EVALUATION OF CONTRACTORS SAFETY AND HEALTH PERFORMANCE USING OSHA MATHEMATICAL STANDARD

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Abstract
The rapid growth in the construction industries has led to increases in accidents and fatality rates which threat on the occupational safety and health. Occupational Safety and Health Act (OSHAct) of 1994 obligate employer to provide and maintain a safe and healthful workplace for all employees. Ignorance and lack of safety compliance from contractors had caused employees to violate the safety procedure and the outcomes were unsafe acts, hazardous condition, injuries and accidents. Contractors play an important role in the accomplishment of the building construction. Thus, there is the need to evaluate contractor's safety and health performance using OSHA mathematical standard. This study is a criteria – based study, and mainly derives quantitative measure in order to evaluate contractor's safety and health performance using OSHA mathematical standard. Twenty (20) construction companies that meet the study criteria were selected. Some contractor's performance is very satisfactorily while some are of average. It can be concluded that the number of subcontractors on sites determine the number of employees on site which determine the status of the accidents on site. Also the number of employees on sites determines the numbers of recordable injury or illness per 100 employees. To increase the benefits of safety management system practice on site by the contractors and better overall performance, it is recommended that the contractors should give credence to implementation of health and safety measures through cordial relationship with the construction workers, with emphasis on accident reduction at the construction sites.
Keywords: accident, contractors, construction, employees, performance.

1. INTRODUCTION.

Occupational Safety and Health Act (OSHAct) of 1994 obligate employer to provide and maintain a safe and healthful workplace for all employees. Construction industries worldwide is associated with high accidents and fatality rates when compare to other industries (Sidumedi, 2009; Ulang, N.M.,Gibb, A.G.F. and Anumba, C.J. 2010). According to Vander, M. T., Toit, W. D., Sikosen, Z., Notje, N., & P.Evert, (2009) the rapid growth in the construction industries has led to increases in accidents and fatality rates which threat on the occupational safety and health.

In Malaysia despite the implementation of safety laws and regulation in the construction industry, accidents rates in the construction industry are truly proven. According to Zakaria, Z., Hussin, Z. H., Noordin, N., & Zakaria, Z. (2010), the NIOSH Chairman, Datuk Lee Lam thye that there are 1,195 confirmed space accidents in which 122 workers suffered permanent disabilities and 7 other killed

compared to 1,365 cases in 1997 which recorded 44 permanent disability cases and 6 fatalities. The high rates of construction accidents have been an issue of concern. The problems still exist because there are certain contractors and sub-contractors who continued to flout safety rules, one of which is unskilled workers who erect scaffolding for high-rise construction.

In a study conducted in Kuala Lumpur and Selangor by Norfairuz, (2003), it was observed that ignorance and lack of safety compliance from contractors had caused employees to violate the safety procedure and the outcomes were unsafe acts, hazardous condition, injuries and accidents. Contractors play an important role in the accomplishment of the building construction. Thus, there is the need to evaluate contractor's safety and health performance using OSHA mathematical standard. The OSHA mathematic calculation enables each construction firm or sites to provide information about their recordable incident rates, lost time rates and severity rates so that they can be compared among the construction firms or sites. As such this paper examined the effectiveness of contractor's safety management system on the site. That is the effectiveness of construction contractors' compliance with safety and health measures in the construction sites, so as to determine its appropriateness and acceptance as a safety management approach. This study is motivated by the lack of literature on the construction contractors' compliance with safety and health measures in the workplace.

2. LITERATURE REVIEW

Majority of the contractors in Malaysia fail to establish a proper safety measures and procedure at the workplace, and the officer- in-charge, the Safety and Health Officer (SHO) have no power to effectively establish such safety measures and procedure at the workplace (Ghani, B. E. M. K., Hamid, E. D. Z. A., AbduRahim, B. E. A. H., Mohamad Kamar, B. E. K. A., & Abdul Rahman, B. M. A. 2009). Therefore, for effective implementation of safety and health at construction sites, there is the need for full support for the safety and health officer from the contractor to enable the safety officers discharge their duties effectively.

Husin, H. N., Adnan, H., & Jusoff, K, (2008) suggests that the current safety management system practice in Malaysia has sound features. However, it lacks the mission, vision and objectives of safety management system as well as lack of awareness and drive for realization of safety among management executives due to over-emphasis on productivity. It requires more constructive and practical ideas towards safety management implementation. Contractors have a role to play in

promoting safety programmers and safety behavior as stipulated in OSHA 1994 Section 17 (Duties of employers and self-employed to their employees). They have an obligation to ensure that their workers are not exposed to risk which can affect their safety and health.

However, it has become a vital issue to select a contractor with knowledge of safety and health together with a good performance on safety and health based on their previous record. Ghani, *et al.,* (2009) also revealed that in Malaysia, the current tread is the undertaking of big project by subcontractor; the main contractor would only lobby for the project, while construction matters would be handed over to the sub-contractor for a substantial profit. This type of contract has been in existence for long in many part of the world, the only thing required is that the main contractor has to make sure that competent subcontractor (with vast knowledge on safety and health) were selected to handle such type of project. Unfortunately, in most construction sites most sub-contractors do not normally have a contractual relationship with the client, and in many instances would not even have a direct contact with contractor or any other parties. Due to this the employers/employees relationship is lost bringing with it the destruction nature of management of employees. Furthermore, Hinze & Gambatese, (2003) were of the opinion that in order to achieve and improve on the safety aspect and safety performance, the sub-contractor must have their own safety programme. A study conducted by Koehn, *et al.*, (1995) and quoted by Ghani, *et al.*, (2009) affirmed that the main contractor must make a proper selection of sub-contractor to ensure that they have the capability in term of both skills and safe operating procedure.

As regard to Malaysia experiences, Ghani, *et al.,* (2009) revealed that majority of the contractor in Malaysia fail to instill a safety culture among their staff and workers due to lack of autonomy power of the officers in charge, to strictly enforce the regulation as they are employed by the contractor. Therefore for effective implementation of safety and health at construction site, there is the need for full support to the safety and health officer from the contractor. And at the same time full commitment and support from top management is needed in order to improve safety performance on sites. According to (Mohamed, 2002), management roles have to go beyond organizing and providing safety policies and working instruction. Langford *et al.*, (2000) as cited by (Mohammed, 2002) found that when employees believe that the management cares about their personal safety, they are more willing to cooperate to improved safety performances. Said, I., Mohd,W..S., &Abdelnaser,O. (2009) have drawn the attention to the fact that contractors are

without doubt, the main party to plan and control construction site safety, and that the designers can only reduce safety hazards in the working environment by considering workers safety issues in their design decision. Despite the involvement the designer and the client on the issue of safety at the construction sites, the management of construction safety on site still rest on the shoulder of the contractor.

3. RESEARCH METHOD

The factor to be considered in selecting the best research methodology should be the influence that such method have on the research problem and objectives (Creswell, 2003). This study mainly derives quantitative measure in order to evaluate contractor's safety and health performance using OSHA mathematical standard.

This study is a criteria – based study. This becomes necessary as different contractors sizes/types exist in construction industry. The implementation of safety measures is only binding on certain sizes/types of contractors. For the purpose of this study, the contractors have to meet certain criteria before been considered in this study. Those criteria are:

1. The construction company must be built/civil engineering, construction.
2. The construction company must be more than twenty (20) years in civil/building construction work.
3. The location of the study and the construction company must be Kuala Lumpur, Malaysia.
4. The target constructions company must be certified ISO 9000 G7 contractors registered with CIDB Malaysia and are large size (with more than 100 workforces). The reason was that large construction companies tend to have a high degree of concept of safety awareness and notions of safety and health performance.

Twenty (20) construction companies were identified to meet the research criteria and were selected for this study, the selection process were in similar reported work of Mattila, M. Marita, I., and Eeva, R.., (1994); Paul, (2007); Dingsdag, D. P., Biggs, H. C., & Sheahan, V. L., (2008), laryea &Mensah, (2010), Eddie, W.L., Cheng, N.R.and Stephen, K (2012) and Mohammed, (2015). The quantitative data framework required is the performance rates of various contractors, which were assessed through OSHA standardized mathematic formula i.e., incident rate (IR), Lost time case rate (LTC) and the Severity rate (SR).

Performance Rates Benchmark

Performance benchmarking is a method of improving construction safety performance in a systematic and logical way by measuring and comparing ones performance against others and then using the lesson learned from the best to make targeted improvement. It involves answering the question who perform better? why are they better? And what action do we need to take in order to improve our performance?

Performance Rate calculation

OSHA standardized mathematic formula can be used by the construction firms/sites to provide information about their recordable incident rates, lost time rates and severity rates so that they can be compared among the construction firms or sites.

The standard is based on a rate of 200,000 labor hours. This number, i.e 200,000 equates to 100 employees, who work 40 hours per week, and 50 weeks per year. Using the standardized based rate, any construction firms/sites can calculate their rate(s) and get a percentage per 100 employees.

1. OSHA Recordable Incident Rate (IR).

The OSHA Recordable Incident Rate (or Incident Rate) is calculated by multiplying the number of recordable cases by 200.000, and then divide it by the number of labor hours at the construction companies.

$$IR = \frac{Number\ of\ OSHA\ Recordable\ case}{Number\ of\ Employee\ labor\ hour\ worked} \times 200{,}000$$

The result of the above calculation will give the number of employees involved in a recordable injury or illness per every 100 employees.

2. Lost Time Case Rate (LTC).

The lost Time Case Rate (LTC), is similar to incident rate calculation, only that it uses the number of cases that contained lost work days. The calculation is made by multiplying the number of incidents that were lost time cases by 200,000 and then dividing that by the employee labor hours at the construction companies.

$$LCT\ rate = \frac{Number\ of\ lost\ time\ case}{Number\ of\ Employee\ labor\ hour\ worked} \times 200{,}000$$

The result of the above calculation will give the number of employees that have suffered lost time because of a work related injury or illness per 100 employees.

3. Severity Rate (SR).

The severity rate is a calculation that gives a construction firms/sites an average of the number of lost days per recordable incident. The calculation is made by dividing the total number of lost workdays by the total number of recordable incidents.

$$SR = \frac{Total\ number\ lost\ work\ days}{Total\ number\ of\ recordable\ incidents.}$$

The result of the above calculation will provide information about the construction companies average days lost due to work related injury and illness based on every recordable incident. The reliability of the data collected was tested using the test – retest method. Reliability testing is aimed at ascertain the degree to which a score is suitable and consistent when measured at different time. The scores are consistent over time.

4. RESULTS AND DISCUSSION

Table 1 is the Analysis of past performance (lagging indicators) of the 20 construction companies that meet the study criteria. The rates were calculated using OSHA established specific mathematic standard employed by is all the construction companies. The standards enable a comparison to be made among the construction companies.

Table I. Analysis of Performance rates of the 20 Construction Firms

S/No	Fatal	Non fatal			Total	Number of subcontractors	Size of the sites	Number of day loss	Number of loss time cases	Number of hrs worked	Incident rate (IR)	Lost time case rate (LTC)	Severity rate (SR)
		NPD	PD	Total									
1	3	19	2	21	24	23	165	66	12	330,000	14.55	7.27	2.75
2	4	20	3	23	27	19	135	75	14	270,000	20	10.37	2.78
3	3	28	2	30	33	18	128	78	17	256,000	25.78	13.28	2.36
4	3	21	2	23	26	20	138	74	13	276,000	18.84	9.42	3.7
5	3	21	2	23	26	22	151	72	13	302,000	17.22	8.61	2.76
6	3	21	3	24	27	19	130	74	14	260,000	20.77	10.77	3.08
7	3	20	2	22	25	21	149	67	13	298,000	16.78	8.73	3.05
8	3	20	2	22	25	22	156	65	13	312,000	16.03	8.33	2.96
9	3	18	2	20	23	23	161	60	12	322,000	16.29	7.45	3
10	3	19	2	21	24	22	160	61	12	320,000	15	7.5	2.91
11	2	18	2	20	22	24	173	45	11	346,000	12.72	6.36	2.25

Table I. (contd)

		Non fatal											
S/No	**Fatal.**	**NPD**	**PD**	**Total**	**Total.**	**Number of subcontractors**	**Size of the sites**	**Number of day loss**	**Number of loss time cases**	**Number of hrs worked**	**Incident rate (IR)**	**Lost time case rate (LTC).**	**Severity rate (SR).**
12	3	19	2	21	24	22	158	63	12	316,000	15.19	7.6	3
13	3	20	2	22	25	21	149	66	13	298,000	16.78	8.73	3
14	3	17	2	19	22	23	162	44	11	324,000	13.38	6.78	2.32
15	3	18	2	20	23	22	162	59	12	324,000	14.2	7.41	2.95
16	3	18	3	21	24	21	145	59	12	290,000	16.55	8.28	2.81
17	3	18	2	20	23	23	170	55	12	340,000	13.58	7.06	2.75
18	3	17	2	19	22	25	180	41	11	360,000	12.22	6.11	2.16
19	3	19	2	21	24	20	143	58	12	286,000	16.78	8.39	2.76
20	2	19	1	20	22	25	178	42	11	356,000	12.36	6.18	2.1

Researcher Analysis, (2015).

Research finding

In Table I. the company site with the highest number of accidents (fatal and nonfatal) has the highest number of incident rates and lost time case rate. The following were the observations from the Table 1.

1. The numbers of fatal accidents increase with less number of subcontractors on site.

2. An increase in the company size of the site decreases the number of fatal accidents on the site.

3. The nature of fatal accidents determines the amount of day's loss. Site 20 has the lowest amount of day loss with 2-fatal accidents. But comparing with Sites 2 and 3, it can be observed that in Site 2, fatal accidents is four (4) and its loss days is 75, while in Site 3, fatal accidents is three (3) and its loss day is 78. Therefore, the nature of fatal accidents determines the number of day loss.

4. The number of subcontractors on a company site determines the size of the principal contractor i.e Site 3 has 18 subcontractors on the site and its site size is 128 while Site 18 and 20 has 25 subcontractors and their site sizes are 180 and 178 respectively.

5. The size of the company site determines the number of hours worked. Site 3 has 128 employees on site and its number of hours worked is 256,000, while Site 18 has 180 employees on the site and its number of hours worked is 360,000.

6. The number of working hour determines the number of accidents on company site, that is the more the working hours the less the number of accidents on site. Site 18 has 360,000 working hours and its total number of accident is 22 while Site 3 has a total number of working hours 256,000 and its total accident is 33.

7. The size of the company site determines the number of employees involved in a recordable injury or illness in every 100 employees. From table i, Site 18 has 180 employees on site and the number of employees/100 involves in injury or illness is 12.22 employees' i.e. 12.22/100 employees, while Site 3 has 128 employees on site and the number of employees involves in injury or illness is 25.78 employees' i.e. 25.78/100 employees. Therefore, as the number of employees on sites increases, the number of employees involves in every 100 employees accidents decreases.

8. The size of the company sites determines the number of employees that suffered lost time per 100 employees because of work related injury or illness. In site 18 with 180 employees, 6.11 employees have suffered a lost time per 100 employees. While site 3 with 128 employees, 13.28 employees has suffered lost time per 100 employees because of work related injury or illness.

9. The number of day loss and the total number of accident determine the average day loss due to those work related injury and illness. Site 7 with 67 numbers of day loss has an average of 3.10 lost days due to those work related injury or illness. Site 1 has the highest number of average loss day i.e 9.08.

Research Discussion

In examining the performance of the contractor's construction company, performance rates were used in order to measure and compare the performance of one contractor against the other. The purpose of measuring performance is to create feedback that can lead to improvement.

The findings of this study have provided the expected feedback of the contractors as regard to health and safety performance. Some contractor's performance is very satisfactorily while some are of average. It is relatively easy to gather lots of performance data, however it takes a great deal of effort to extract from the data useful trends and to identify where efforts for improvement should be directed. Also, it is difficult to develop ways to present the data so that the information leaps out in a way that will create a reaction that leads to improved performance. This was achieved using OSHA mathematical standard.

Performance rates (incident rate, lost time case rate and severity rates) only indicate the past performance (lagging indicators) and they cannot indicate the future performance of a contractor's construction company. Contractor's health and safety performance is basically aimed at reducing or eliminating accident at workplace. As such from the finding of this study it was determine that the number of subcontractors on site determines the number of employees on the site and the number of employees on site determines the rate of accidents on site. This finding indicates that the more the number of employees on site the less the number of accidents on the site. This means that adequate number of workers will be on particular workstation, the chance of accident occurring will be less and the work can be completed within the shortest time. But in sites with less number of employees more time is required and the chance of accident occurring is high. Also from the analysis using OSHA mathematical standard and the finding of the study, the number of employees involved in a recordable injury or illness per 100

employees is determined by the number of employees on site. Lost time case and the severity rate are also determined by the number of employees on site.

5. CONCLUSION AND RECOMMENDATION

As regard to the evaluation of contractors safety and health performance, it can be concluded that the number of subcontractors on sites determine the number of employees on site which determine the status of the accidents on site. Also the number of employees on sites determines the numbers of recordable injury or illness per 100 employees. This means that contractors with higher numbers of subcontractors and employees on site will have less of accident occurrence on site and their safety and health performance is high.

It is in the opinion that the high accident rates identified associated with some contractors in Kuala Lumpur Malaysia can be reduced following the footstep of those with effective safety and health performance records or by taking a precautionary measures. Effective awareness or compliance to safety management system is helpful for improvement in construction site safety management system performance. In order to improve safety management system on site contractors and the subcontractors must train and educate their workers that the issues of safety and health should be the responsibility of everyone within the construction site and those outsiders that are affected by the construction operation. Adequate training of workers is important in order to increase their awareness most especially as regard to identifying and minimizing risks/hazards on the sites. Many safety professionals were of the opinion that training and educating construction workers help in reducing cost and save lives.

Toole, (2002), had found out that if workers lack proper training on safety and health, the workers' may not be able to recognize potential hazard at the construction sites. This shows that safety and health training plays a significant role in the enhancement of safety in construction. For those contractors that have been beneficiaries of improved safety and health management system in their organization/or construction sites, it is recommended that they should pay more emphasis on meeting the safety requirement standard at construction sites by organizing induction training for new workers, training and educating the old workers, promoting safety measures at the workplace through poster, video and audio media. In addition targeting workers' behavior toward accident prevention measures through monitoring and rewarding can help improve safety and health standard compliance at the construction sites. Thus, to increase the benefits of safety management system practice on site by the contractors and better overall performance, it is recommended that the contractors should give credence to implementation of health and safety measures. This can be achieved through cordial

relationship with the construction workers, with emphasis on accident reduction at the construction sites. Also, appointment of a trained safety, health and welfare personnel assist by a staff whose responsibilities are to inspect, monitor and ensure compliance with approved regulation on a daily basis. Furthermore, the finding of this research work can assist the contractors to improve safety practice on site by ensuring good implementation of safety management system on construction sites.

REFERENCE

Creswell, J. (2003). J. 2003. Research Design Qualitative, Quantitative, and Mixed Methods Approaches. *Handbook of mixed methods in social & behavioral research*, 209-240.

Dingsdag, D. P., Biggs, H. C., & Sheahan, V. L. (2008). Understanding and defining OH&S competency for construction site positions: Worker perceptions. *Safety science*, *46*(4), 619-633.

Eddie, W.L., Cheng, N.R.and Stephen, K. (2012). Exploring the perceived influence of safety management practices on project performance in construction industry. *Safety science*, 50.

Ghani, B. E. M. K., Hamid, E. D. Z. A., AbduRahim, B. E. A. H., Mohamad Kamar, B. E. K. A., & Abdul Rahman, B. M. A. (2009). Safety in Malaysian Construction: The Challenges and Initiatives.

Hinze, J., & Gambatese, J. (2003). Factors that influence safety performance of specialty contractors. *Journal of Construction Engineering and Management*, *129*(2), 159-164.

Laryea, S & Mensah, l,. (2010). Health and Safety on Construction Sites in Ghana. Construction Building and Real Estate Research Conference of Royal Institute of Chartered Surveyors. 2 – 3 Sept.

Mattila, M. Marita, I., and Eeva, R. (1994). Effective supervisory behaviour and safety at a building site. *International Journal of Industrial Eegonomics* 13.

Mohamed, S. (2002). Safety climate in construction site environments. *Journal of Construction Engineering and Management*, *128*, 375.

Mohammed, Y.D, (2015). Assessment of performance compliance to construction site safety management system in Klang Valley, Malaysia. Thesis submitted to School of Graduate Studies, Universiti Putra Malaysia in fulfillment of the requirement for Doctor of Philosophy.

Norfairuz, F. (2003). *Amalan Keselamatan di tapak bina: Kajian kes Projek perumahan di sekitar Kuala Lumpur dan Selangor.* Fakulti Kejuruteraan Awan, Universiti Teknologi Malaysia. Unpublished thesis

Paul, M. (2007).Safety performance on twenty construction sites in Dublin.Dublin Institute of Technology.

Said, I., Mohd,W..S., &Abdelnaser,O. (2009). The role of clients in enhancing construction safety. *of engineering, annals of faculty of engineering hunedoara, 7*(2).

Sidumedi, K.S.(2009). An investigation into the relationship between the corporate culture of South African construction firms and performance. (Online) http://wiredspace.wits.ac.za/handle/10539/7942 [Accessed: 3. Nov. 2011].

Toole, T. M. (2002). Construction site safety roles. *Journal of Construction Engineering and Management, 128*(3), 203-210.

Ulang, N.M.,Gibb, A.G.F. and Anumba, C.J. (2010). The communication of health and safety information in construction. *Proc. Of Cib World Congress [Cib W099 Special Track], Manchester,1 May 2010.*

Vander, M. T., Toit, W. D., Sikosen, Z., Notje, N., & P.Evert. (2009). Managing construction health and safety, . *conference on managing construction health and safety "optimising on-site health and safety.*, 20 - 100.

Zakaria, Z., Hussin, Z. H., Noordin, N., & Zakaria, Z. (2010). Accidents at the Construction site in Northern Area: Malaysian Experienced. *Management Science and Engineering, 4*(3), 106-116.