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An innovative methodology for identification of fall hazards and assessment of risk at high rise construction site

Mr. Tushar Hiratkar¹, Dr. Aditya Tiwary²

¹PG Student, Fire Technology & Safety Engineering Department, IPS Academy, Institute of Engineering & Science, Knowledge Village, Rajendra Nagar A.B. Road, Indore-452012

²Associate Professor, Fire Technology & Safety Engineering Department, IPS Academy, Institute of Engineering & Science, Knowledge Village, Rajendra Nagar A.B. Road, Indore-452012

ABSTRACT

The work productivity of laborers in an organization is impacted by a few variables, one of which is related occupational health and safety system and there is a huge impact of safety and health program on work productivity of laborers either all the while or somewhat. An unfortunate safety standard fundamentally starts from the conviction that safety and productivity are totally unrelated targets, one consuming the other. Yet, by and by they are associated. Statistics from the Occupational Safety and Health Act 1994 have shown that the number of fatalities in the construction industry is five times greater than in other sectors. Thus, there is a critical need to alleviate this issue. A research has been conducted to investigate the root causes of fall hazards on construction sites. Therefore, this research is intended to identify and highlight the types of fall hazards that are most commonly found at construction sites today and the main causes that contribute to falls, as well as by using hierarchy of control method, the most effective solutions to overcome the fall hazards. In this research, how the loss of time and productivity occurred due fall hazards on high rise construction site has analyzed on basis of the data obtained from various departments of the organization. The fall hazards has been overcome by substitution of innovation (fabricated scaffold and stool) and functional relationship between safety and productivity element analyzed. Hence, we achieved the loss of time and productivity on acceptable level which shows that, the increase in safety culture has reduction in accident and growing the organization productivity.

Keywords- Fall hazards, fall accidents, risk identification, risk assessment, construction site

I. INTRODUCTION

1.1 Background of The Study

Construction sector is very essential and integral part of infrastructure development which gives – the tremendous boost to our country's economy. The development business has enlisted gigantic development worldwide lately. Albeit the advancement of innovation is fast in a large portion of the areas, development work is still work concentrated. The development area is the most risky ventures. Consistently, individuals pass on because of word related mishaps or business related sicknesses. Altogether, it arrives at more than 2.78 million passing and about 374 million non-deadly business related wounds and ailments every year [26]. The human expense of this everyday misfortune is huge, and the monetary weight of poor word related security and wellbeing rehearses is assessed at 3.94% of global Gross Domestic Product each year [26]. Internationally, among all, accidental wounds address a significant general medical issue and a main source of passing [27]. After street traffic wounds, falls address the subsequent driving reason for accidental injury passing around the world. Estimation is a number of 646000 fatal falls and some 37.3 million nonfatal falls each year, severe enough to require medical attention [28].

A peril is an expected wellspring of mischief or an antagonistic wellbeing impact on people. Risk is the probability that an individual might be hurt or experienced antagonistic wellbeing impacts whenever presented to a peril. Hence, chance can be limited, albeit the risk is there. Two significant perils that are normal in building locales have been distinguished by Abdul et al [1]. Actual injury dangers are regularly brought about by hardware utilized, for example, frameworks, power access gear, stepping stools, plant and apparatus for uncovering and cycles like manual dealing with, and rooftop work [1]. These risks can make direct injury laborers at site and, if extreme, it might actually cause passing. This study is concentration to recognize the reasons for mishaps at tall structure building site and to distinguish the preventive measures for mishaps at tall structure building site. Other than that, this exploration helps in making sense of the reasons for mishaps and recognizing region where avoidance activity ought to be carried out, so laborers and top administration will increment mindfulness in forestalling site mishaps.

1.2 Objectives of The Research

- To identify the all possible hazards related to fall in High-rise Building Construction, to conduct occupational health risk assessment.
- To study the underlying causes of accident cases and near-miss incidents occurred at project site.
- To make the statistical analysis of accident and cost associated with it.
- To calculate the risk rating based on the risk matrix and to compare the risk rating before & after the control measure taken.
- To reduce injuries related to working at height
- Raise awareness of Occupational Health Safety Workers obligations and our workplace services profile in the construction industry.
- A coordinated approach by team in the method of addressing identified hazards, measure improvement by comparison of workplace condition assessment data.

1.3 Scope of The Research

The scope of research the study is focus to identify the causes of accidents at high-rise building construction site and to identify the preventive measures for accidents at high-rise building construction site. Besides that, this research helps in explaining the causes of accidents and identifying area where prevention action should be implemented, so that workers and top management will increase awareness in preventing site accidents.

II. LITERATURE REVIEW

Falls are one of the OSHA's Focus Four that causes deaths of workers on construction site [24]. Fall is characterized as a descending development right down to the floor. A fall danger is a sort of actual perils that cause specialist's misfortune body balance when work at building site. Falls are generally causes by perilous demonstration, hazardous working condition, correspondence issues and the executive's responsibility. The workers that are introduced to fall chances are cause by their attitude on prosperity and prosperity confirmation is a pointless utilization that can be saved and the shortfall of correspondence among workers and the person in charge [25].

The construction industry of Malaysia represents the epicenter of growth of the country and has been propelled by demand for high-rise building projects [12]. In the past 20 years, the construction industry had contributed 3–5 percent to the GDP and played a significant role in the development of the country [14]. Nonetheless, the unfortunate time execution is the most well-known in the Malaysian development industry and on account of this the vast majority of the undertakings in Malaysia are accounted for as being late [14, 15]. Subsequently, the client and partners are confronting not kidding issues connected with monetary waste, quality misfortunes and burdens with delays in development projects [13]. The delay in construction projects affects the micro and macro levels of the economy of the country. At the miniature level connected with the expense overwhelm, project deserting while large scale level arrangements with the negative pace of public development of the country [16].

According to V. Sakthiniveditha et al. (2003) presumed that Building projects are one of the main undertakings which assume an essential part in the nation's turn of events. It is assessed that for the more prominent turn of events, the elevated structure (or) multi-story structures are the most fundamental piece of the development. The bigger piece of the structure prompts tall building towers.

Thus the gamble engaged with this piece of the development business additionally positions higher. Takes a chance in development projects are viewed as one of the most well-known issues that cause various adverse consequences on the development projects. Building dangers must be limited when the reason is known. The point of this study was to investigate the gamble appraisal while developing elevated structures. This study was conducted based on a review of the literature and a questionnaire. The information for this examination will be assembled through an itemized review of polls. The survey comprises of two areas and the main segment comprises of general inquiries, the subsequent segment contains the rundown of significant dangers and the sub-gambles implied. This work centers on recognizing and evaluating the dangers in elevated structures, and upgrading the dangers that happen during building development. [5]

Ahsan Nawaz et al. (2019) presumes that Building is a very hazardous business that misses the mark on great standing for risk the executives. However, because of expanded contention and development exercises this steadily gives it really meaning. That's what the exploration shows, in the feeling of territory Low-level gamble control was applied. The discoveries likewise demonstrate that there is a more noteworthy level of relationship between certain gamble the board and undertaking productivity. The outcomes exhibit the significance of hazard the executive's procedures, their utilization, inclusion and impact on the presentation of the worker for hire's development projects perspective, along these lines empowering the primary task members to utilize risk the board. [7]

Pitroda et al. (2021) given Information on Identification of risk factors and expectations of Indian construction professionals, i.e. workers for hire, proprietors, project supervisors and designers, on the significance of various development dangers and how the dangers ought to be divided between contracting parties. Risk the board is the methodology that covers assessment risk investigation with the guide of answering subjectively and quantitatively with the suitable administration and control procedure. The term has gained unmistakable quality in different businesses. The system is also used indifferent companies for improving their output in their ventures to reduce their losses and improve their profits. The poll test is assessed with the utilization of the Overall Significance Record (RII) device for clients, workers for hire, specialists and engineers. We focused on understanding Gamble the board framework for development tasks and presenting inside and out data on the utilization of chance administration in tall structure projects. [4]

Leenu Paul (2018) Risk the executives is an instrument for characterizing and dealing with specific dangers in an undertaking and with sufficient consideration. This study's philosophy relies upon the poll review that was assembled from the neighborhood skyscraper development workers for hire. Pilot study and interviews are conducted to identify the risk factors which affect the construction industry's efficiency. A sum of 24 gamble influencing factors in three divisions are recognized through pilot study and from master counsel. The risk management and assessment can be improved by combining qualitative and quantitative methodologies to analyze the risks. [8]

According to Occupational Safety and Health Act 1994, section 24 [17], the employees are responsible to wear or use at every one of the hours of any defensive hardware or apparel which given by the business. Great housekeeping is the best safeguards against mishaps during development [19]. Therefore, good housekeeping is an important part in any construction site which helps to reduce occurrence of accidents and improve the overall safety performance [20]. Investigation is one of the normal types of examination to forestall any mishaps. Inspections are part of a preventive or proactive to accident prevention [18]. Training is an essential and significant piece of mishap anticipation strategy [21]. Every one of the organization ought to guarantee that the preparation program is an indispensable piece of the guidance given to all men in development work and ensure them specific consideration towards to the security issues [18]. Accordingly, there are important to carry out the fitting avoidance activity to successfully forestall the event mishaps.

III. PROPOSED METHODOLOGY

3.1 Introduction

At the time of the research the all basic fall protection system provided on construction site. Hard barricading, horizontal and vertical safety net provision on building periphery area, vertical and horizontal closing by weld mesh for lift shaft, all floor cut-outs covered by weld mesh and provision of automatic climbing system for operational floor was seem. All proactive precautionary safety measures were taken on construction site but still continuous breaking on running work occurred due to height work which was held inside the periphery area.

The survey was conducted on administrative management and production worker of building construction to determine the health and safety awareness on hazardous area. The real names are not used for confidentiality purpose. And the methodology used for the relation between productivity and safety is done by using data occurred on research and using this data graph plotted accordingly. Graph is plotted between month versus loss of productivity and month versus loss of time due to accident or incidents. The two graph shows the loss of productivity and loss of time due to accident or incidents and how it overcome after innovation implementation on construction site.

3.2 Methodology

In this research, the methodology used for reducing the fall hazards is Hazard Identification and Risk Assessment (HIRA) and hierarchy of control. During site survey, number of reportable and non-reportable accident/incidents height work and fall from height found recorded. To minimize this reportable and non-reportable accident/incidents, prepared HIRA and implement on construction site. Using hierarchy of control, eliminate the main hazard, substitute the innovative thing, and apply engineering and administrative control. The graph is plotted between loss of productivity and loss of time due to reportable and non-reportable accident/incidents. Also the plotted graph shows how the hazard has overcome and productivity gain with following safety on construction site after substitution of hierarchy of control.

3.3 Data Obtained From Industry

The construction site choose for research is the commercial building project. This construction commercial project start from 1st November, 2019 and completion date has been decided on 31st October, 2021. But due to Covid-19 pandemic, the construction site has been going late. Also there was huge problem stand to arrange the manpower for construction site during this pandemic. When the manpower arranged, the construction activities was going on full swing. On this stage, the most of worker bypasses the safety to achieve target of per day productivity and on research, it was found that most of reportable and non-reportable accident/incidents occurred during this period. In research, the reportable and non-reportable data has been collected by first aid record, medical treatment record and accident/incident record by the organization.

Total Non-reportable accident/incidents			
Sl. No.	Month	Non-reportable accident/incidents due to...	Total non-reportable accident/incidents
1	Mar-21	Scaffolding	7
		Elevated platform	1
		Ladder	5
		Floor opening	2
		Roof	2
		Other	5
2	Apr-21	Scaffolding	11
		Elevated platform	1
		Ladder	4
		Floor opening	1
		Roof	0
		Other	3
3	May-21	Scaffolding	10

		Elevated platform	5
		Ladder	3
		Floor opening	0
		Roof	0
		Other	7
4	Jun-21	Scaffolding	7
		Elevated platform	1
		Ladder	5
		Floor opening	3
		Roof	0
		Other	7
5	Jul-21	Scaffolding	9
		Elevated platform	7
		Ladder	11
		Floor opening	5
		Roof	0
		Other	5
6	Aug-21	Scaffolding	11
		Elevated platform	4
		Ladder	6
		Floor opening	3
		Roof	1
		Other	5
7	Sep-21	Scaffolding	7
		Elevated platform	6
		Ladder	9
		Floor opening	10
		Roof	0
		Other	7
8	Oct-21	Scaffolding	11
		Elevated platform	3
		Ladder	5
		Floor opening	1
		Roof	2
		Other	3
9	Nov-21	Scaffolding	10
		Elevated platform	0
		Ladder	1
		Floor opening	1
		Roof	0
		Other	3
		Total	236

3.4 Data Analysis

Analysis on this collected data by month wise happening the all reportable and non-reportable accident/incidents, it was found that the most of accident/incidents occurred due to the height work and material fall from height. Due to unsafe act and unsafe condition of working at height, analyze that there was huge loss of time and loss of productivity occurred in every month.

The following calculation has been done taking data from the table 3.1 of loss of productivity due to loss of time because of non-reportable accident/incidents.

The construction site having 1200 nos. workers strength and the productivity of single day was 600000/- Rs.

So,

$$LP = \frac{P \times T}{SWH} \dots\dots\dots 3.1$$

- Where, LP = Loss of productivity
- T = Total loss of time in month (in hrs.)
- P = Productivity of a day
- SWH = Standard working hours = 8 hrs.

From eq.3.1, the productivity loss in the month of March-21 is

$$LP (\text{mar-21}) = \frac{600000 \times 7.08}{8} = 531000/- \text{ Rs.} \dots\dots\dots 3.2$$

$$LP (\text{apr-21}) = \frac{600000 \times 6.50}{8} = 487500/- \text{ Rs.} \dots\dots\dots 3.3$$

$$LP (\text{may-21}) = \frac{600000 \times 7.63}{8} = 572250/- \text{ Rs.} \dots\dots\dots 3.4$$

By using eq. 3.1, the loss of productivity of balance month is find out and the given data shown below-

Loss of time & productivity due to non-reportable accident/incidents								
Sl. No.	Month	Non-reportable accident/incidents due to...	Total non-reportable accident/incidents	Loss of time (in min.)	Total loss of time in a month (in min.)	Total loss of time in a month (in hrs.)	Loss of Productivity in a month (Rs.)	Total loss of productivity
1	Mar-21	Scaffolding	7	145	425	7.08	531000.00	51,40,500 Rs. before innovation
		Elevated platform	1	20				
		Ladder	5	95				
		Floor opening	2	40				
		Roof	2	30				
		Other	5	95				
2	Apr-21	Scaffolding	11	225	390	6.50	487500.00	
		Elevated platform	1	20				
		Ladder	4	75				
		Floor opening	1	20				

Available at www.ijmasr.org

Volume-1, Issue-2, February 2026, Page- 16-27

		Roof	0	0			
		Other	3	50			
3	May-21	Scaffolding	10	205	458	7.63	572250.00
		Elevated platform	5	95			
		Ladder	3	53			
		Floor opening	0	0			
		Roof	0	0			
		Other	7	105			
4	Jun-21	Scaffolding	7	145	373	6.22	466500.00
		Elevated platform	1	20			
		Ladder	5	65			
		Floor opening	3	48			
		Roof	0	0			
		Other	7	95			
5	Jul-21	Scaffolding	9	165	595	9.92	744000.00
		Elevated platform	7	115			
		Ladder	11	170			
		Floor opening	5	85			
		Roof	0	0			
		Other	5	60			
6	Aug-21	Scaffolding	11	220	548	9.13	684750.00
		Elevated platform	4	65			
		Ladder	6	90			
		Floor opening	3	48			
		Roof	1	20			
		Other	5	105			
7	Sep-21	Scaffolding	7	145	643	10.72	804000.00
		Elevated platform	6	99			
		Ladder	9	144			
		Floor opening	10	150			
		Roof	0	0			
		Other	7	105			
8	Oct-21	Scaffolding	11	118	371	6.18	463500.00
		Elevated platform	3	48			
		Ladder	5	90			
		Floor opening	1	15			
		Roof	2	45			
		Other	3	55			

Available at www.ijmasr.org

Volume-1, Issue-2, February 2026, Page- 16-27

9	Nov-21	Scaffolding	10	210	310	5.16	387000.00
		Elevated platform	0	0			
		Ladder	1	20			
		Floor opening	1	20			
		Roof	0	0			
		Other	3	60			

Table 3.3 Loss of time & productivity due to non-reportable accident/incidents before innovative substitution

IV. RESULTS AND DISCUSSIONS

Analyze data shows that there was huge loss of time and productivity occurred day by day and the impact of this loss indirectly falls down the company graph. So, to overcome the loss, we prepared the hazard identification and risk assessment. Using HIRA document the fabricated scaffold and stool (innovative substitution) implement on construction site. After this innovative substitution on construction site, we got our result which is planned at the start of research. By using innovative substitution, the hazards related to height work and fall of material/person comes to acceptable level. The given data shows the loss of time and productivity comes to acceptable level.

Loss of time & productivity due to non-reportable accident/incidents after innovative substitution								
Sl. No	Month	Non-reportable accident/incidents due to...	Total non-reportable accident/incidents	Loss of time (in min.)	Total loss of time in a month (in min.)	Total loss of time in a month (in hrs.)	Loss of Productivity in a month (Rs.)	Total loss of productivity
1	Dec-21	Scaffolding	0	0	10	0.187	14062.50	56250 Rs. after innovation
		Elevated platform	0	0				
		Ladder	0	0				
		Floor opening	0	0				
		Roof	0	0				
		Other	1	15				
2	Jan-22	Scaffolding	0	0	10	0.187	14062.50	
		Elevated platform	0	0				
		Ladder	0	0				
		Floor opening	0	0				
		Roof	0	0				
		Other	1	15				
3	Feb-22	Scaffolding	0	0	10	0.187	14062.50	
		Elevated platform	0	0				
		Ladder	0	0				
		Floor opening	0	0				
		Roof	0	0				
		Other	1	15				
4	Mar-22	Scaffolding	0	0	10	0.187	14062.50	
		Elevated platform	0	0				
		Ladder	0	0				
		Floor opening	0	0				

Available at www.ijmasr.org

Volume-1, Issue-2, February 2026, Page- 16-27

	Roof	0	0			
	Other	1	15			

Table 3.4 Loss of time & productivity due to non-reportable accident/incidents after innovative substitution
 With reference data of table 3.3 and 3.4 the following graph plotted between loss of productivity and loss of time with respect to month. It has shown the loss of productivity and time before and after innovative substitution implemented on construction site.

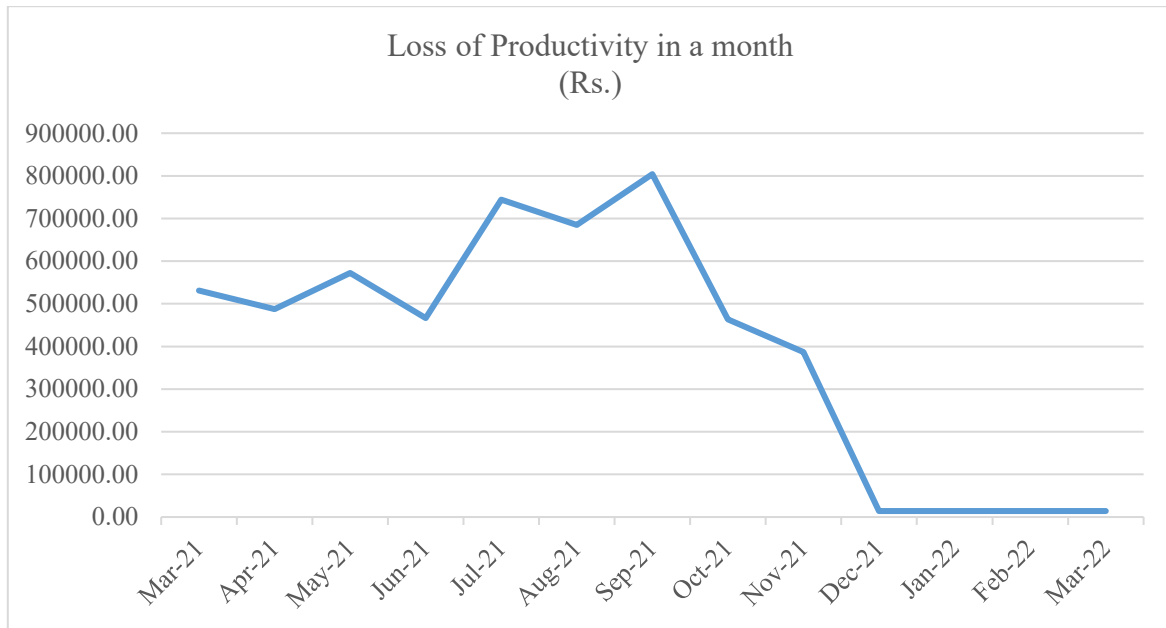


Fig. 1.1 Loss of productivity with respect to month

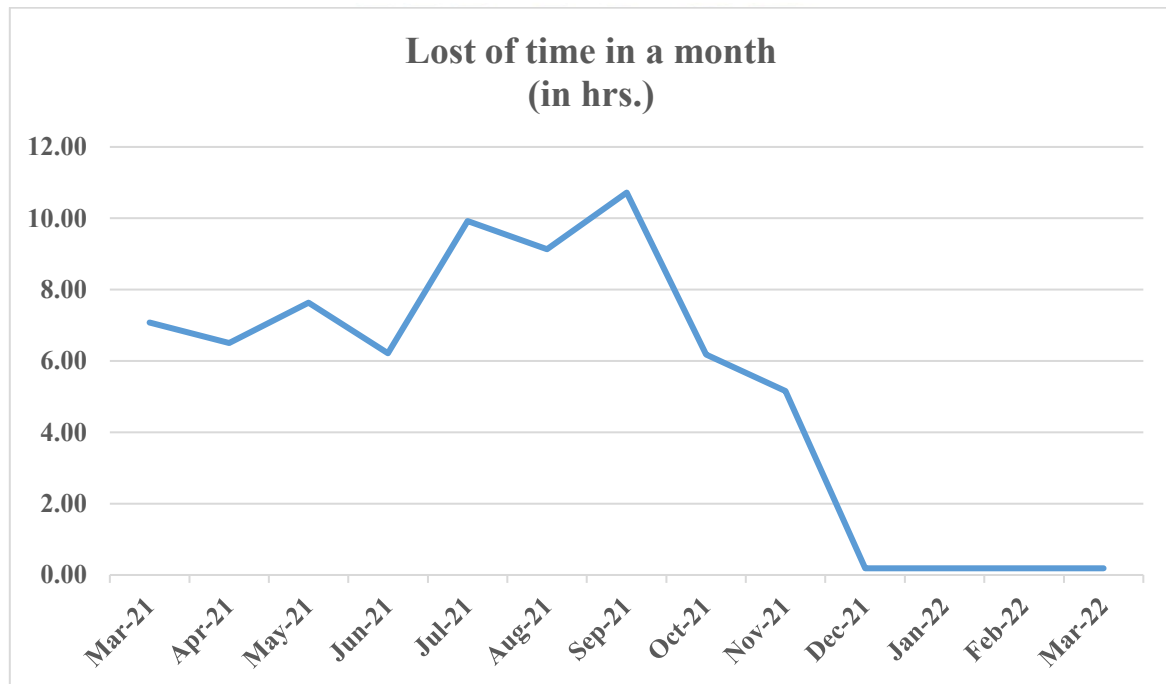


Fig. 1.2 Loss of time with respect to month

CONCLUSION

Production and safety plays an importance job in prompts the smooth running of an organization. To run an organization both need to run in appropriate equilibrium. From the results it is seen that with section of the time production increases and simultaneously occurrences diminishes. The main components of safety like safety training, Risk assessment, Hazard analysis, consistent checking assumes an essential part in accomplishing the decreased mishaps rates with high efficiency. So the main job in accomplishing these is to keep up with all the safety components in working environment. By upholding more safety components, training, analysis, corrective actions, Management ought to give need to both efficiency and security then an organization can be known as an effective organization.

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