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Retraction

Retraction: The Influence of Safety Practices on Construction Labour Productivity (*IOP Conf. Ser.: Mater. Sci. Eng.* **620** 012075)

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The Influence of Safety Practices on Construction Labour Productivity

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ABSTRACT

The objective of this study was to identify the most influencing safety practices on construction labour productivity. One hundred and forty four peoples from contractor, client and consultant companies in the construction industry are the respondents of the questionnaire survey. Thirty one safety practices have been selected from various sources as the questionnaire item. The average index method, Kruskal Wallis test, and factor analysis technique were used to make an analysis and get a result. The result showed that the using of basic personal protective equipment (PPE) and the existence of safe guard device are the most influencing safety practices on labour productivity. The contractor result is the highest score compare with the client and consultant. From factor analysis technique, it is obtain five safety practices groups base on their similarities. This study revealed that the implementation of good and appropriate safety practices can give a positive influence to the labour productivity base on middle management staff opinions.

Keywords: safety practices, labour productivity, construction industry.

1. INTRODUCTION

Labour productivity is an important subject and dominant in a construction management process that is influenced by the use of resources in order to be efficient and economical use which will eventually affect all stages of the process in a construction. Labour productivity in construction industry is influenced by a lot of factors. Myers [1], categorized of the factors into four groups, namely : the quantity and quality of natural and man-made resources, the quality and extent of the education and training of the labour force, the levels of expectation, motivation, and well being, and the commitment to research and development. Tucker [2] determined the reasons causing productivity loss are the relative influence of labour costs, more sophisticated labour demands, more complex and larger projects, more participants and communication, centralization and specialization, accelerated schedules, increased paper work, and lack of research. Other factors defined are containing congestion, sequencing, weather, supervision, plant status, information, equipment, tools, materials, and rework [3].

Safety is one of the influencing factors on labour productivity in construction industry based on previous research by [4], [5], [6]. Safety can included in the labour factor, in management factor, in supervision factor, and others. The National Audit Office report [7] also identified the root cause of the inefficiency in construction industry. One of the problems is the industry demonstrates a poor safety record and an inability to recruit good staff. Construction industry has been experiencing chronic problems such as poor safety, inferior working conditions, and insufficient quality. This industry has earned the reputation of being dangerous or highly hazardous industry because of the disproportionately high frequency of accidents and fatalities that occur on construction sites [8], [9], and [10]. Being dangerous refers to being risky, hazardous, or unsafe.

In safety management, there are two terms related to safety practices, namely unsafe actions and unsafe conditions. Injuries are the result of a combination of unsafe actions and unsafe conditions. Unsafe actions may be the outgrowth of a number of causes, including lack of proper training, lack of the attention to the work, carelessness, macho behaviour, and inadequate instructions. Unsafe actions may include actions taken by managers or the failure of managers in doing action to make the job safe. The mental environment prompts many unsafe actions. Unsafe actions by workers may also be influenced by management. It should be noted that unsafe actions can occur even though workers would prefer not to sustain any injuries [11]. According to Abdelhamid and Everett [12], an unsafe condition is a condition where the physical layout of the

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workplace or work location as well as the status of tools, equipment, and/or materials are in violation of contemporary safety standards. Examples of unsafe conditions include open sided floors, defective ladders, improperly constructed scaffolds, protruding ends of reinforcing rods, protruding nails and wire ties, unshored trenches, defective equipment, overloaded tools or equipment, unprotected explosive materials, ungrounded electrical tools, flying materials, etc.

Safety and productivity issues have gained vital importance in the competitive global environment [13]. Low labour productivity and unsafe working environment have often been claimed to relate to each other. It has been said that the improvement of the working environment lays the foundations for the improvement of labour productivity [14].

In line with the increasing awareness of all parties involved in the construction industry about the importance of occupational safety and health to improve labour productivity, the researcher begins to search a focus that is related to that subject. Base on the above explanations, it needs to identify the safety practices that give a positive influence to increase labour productivity. The research aim is to determine the most influencing safety practices on labour productivity in construction industry. With respect to so many safety practices from various resources, this paper has been summarized the safety practices to be asked to the respondents in the questionnaire survey.

2. METHODOLOGY

In total, 144 questionnaires filled by the respondents. Respondents for this research were people who work as contractors, consultants, and owners in a middle management position. In accordance with the scope of the research, the work site was in the Pekanbaru City, Riau Province, Indonesia. The selected respondents were the people who worked at the contractor company with grade 5, 6, and 7 in Indonesian contractor grade system. The contractor on that grade can handle the job with project value over 1 billion rupiah to 10 billion rupiah, over 1 billion rupiah to 25 billion rupiah, and over 1 billion rupiah to unlimited value. Grade 7 is the highest level for contractors in Indonesia. Consultants were those who work at a company with grade 4 selected as respondents. It is the highest level of a consultant company in Indonesia. A company in this level can do the job with project value over 400 million rupiah to unlimited. It was decided to choose the method of distributing the questionnaire directly by going to the company head office and the location of the construction project. The location of respondents was in the same city, so it was quite efficient when distributing the questionnaires by means of direct distribution.

For data analysis, there were three types of statistical method used, namely descriptive statistics, inferential statistics, and factor analysis technique. This study also tested the reliability and validity of the research instruments and results from the research questionnaire survey, using reliability and validity test. The data was then analyzed utilizing the statistical computing package SPSS (Statistical Package for Social Science) version.17.0. In descriptive statistic, the average index was obtained from the frequency analysis that was measured to rank each safety practices which is influence to labour productivity. This formulation was used to calculate average index by Al-Hammad and Assaf [15].

Average Index (AI) = $\sum (a_i.x_i) / \sum x_i$,

where, a_i = constant expressing the weight given to i, and x_i = variable expressing the frequency of response for i = 1,2,3,4,5. In this questionnaire, the choices are : 1 = not influence, 2 = less influence, 3 = moderately influence, 4 = influence, and 5 = very influence.

To specify the level of influence of safety practices on labour productivity as in questionnaire, this study applied the classification of the rating scales proposed by Abd Majid [16] as the following, and was adjusted to the statements in the questionnaire. This also showed the strength of indices of respondents' options. Not Influence $0.00 < AI < 1.50$, Less Influence $1.50 \leq AI < 2.50$, Moderately Influence $2.50 \leq AI < 3.50$, Influence $3.50 \leq AI < 4.50$, and Very Influence $4.50 \leq AI < 5.00$.

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For inferential statistic, Kruskal-Wallis test was used to compare three or more groups of data samples (*K* populations) and that might have different sample sizes. This technique is commonly used as an alternative if the assumptions in the ANOVA (Analysis of Variance) test cannot be met or data are not a normal distribution. Kruskal-Wallis test is a distribution-free test (Morgan, et al, 2007). The preparation of the Kruskal Wallis test hypothesis and the steps of hypothesis testing are as follows: If H_0 : All *K* populations are identical, and If H_1 : Not all *K* populations are identical.

This research used Kruskal-Wallis test for several reasons, i.e:

a. There are three groups of respondents (owners, contractors and consultants),
b. Different number of respondents for each group, and
c. Data are not a normal distribution

From the reasons above, the Kruskal Wallis test was suitable for this questionnaire analysis. This study examined whether the response of the three groups of respondents (owners, contractors and consultants) was significant.

The factor analysis technique was applied to reduce the large amount of data to a small number of factors (or components), showing the group of safety practices that has the most infuence on labour productivity. The factor analysis technique is too complex to be described here, but can be read in most statistical texts. In short, it takes into account the weighting of the various variables (items), scored by the respondents, and combine them together to form a group of factors (group of safety practices).

Each safety practices for the questionnaire purpose named as P1 to P31. All statements given in the questionnaire are positive statements, or the opposite of the statements of "unsafe actions" and "unsafe conditions". It is intended that respondents think the positive influence of safety practices on labour productivity.

3. RESEARCH FINDINGS

Discussion of the research findings was based on results of the average index and classification of rating scales and factor analysis technique which are shown in Table 1 and Table 2.

3.1. Descriptive statistic

Table 1. Rank of Safety Practices from All Types of Respondents

Code	**Safety Practices**	**AI (N=144)**	**Rank**	**Class of Rating Scales**
P1	Using basic personal protective equipment and clothing, e.g. safety shoes, helmet, and gloves	4.61	1	Very Influence
P9	Providing and installing safe guard devices e.g. safety net, guard rail, and safety sign board	4.52	2	
P18	Paying more attention to the dangerous works, like working in the roof, under ground work etc.	4.49	3	Influence
P4	Supervisor should have safety knowledge, motivate, and push their workers to work safely.	4.47	4	
P22	Paying more attention to the heavy equipment, e.g. tower crane, bulldozer, scrapper also operator's skill	4.45	5	
P2	Using any other specialized protective equipment required for a specific task, e.g. respiratory, eye, face, and hearing protection	4.40	6	
P21	Using appropriate equipment and tools	4.36	7	
P6	Awareness of workers toward safety	4.35	8	
P7	Working area is tidy and clean from the rubbish and waste material	4.34	9	
P31	Strict / firm management toward safety practice on the project	4.33	10	
P23	Paying more attention to the supporting work devices, such as ladder, scaffolding, platform, and safety harness	4.31	11	

P8	Providing adequate worker facilities e.g. toilet and barracks	4.31	12	
P14	Safety orientation for new workers	4.28	13	
P10	Allocation planning at the site, and providing traffic line of workers and materials	4.26	14	
P30	Designation of safety officer at the site	4.26	14	
P28	Developing safety plan for the whole site and for each task	4.26	14	
P3	Not taking an obvious risk when conducting the job	4.26	14	Influence
P13	Giving a short training when using new equipment or tools	4.25	15	
P16	Safety inspection regularly at the site	4.25	15	
P20	Checking condition of equipment and tools before using	4.25	15	
P19	Maintenance and repair of equipment and tools	4.24	16	
P29	Communicating safety target / goal to the workers, such as “zero accident” target, safety first, etc.	4.24	16	
P17	Safety hazards inspection before starting the works	4.22	17	
P12	Conducting safety training regularly for the employees	4.20	18	
P15	Giving a short training about method and procedure of the work	4.20	18	
P25	Clear and written safety policy and regulation at the site	4.19	19	
P24	Conducting field safety meeting / toolbox meeting regularly	4.17	20	
P5	Executing hazard analysis and work analysis before working toward safety	4.17	20	
P27	Investigation of an accident to know the causes of the accident as a preventive and corrective action for the future	4.14	21	
P11	No adverse environment, such as noise, light, dust, and heat	4.13	22	
P26	Safety evaluation/monitoring program regularly	4.07	23	

Table 1 is a summary for overall results from three types of respondents. In this table, P.1 and P.9 are considered as safety practices which are very influential to the labour productivity. The respondents choose that using personal protective equipment (PPE) and providing and installing safe guard devices give a positive impact to improve productivity. The remaining 29 safety practices are categorized as “influence” items.

3.2. Test of Differences of Mean Score (Kruskal-Wallis test)

Table 2. Kruskal-Wallis test result

	Ranks			**Test Statistics[a,b]**	
Company		N	Mean Rank		Mean
Mean	1 - client	31	32.92	Chi-Square	36.401
	2 - contractor	31	70.73	df	2
	3 - consultant	31	37.35	Asymp. Sig.	0.000
	Total	81			

a. Kruskal Wallis Test
b. Grouping Variable: company

This section will test whether there are differences in average scores between the three types of respondents using the Kruskal-Wallis test for several independent samples. The result is given at Table 2. The assumptions for this test are; Ho : mean value of the three types of respondents is identical, and Ha : mean value of the three types of respondents is not identical. From the test results, it is obtained that $\alpha = 0.05$, Sig = 0.00. Because Sig < α (0.00 < 0.05), then Ho is rejected or Ha is accepted. The conclusion is the average value of the three types of companies is not identical or not significant. There are differences among the three groups. There is a difference in opinions

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from the respondents in providing an assessment for each safety practice that influences labour productivity.

Based on 'mean rank (AI)' at the Table 2, the high mean rank scores indicate that the respondents at that company have the high mean rank. In this case, the contractors have a mean score 70.73 as the highest value, followed by consultants with 37.35, and client with 32.92. This also means that respondents who work in the contractor company assess safety practices as more influencing than the other two companies.

3.3. Factor Analysis Technique

The average index is used to identify the items that will be clustered into a number of factors that have the closest or similar characteristics. Mean score from each item is less than two (4.61 to 4.07), and almost close to each other; it means that respondents consider most items are in “influence category” on the labour productivity. This result shows that it is significant to analyse the finding using factor analysis.

From Table 3, the value of KMO MSA test was 0.919, certainly and substantially exceeding the recommended value of 0.70. Meanwhile, the value of Bartlett’s Test of Sphericity was 3278.997 and significant at 0.00. It means that the variables are correlated highly enough to provide a reasonable basis for factor analysis.

The factor analysis technique was utilized to help identifying the underlying cluster of factors that dominate safety performance. The research has applied the factor analysis on the 31 safety practices.. Test of factorability was performed using Kasier-Meyer-Olkin's measure of sampling adequacy. In order to give meaning to the results of the factor analysis, it is necessary to assign an identifiable name to the group of factors of high correlation coeficients. Table 4 shows that there are five factors obtained from the rotated factor matrix. The bold and italic value indicated that the item is included into the above component/factor. Example item P24 is in component 1; it has the greatest value contained in component 1.

Table 5 is a result of factor analysis for questionnaire about safety practices that influence labour productivity in construction. These are five factors that have been formed and have similar characteristics. The factors can be identified by delivering the group name based on their similar characteristics, such as in the column (3) of Table 5.

Table 3: KMO and Bartlett's test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.919
Bartlett's Test of Sphericity	Approx. Chi-Square	3278.997
	Df	465
	Sig.	0.000

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Table 4. : Rotated factor matrix

	Component				
Item	**1**	**2**	**3**	**4**	**5**
P24	0.662	0.281	0.190	0.228	0.196
P5	0.599	0.482	0.060	0.096	0.158
P11	0.616	0.168	0.160	0.168	0.443
P1	0.564	-0.079	0.212	0.343	0.361
P13	0.576	0.281	0.261	0.249	0.268
P12	0.546	0.211	0.214	0.544	0.169
P16	0.555	0.296	0.248	0.485	0.115
P17	0.548	0.302	0.400	0.204	0.212
P3	0.476	0.044	0.359	0.058	0.312
P29	0.194	0.717	0.179	0.404	0.164
P28	0.225	0.679	0.262	0.135	0.185
P26	0.431	0.621	0.261	0.236	0.265
P27	0.120	0.607	0.429	0.252	0.226
	Component				
Item	**1**	**2**	**3**	**4**	**5**
P25	0.220	0.526	0.250	0.389	0.435
P20	0.296	0.320	0.725	0.097	0.196
P19	0.255	0.293	0.666	0.061	0.371
P21	0.246	0.205	0.666	0.324	0.044
P22	0.097	0.084	0.667	0.457	0.239
P23	0.196	0.455	0.610	0.112	0.194
P30	0.206	0.502	0.201	0.520	0.115
P4	0.288	0.305	-0.033	0.464	0.480
P31	0.065	0.407	0.057	0.704	0.326
P18	0.211	0.036	0.367	0.559	0.363
P15	0.441	0.280	0.282	0.614	-0.014
P14	0.407	0.245	0.251	0.550	0.129
P9	0.300	0.140	0.104	0.176	0.689
P10	0.266	0.382	0.242	0.045	0.586
P8	0.106	0.309	0.308	0.210	0.558
P2	0.501	0.192	0.114	0.116	0.540
P6	0.256	0.390	0.324	0.058	0.510
P7	0.145	0.016	0.365	0.381	0.557

Extraction Method: Principal Component Analysis
Rotation Method: Varimax with Kaiser Normalization
Rotation converged in 25 iterations

Table 5 . Result of Extracted of Factor Analysis

Factor	**Safety Practices**	**Name of the Group**
(1)	**(2)**	**(3)**
1	P1, P3, P5, P11, P12, P13, P16, P17 and P 24	Standard and Procedure
2	P25, P26, P27, P28, and P29	Management
3	P19, P20, P21, P22, and P23	Equipment and Tools
4	P4, P14, P15, P18,P30, and P31	Personnel
5	P2,P6,P7,P8,P9, and P10	Environmental

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3.4. Reliability and Validity Test

From Table 6 the Cronbach's Alpha values are 0.932 and 0.942. If alpha is bigger than 0.90, it means it has perfect reliability. Value of Guttman Split-Half coefficient is 0.930; it is bigger than value of r product moment from product moment table r table. Obtained from r table for α = 0.05, and degrees of freedom (df = n-1 = 144-1 = 143), the value is 0.164. It can be concluded that all instruments used in these questionnaires meet the requirements of reliability. If an item is valid, it must be reliable. There are 31 items which will be tested whether they are valid or invalid. To declare that an item is valid must be proved through calculation. To determine the level of validity, it should be noted the value of r_{count} compared to r_{table}. If the value obtained for r_{count} is greater than the value of r_{table} from product moment table, it means that each item in this research is considered valid. From the result, the value of r_{count} for all safety practice items is greater than the value of $r_{table.}$ The value of r table = 0.164. This indicates that all of the research instruments meet the standards of validity.

Table 6. Reliability test

Cronbach's Alpha	Part 1	Value	0.932
		N of Items	16[a]
	Part 2	Value	0.942
		N of Items	15[b]
		Total N of Items	31
		Correlation Between Forms	0.870
Spearman-Brown Coefficient		Equal Length	0.930
		Unequal Length	0.930
		Guttman Split-Half Coefficient	0.930

a. The items are: P1, P2, P3, P4, P5, P6, P7, P8, P9, P10, P11, P12, P13, P14, P15, P16.
b. The items are: P16, P17, P18, P19, P20, P21, P22, P23, P24, P25, P26, P27, P28, P29, P30, P31

4. CONCLUSIONS

Based on the analysis, some conclusions can be drawn as follows:

a. All respondents agreed that safety practices have a positive influence on labour productivity, it can be seen from the results, the answer given just two types, namely "very influence" and "influence"
b. Safety practices P1 (using basic personal protective equipment and clothing, e.g. safety shoes, helmet, and gloves) and P9 (providing and installing safe guard devices e.g. safety net, guard rail, and safety sign board) obtaining the highest average index (AI) score, so get into the category of "very influence", the others (29 safety practices) fall into the category "influence".
c. Based on the results of the questionnaire, it was found that respondents from the contractors have a mean or average index higher than clients and consultants. It can also be interpreted that they are more aware and understanding of the influence of safety practices on labour productivity in construction field. The reasons is the contractor is the direct executor of the construction work, so they should be knowing the safety management.

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d. There are 5 factors or groups that are formed from the results of the factor analysis technique, namely: standard and procedure, management, equipment and tools, personnel, and environmental. All the safety practices in the questionnaire survey form, which amounted to 31 items have been get into the groups that have similar characteristics.

e. From the reliability and validity test, the result showed that the instruments in the questionnaire are reliable and valid.

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