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Evaluation of Safety Issues for Workers by Applying Safety Management System and Risk Assessment at Metro Rail Construction Work Project

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Abstract: *Construction industry is one of the top dangerous industries in India because there is a high risk of accident occurrence where the construction workers are exposed to accidents such as fall from height. The awareness of safety at workplace in India has emerged since 1967 with the introduction of the Factories Act 1948 (FA), followed by The Act is administered by the Ministry of Labour and Employment. Rapid transportation system becomes a significant factor for the developing country. Apart from that it is very essential to control the traffic in the high dense and populated country like India. So this where the need of metro rail is generated. A metro project is carried out in Pune under Pune Metro Rail Project. This thesis work is carried out for a part of Pune metro project. In the present scenario, in India maximum accident occurs in construction industry as the Indian construction company is lacking a huge with updated safety instrument and lack of knowledge about safety. This studies is deals with the safety policies, there work environment, responsibilities of a safety personnel in company. The company has a very strict and well defined safety rules which follows BIS standard, OSAH standard and BOCW. The duty of safety engineer is to look after whether any activity, in the site or out of the site, related to the project is going safely or not. It has to be checked by safety personnel as well as the engineer whether any work is following the safety integral management system of the company.*

At the design stage different activities must kept in mind and a safe design must be given so that to reduce the accidents. All activities must have the instructions separately to check the accidents like earthwork in it's as a unique activity so it requires the separate instructions. Some work could be done on the selection process of labour and supervisors and a good communication and better behavior could again check the follow up of different tools and equipment and precautions while working on the site. Training classes must be done on the site with proper process so that the importance of the safety gets clear to the labour with the benefits of that.

Keywords: Metro rail project, HIRA, safety, Health, Construction, Incidents, OSAH, BOCW

I. INTRODUCTION

Construction industry plays a major role in the economic growth of a nation and occupies a pivotal position in the nation's development plans. India's construction industry employs a work force of nearly 33 million people and its market size is worth more than 6.7 lakh crore rupees. It is the second largest contributor in the GDP after agricultural sector. Construction occupational fatalities, injuries and disease result in considerable human suffering and effect not only workers directly involved in the construction but also their families and communities and contribute to the national cost for the medical care and rehabilitation. There is a need to look in different problems related to the labour, there must be some welfare job plan and safety plan and the contractors should follow the different laws.

At the design stage different activities must kept in mind and a safe design must be given so that to reduce the accidents. All activities must have the instructions separately to check the accidents like earthwork in it's as a unique activity so it requires the separate instructions. Some work could be done on the selection process of labour and supervisors and a good communication and better behavior could again check the follow up of different tools and

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equipment and precautions while working on the site. Training classes must be done on the site with proper process so that the importance of the safety gets clear to the labour with the benefits of that. All practices and efforts is to achieve the zero accidents, but the human nature is to that we commit mistakes because of our negligence, so there is a need and we could say that the rights of those who is given efforts by keeping in risk to their life that an insurance scheme must be given according to workers compensation act. With the usage of software's we can maintain a proper management system and the statistics of labour for the same.

Fig 1.1 Road map of Pune Metro Rail Project

1.1 Following are the objectives of research

- To understand the safety policy of in a given workplace Group Metro Project.
- To Determine Broad Parameters of EHS Management at site.
- Identify highly hazardous operations within the scope of work and specify integrated preventive measures to mitigate the same.
- To ensure compliance with relevant applicable legislation.
- Continual EHS performance improvement by directing focus on the key areas for improvement in a consistent manner.
- To discuss issues regarding labor safety.
- Study of various laws and legal provisions related to labour safety and give a comparison with respect to different contract document.
- To develop safety measures taken for each individual activity at different construction stages.
- To provide best safety management system and monitoring process for site safety.
- To identify various socio-culture issues in safety.
- Skilled labour benefits over unskilled labour.

II. SYSTEM DOMAIN

2.1 Introduction

As the population of India is increasing day by day traffic control becomes a significant challenge for the government. In fact the space is limited, so the traffic accident rate is also increased day by day. This challenge is confronting the administration of India is the search of proper solution for traffic management. If we see the developed country, most of the people even who has ability to effort personal vehicle, is using public transport or masstransport system. Due to various advantages metro is considered as the best rapid masstransport system.

Construction sequence

2.2 Road diversion and barricading

First a regulation is implemented for the traffic for 1 lane movement in each side for a length of 200 meter between two points. Mark the road both side at 4 meter distance from the divider. Barricade the area properly with caution board and restrict the unauthorized entry. All the light post is removed then from divider and dismantle the median. Before excavating the lane or area is to be checked for any obstacle.

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Piling- Piling is done where the strata is not strong enough to sustain the load. Fig 2.1 shows thepiling machine. At the bottom of the piling arm, the cutter, dig the soil and put an iron pipethere.This pipe act as mold box. The desired reinforcement is done before the concreting. Afterconcreting is left for 4-5 days putting a load on the piling to make it stronger. When thedesired strength is achieved a pile cap is constructed to make a base on the ground forfurther construction

Fig 2.1 Piling machine

Pier construction-Above the pile cap reinforcement is carried out for pier. Cross section of the piercan be round of 5 ft. dia and 5*4 ft. cross section if it is rectangular. Round pier is generally used for the single pier and rectangular cross-section is used for the extended pier and in station beam. At the bottom of the pier a protector is provided for the sock resistance.So that it protect the base of the pier. A pier cap is mounted then on the pier. Pier cap ispre casted in the casting yard. Fig 2.2 is showing the completed pier along with pier cap.Weight of the normal pier cap is around 70 ton.

Fig 2.2 Pier

Girder erection-This is the final stage of civil construction of elevated metro rail. Two type of girder isused there in order to the limitation of space for the crane. The girder length is also vary like 25 meter, 23 meter and 22 meter. As shown in fig 2.3 the cross sect ion can be 'U' or'I'. Weight of each girder is around 140 ton. Erection of girder is the most critical movement of whole construction. Two crane of 150 ton capacity is engaged for one girdererection. Fig.. shows the elevation sketch how the girder is erected. The trailer to convey the girder from casting yard to the erection site, is having around 36 meter long. And the maximum speed to travel is around 3-4 km per hour. This operation is done when the traffic is very light or mostly at night.

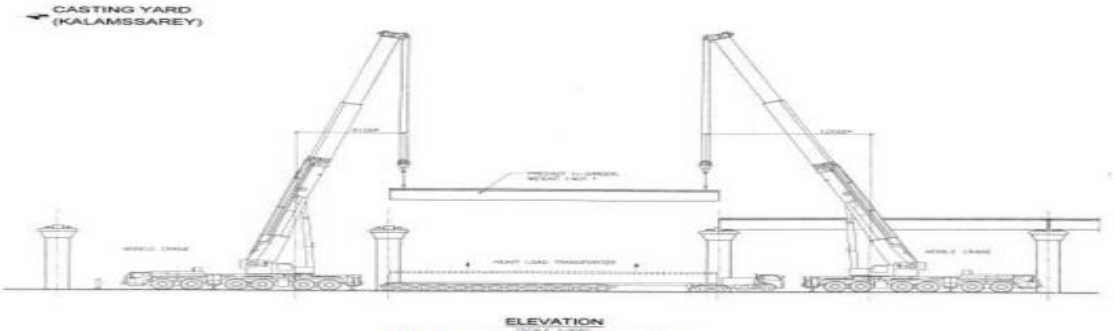

Fig 2.3 Girder erection

Following are the system under metrol construction safety domain

- Work permit system.
- House Keeping.

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- EHS policy.
- Visibility.
- Proactive target settings.
- Company Culture
- Legal requirement.
- EHS rules.
- EHSO responsibilities
- EHS Risk assessment

III. PROBLEM IDENTIFICATION

Factors that influenced contractors to adopt safety management practices Understanding what has influenced contractors to adopt their current safety management practices can help those seeking to encourage wider adoption of these practices, both internally in their own organization and across the construction industry. Therefore, contractors were asked to rate how influential 10 factors were in their decision to adopt their current safety management practices. The chart at right shows the percentage who consider each factor influential or highly influential. All other factors are considered highly influential by about half of contractors, suggesting that there are many influences driving contractors to adopt safety practices.

- Some reflect what contractors are compelled to do, such as regulatory requirements and owner/client demand, which suggests that keeping up this external pressure is important to sustain gains in the adoption of safety practices in the industry.
- Others reflect the importance of contractors' standing in the industry, such as industry leadership in overall safety culture, and keeping a competitive advantage. These indicate how important the focus on safety has become in the construction industry.
- direct business factors have also been influential, including avoiding potential business disruptions and the desire to improve productivity, which suggests more data on these factors could still be influential. Contractors were asked about the percentage of projects on which different types of safety training were offered or required. The chart below shows the percentage of GCs and trade contractors who offer or require these types of training on 75% or more of their projects.
- Providing safety and health training is a common practice among GCs and trade contractors alike, with about three quarters saying they offer it on 75% or more of their projects.
- The highest percentage of GCs (80%) report that all employees receive orientation training on a new site on 75% or more of their projects. This is a less common offering by trade contractors, with only 67% reporting that they offer this training at that frequency.
- A higher percentage of GCs commonly require supervisor training on safety than do trade contractors. About 70% of GCs require supervisors to have safety and health leadership training and to undergo basic safety and health training themselves (minimum of OSHA 30- hour training in the U.S.) on the majority of their projects, while only around 50% of trade contractors have the same requirements.
- A lower percentage of GCs (57%) require basic safety and health training for jobsite workers on the majority of their projects than do those that require supervisory training. In fact, the percentage of GCs requiring this training is nearly equal to trade contractors (56%). Basic safety and health training for jobsite workers in the U.S. is a minimum of OSHA 10- hour training. Despite relatively robust requirements by GCs for supervisors, these findings demonstrate a tendency for contractors to focus training on the immediate needs of the site rather than amore comprehensive series of requirements. They suggest that more attention to safety training requirements is needed for jobsite workers in particular.

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IV. PROBLEM SOLUTION

4.1 Causes of accidents and preventive measures

Causes of accidents are normally due to the unsafe acts and unsafe conditions. Normallyit means that most of the accidents could be avoided at the construction site and forexample a percentage is being giving below that the percentage of the unsafe act ismuch higher and therefore all accident can be avoided by are working processes, afterall some accident could not be avoided and that are natural calamities which could take at any place and anyone cannot avoid that.

- 98% of accidents were caused by unsafe actions and unsafe conditions.
- Unsafe acts 78%
- Unsafe conditions – 20%
- Natural calamities – 02%
- All accidents caused by unsafe acts and conditions are preventable.

4.2 Collective techniques to motivate workers in safety

- conducting tool box meetings
- conducting safety contests.
- Maintain safety bulletins boards.
- Exhibiting posters.
- Circulation of journals
- Displaying safety signs and slogans.
- Group activities
- celebrating safety day, etc.

V. EHS CHALLENGES

The metro project work is constructed on the busy road. So safety precaution of the worker and the engineer along with the public is significant concern of the project. Due tothe heavy traffic during the pick hour as the road where is it being constructed, isconnected to national highway, so many limitations come during the construction. This challenge confronting all the safety personnel along with all the employees to adopt as afety policy and to apply the control measures to minimize the probability of risk or theimpact of undesirable EHS consequences. Risk control measures that have been implemented and are still effective in controlling the hazard.

5.1 EHS challenges

- Traffic Management i.e working on live traffic while Barricading boards Installation & Cleaning.
- Space constraint.
- Work at height including, Station work, Pier cap erection & U-Girder erection.
- High Workmen Rotation.
- Managing Union workmen

5.2 Control Measures

Following the safety policies the initiatives taken by the company to overcome the above challenges are

i. To manage the traffic control, at every 200 meter a traffic marshal is employed. Apart from that to avoid the accident a strong barricading is provided at the both side of workplace. The proper deviation and caution board is also provided. For the night all the deviation sign and the caution board are written with light reflective materials as shown in fig 6.1

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Fig 6.1 barricading and diversion.

ii. Project EHS Department in co-ordination with assigned trainer will conduct Safety training programs on different topics. Project Manager, Section in charge, Site engineers, supervisors & workmen attend the program to enhance their technical knowledge with respect to safety and learn how to integrate safety into the work-practices. It is compulsory for all staff members to attend this programmer at least once as early as possible from the date when they joined in company service. Apart from training program everyday morning toolbox talk is given at the site by the engineer in presence of safety officer as shown in fig 6.2

Fig. 2.2 tool box talk.

iii. All the excavated area generated due to piling work is barricaded with the caution board.

iv. Proper housekeeping is carried out every time to main the the workplace clean.

v. To prevent fall from height and the materials falling two layer of safety net is to provided. Apart from that if anywhere any work is carried out at height a caution boardis given to make aware from the material fallings. As per the regulations all theworkers are working at height must be provided the required PPE's

vi. In every month noise, dust particle at the work premises, illumination, air contaminant is checked whether it exceeds the standards or not. To prevent the dust water sprinkleris spread to the road and the working place as shown in fig.

vii. Various types of colorful posters are provided beside the road to increase the safetyawareness. Apart from that the every year some award is given to the worker orengineers for proper motivation.

VI. METHODOLOGY

6.1 The following like cases will studies are necessary to clearly understand the scenario. Case studies will clear the exact picture of the situation we want to look for and will guide us further to modify our rules if they need advancement or modify them in case of failures. Hazard Identification and risk assessment HIRA methodology use to find out the Hazards risk associated with working condition.

Sr.No.	Observation Comparison Chart
1	Site (Trailer) Facility Security and Public Safety
2	Facility Security and Public Safety
3	PPE
4	Housekeeping
5	Fire Protection / Prevention
6	Contractor (Subs) Provisions

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7	Fall Protection
8	Scaffolding
9	Electrical
10	Hand & Power Tools
11	Heavy Equipment
12	Cranes / Hoists / Elevators
13	Trenching & Excavations
14	Ladders / Stairways
15	Concrete & Masonry
16	Steel Erection
17	Welding & Cutting
18	Demolition & Blasting
19	Hazardous Substances
	TOTAL POINTS 180 of 19

6.2 Hazard Identification and Risk Assessment-HIRA

Hazard Identification Risk Assessment (HIRA) is a process of defining and describing hazards by characterizing their probability, frequency, and severity and evaluating adverse consequences, including potential losses and injuries. One of the "root causes" of workplace injuries, illnesses, and incidents is the failure to identify or recognize hazards that are present, or that could have been anticipated. A critical element of any effective safety and health program is a proactive, ongoing process to identify and assess such hazards.

To identify and assess hazards, employers and workers:

Collect and review information about the hazards present or likely to be present in the workplace. Conduct initial and periodic workplace inspections of the workplace to identify new or recurring hazards. Investigate injuries, illnesses, incidents, and close calls/near misses to determine the underlying hazards, their causes, and safety and health program shortcomings. Group similar incidents and identify trends in injuries, illnesses, and hazards reported.

Consider hazards associated with emergency or non-routine situations. Determine the severity and likelihood of incidents that could result for each hazard identified, and use this information to prioritize corrective actions. Some hazards, such as housekeeping and tripping hazards, can and should be fixed as they are found. Fixing hazards on the spot emphasizes the importance of safety and health and takes advantage of a safety leadership opportunity. To learn more about fixing other hazards identified using the processes described here, see "Hazard Prevention and Control.

Action item 1: Collect existing information about workplace hazards

Action item 2: Inspect the workplace for safety hazards

Action item 3: Identify health hazards

Action item 4: Conduct incident investigations

Action item 5: Identify hazards associated with emergency and no routine situations

Action item 6: Characterize the nature of identified hazards, identify interim control measures, and prioritizethe hazards for control.

VII. RESULT ANALYSIS

The following study clearly understand the scenario.

Case studies will clear the exact picture of the situation we want to look for and guide us further to modify rules if they need advancement or modify them in case of failures. Hazard Identification and risk assessment HIRA methodology use to find out the Hazards risk associated with working condition

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Result and observation table

Sr.No.	Observation Comparison Chart	CASE-1		CASE-2	
		Yes	No	Yes	No
1	Site (Trailer) Facility Security and Public Safety	6	2	5	3
2	Facility Security and Public Safety	4	4	6	2
3	PPE	4	3	5	2
4	Housekeeping	3	5	4	4
5	Fire Protection / Prevention	5	2	5	2
6	Contractor (Subs) Provisions	3	3	4	2
7	Fall Protection	5	2	4	3
8	Scaffolding	5	3	6	2
9	Electrical	7	3	6	4
10	Hand & Power Tools	5	3	5	3
11	Heavy Equipment	10	3	9	4
12	Cranes / Hoists / Elevators	9	5	10	4
13	Trenching & Excavations	7	4	6	5
14	Ladders / Stairways	4	5	7	2
15	Concrete & Masonry	5	4	4	5
16	Steel Erection	4	3	4	3
17	Welding & Cutting	8	3	5	6
18	Demolition & Blasting	9	4	5	8
19	Hazardous Substances	3	3	3	3
	TOTAL POINTS 180	**106**	**64**	**103**	**67**

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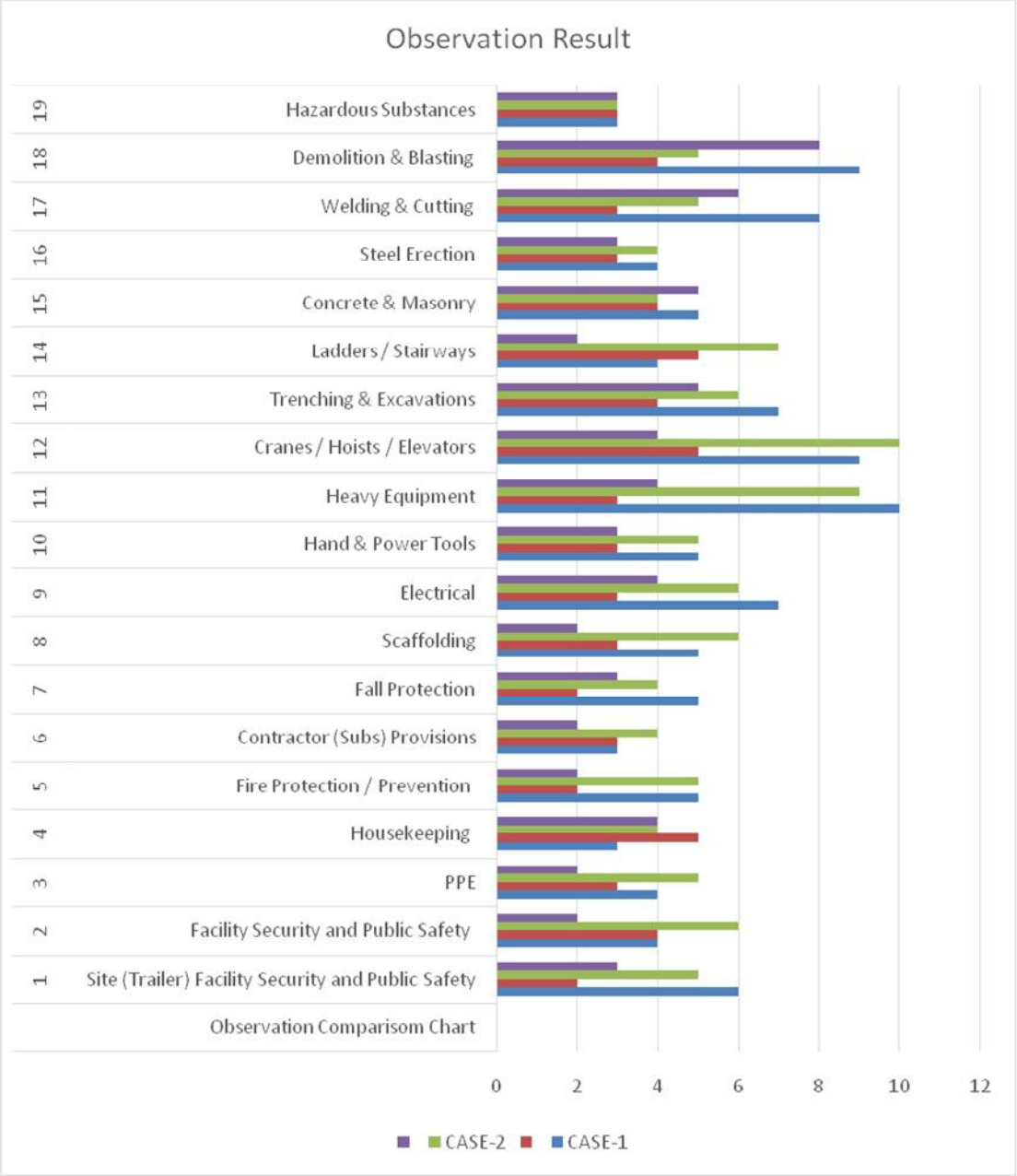

Chart-1 result and observation Case 1 & 2

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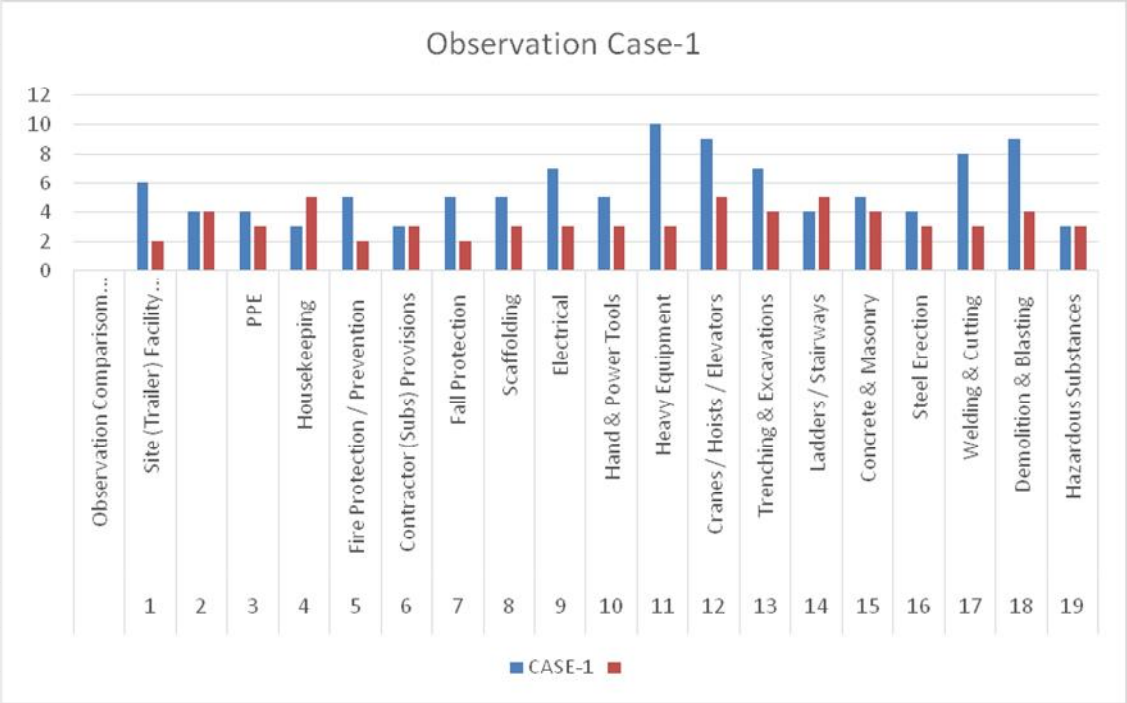

Chart-2 result and observation Case 1

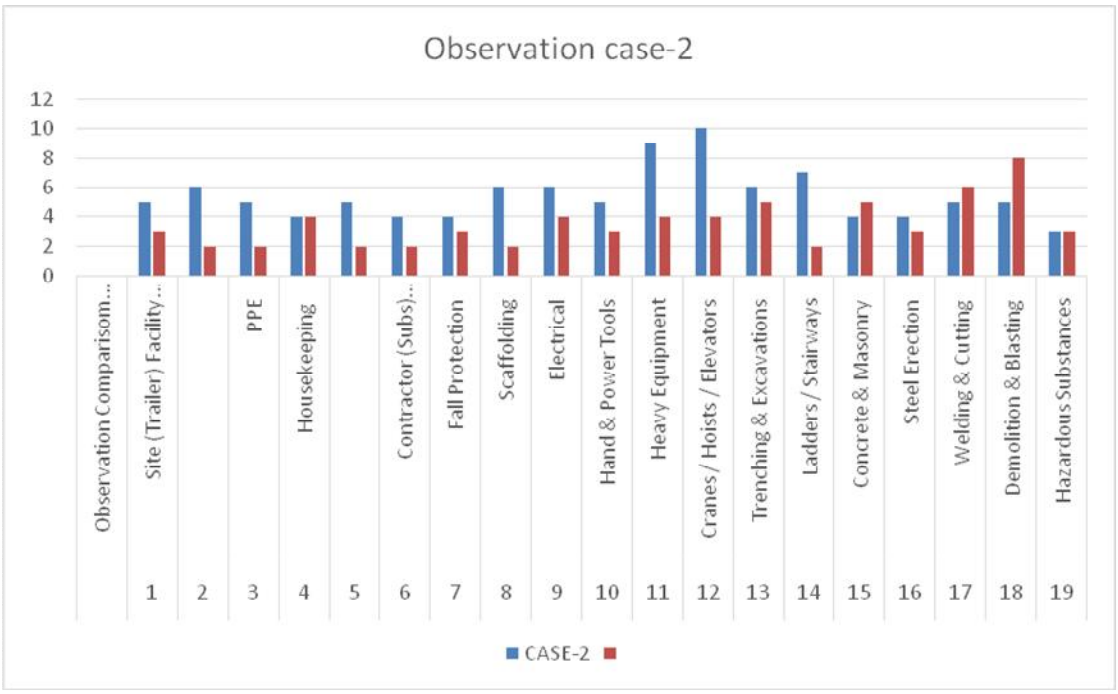

Chart-3 result and observation Case 2

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RISK ASSESSMENT MATRIX (RAM)

			SEVERITY				
	SCALE		Negligible	Slight	Moderate	High	Very High
			1	2	3	4	5
PROBABILITY	Very Unlikely	1	1	2	3	4	5
	Unlikely	2	2	4	6	8	10
	Possible	3	3	6	9	12	15
	Likely	4	4	8	12	16	20
	Very Likely	5	5	10	15	20	25

Note: Any of the Risk having a score of Probability & Severity as 15 or more shall be considered as significant Risk.

Risk	Risk Level		Action
1 To 6	Low Risk	Non-Significant	If the risk is in the **Green Zone**, consider as **Low Risk** on the Risk Assessment Matrix (RAM), this is broadly acceptable and no further action is required.
8 To 12	Medium Risk	Non-Significant	If the risk is in the **Yellow Zone,** consider as **Medium Risk** on the RAM, this is in the tolerable regions and needs to be demonstrated to be As Low As Reasonably Achievable (ALARP) by recommending further action.
15 To 25	High Risk	Significant	If the Risk is in the **Red Zone**, consider as **High Risk** on the RAM, this is not acceptable and action has been proposed to reduce the risk level. HIRA Review team shall propose the actions plan, for reducing high risk to medium or low risk and consider as acceptable risk. Consider HSE Management Programme for all Significant Risk.

VIII. CONCLUSION

Though the Metro Rail Construction project work is a multinational construction company due lack of modern technology still there are some accident take place. During the stipulated time of project there was no any fatal case but some minor injuries is taking place. Even everyday some people are injured at first aid level. Safety is not a responsibility of any particular person or only the safety engineers. From the very first day when a employee employed, he is advised to take care of own safety himself. This is really tough to make a site totally injury free but not impossible. Project is updating its safety policy or EHS management system to make a project totally accident free. Safety become their first concern and they provide more layer of protection to prevent the risk at the workplace. In this project the main challenges were height work, and traffic management. Firm is successfully tackle those challenge by implementing new technologies and established fluent communication system. Through different report and punishment for in-compliance of unsafe work the accident rate becomes under controlled.

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