in fig 1.

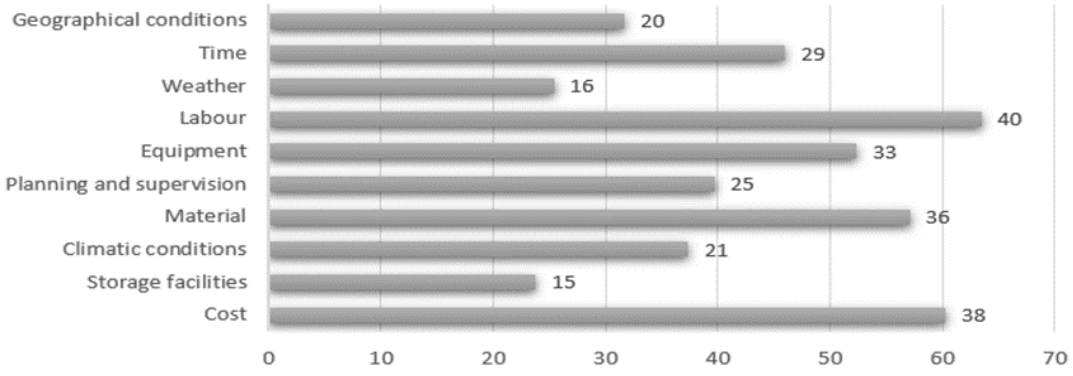

Fig 1: Factors that affect material flow

Almost 11 workers were employed at the site at its finishing stage. Out of the 11 workers, 3 skilled and 2 unskilled workers were employed for masonry works. The rest of the workers were unskilled labourers who were mainly employed as helpers in the site. Most of the workers employed at the site had 5-10 years of work experience. Flow of material on site is formulated from case study and is shown in fig 2.

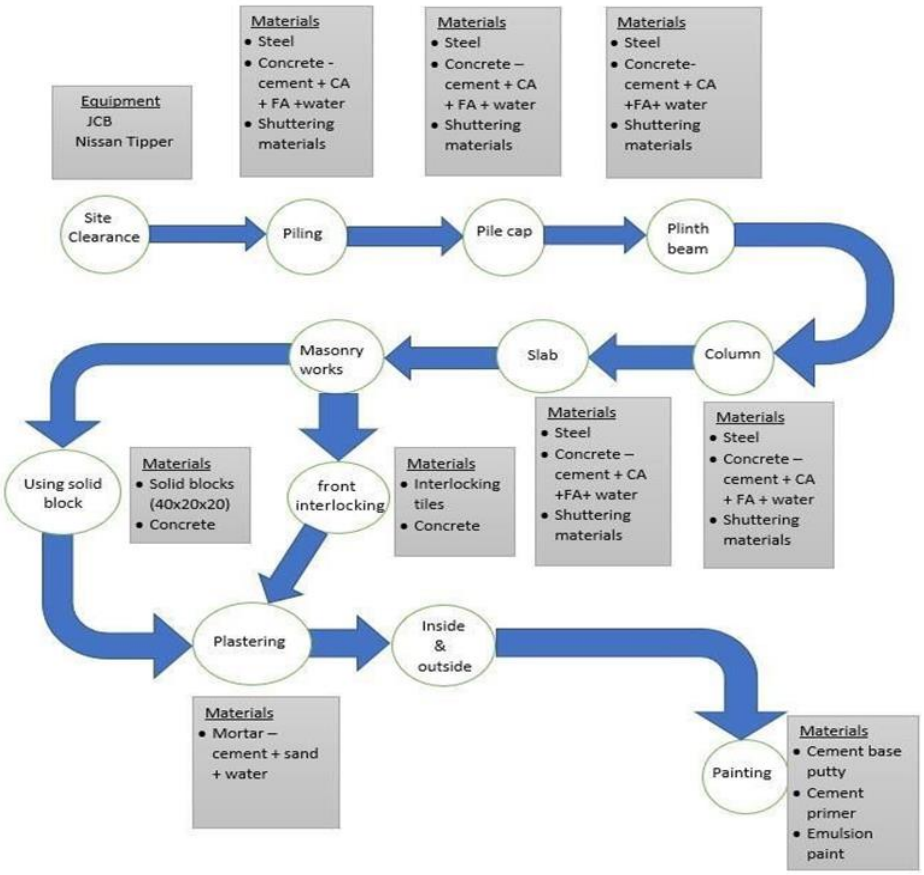

Fig 2: Flow of material on site

Analysis

The site engineer as well as the on-site workers agreed that improper material flow and its factors are one of the major problems experienced in the site. Loading and unloading of construction materials, transportation of materials to and from site, masonry works, storing of cement and tile cutting were listed as the major activities that were responsible for the improper flow of material on site. Using materials such as tarpa during masonry work can help in reducing wastage of concrete during masonry and plastering works.

From the responses obtained from the workers, it can be inferred that the major factors of improper material flow such as labour, material, equipment, time, cost etc are the major problems that affect the project work. The manpower allotted for each work was done on a particular basis – Planned manpower and actual manpower. Most of the time the actual manpower was more than planned one. This itself shows that the labour flow is inappropriate and may cause risks and also affect in completing the work on estimated time. Table 1 show in detail for each item of work, the planned and actual labour flow for various months from the case study.

Table 1: Manpower planning per month

SI NO	ITEM OF WORK	MAY		JUNE		JULY		AUGUST		SEPTEMBER		OCTOBER		NOVEMBER	
		Planned	Actual	Planned	Actual	Planned	Actual	Planned	Actual	Planned	Actual	Planned	Actual	Planned	Actual
1	CLEARING SITE	4	4												
2	STEEL WORK FOR PILLING	28	28												
3	BOARING AND CONCRETE	182	182												
4	EARTH WORK EXCAVATION FOR PILLIE CAP AND BEAM			27	37										
5	PILE CAP PCC SHUTTERING			11	19	7									
6	PILE CAP AND BEAM PCC CONCRETE			9	11	7									
7	STEEL WORK FOR PILE CAP AND BEAM AND COLUMN			12	12	45									
8	SHUTTERING FOR PILE CAP			37		20									
9	SHUTTERING FOR BEAM			12		25									
10	CONCRETE FOR PILE CAP AND BEAM					18									
11	COULUMN PEDASTRIAL STEEL WORK					12									
12	COULMN PEDASTRIAL SHUTTERING					18									
13	COLUMN PEDASTRIALCONCRETE					20									
14	MEP WORKS														
15	TOILET COLUMN SHUTTERING GF					10									
16	STEEL WORK FOR COLUMN					10									
17	CONCRETE					10									
18	SLAB SHUTTERING					26									
19	SLAB STEEL WORK					22									
20	SLAB CONCRETE					20									
21	SOLID BLOCK MASONRY							22							
22	LINTEL WORK							4							
23	SOLID BLOCK MASONRY							22							
24	PLASTERING							44							
25	TOILET WALL TILE							4		24					
26	SEPTIC TANK WORK							58							
27	FRONT SIDE QUARRY MUCK FILLING							54							
28	FRONT SIDE KURB							38		40		20			
29	INTERLOCKING									45		42			
30	TURFF WORK											41			
31	ACP CLADDING											75			
32	WINDOW AND DOOR FIXING											56			
33	PAINTING INSIDE AND OUTSIDE AND FINISHING											120			

Also materials are an important parameter affecting the material flow in the construction sites. Materials had become scarce due to the lockdown issues and also due to improper handling and wastage. Improper flow of materials had resulted in wastage of materials thus materials being scarce at the time of need. Wastage was one of the main issues faced in sites due to either unskilled labour or due to careless work.

The detailed list of materials needed were cement, steel, coarse aggregate – 20mm, 12mm, 40mm, M sand. All these were kept in stock and were purchased each month according to the need but admist COVID -19, there came the issue of shortage of materials and at the same time equipments also. Equipments weren't neither maintained well nor kept safely. Hence it too became an issue during the work progress. Table 2 and Table 3 gives in a detailed view of the number of equipments needed for each work, as per planning and as per execution and also the actual materials needed for the construction, its quantity purchased per schedule respectively from the case study.

Table 2: Actual equipment needed per month as per schedule

SL NO	DESCRIPTION OF WORK	DURATION OF WORK	TYPE OF MACHINARIES	MAY		JUNE		JULY		AUGUST		SEPTEMBER		OCTOBER	
				As per planning	As per execution	As per planning	As per execution	As per planning	As per execution	As per planning	As per execution	As per planning	As per execution	As per planning	As per execution
1	Excavation		JCB	1	1										
			NISSAN TIPPER	1	1										
2	Concrete		Concrete mixer machine			1	1	1	1	1	1	1	1	1	1
			Concrete pump					1	1	1	1				
			Vibrator					1	1	1	1	1	1	1	1
			Urbana			3	2	2	1	2	2	2	1	2	2
3	Centering and Shuttering		wood			150	300	300	350						
			span			100	150	200	180						
			sheet			100	200	200	200						
			steel cutting machine	1	1	1	1	1	1	1	1	1	1	1	1
			cutting machine small	1	1	1	1	1	1	1	1	1	1	1	1
			wood cutter	1	1	1	1	1	1	1	1	1	1	1	1
			Lighting arrangement all	5	8	8	8	5	8	8	8	8	9	9	9

Table 3: Actual material and its quantity purchased per schedule

	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	TOTAL
Cement	710	50	1490	850	300	300	3700
Steel	6500	9800	1000	8000	9001	7000	41301
20mm	994	200	2200	1190	450	450	5484
12mm	600	50	1192	680	240	240	3002
40mm	0	2000	450	3000	2500	1000	8950
M Sand	1278	100	2682	1530	540	540	6670

The time allotted for the completion of most of the work got delayed due to adverse weather condition, scarcity of materials, labours and also due to lockdown related issues. The estimated time for the completion of work was around 4 months. But it had been extended till 6 months due to prevailing circumstances. After the lockdown, when work became normal, there was shortage of labourers as majority of them who had been indulged in the work were from other states. Those who returned back to work were within the age group of 50 and due to the prevailing conditions they couldn't get back to work and hence the work was at stake. Cost was also affected during this economic crisis. The cost of each material before the crisis had become double the value during the crisis. Enough budgets to carry out the work within the stipulated time was a main cause which ultimately made the work to get extended. The actual cost involved in the construction was much more than the planned work. Not only proper planning resulted in improper material flow but also due to the present scenario, the work was at stake and enough budgets wasn't there to start the work.

CONCLUSION

There had been a surge of issues regarding material flow in construction sites due to improper handling, transportation, usage etc. From the above case study, it can be inferred that due to COVID - 19 scenarios there has been a rise in problems with material flow at construction sites. It can be inferred from the surveys conducted by different scholars that only certain metrics should be used to assess material flow. Geographical conditions, access to raw materials, labor skills, warehouses, and disposal are among the many established factors that influence the material flow through the questionnaire survey carried out. Cost inflation, reduced efficiency, increased waste, additional duration for project work to be completed are the challenges due to improper material flow.

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