

# Validation of Predictive Construction Workers Safety Behavior Model

Mohammed Y. D, Ajala J. O

**Abstract**— Safety Manager’s leadership style has a great impact on workers’ safety behaviors on construction sites. Effective leadership styles have been associated with benefits such as increased operational efficiency; reduction in insurance cost and workers retention and satisfaction. The aim of this paper is to validate the proposed construction workers safety behavior model. Model validation is associated with the process of assessing the ability of the model to do what it set out to achieve. The validation process tries to ensure that the model represents the characteristics of the general population and not peculiar to the samples used in its estimation. Certain criteria were set for the study in order to validate the predictive model obtained from the analysis conducted with the SPSS 20. Ten (10) construction safety practitioners (experts) were identified within the study area. External validation approach was adopted for the study. This type of approach where experts verify the tentative results of the research generate more confidence in the validity of the findings. The majority of the responded were in favor of the model indicating that the model is a positive contribution to the subject of construction workers safety behavior. It can be concluded from the opinion of the experts that the model is of an acceptable standard and can be a viable tool for decision making. The clients, contractors and the stakeholders can use the model to make appropriate decision, take suitable measures and devote the necessary resources required for accident prevention. Also the contractors seeking to improve safety and health at their workplace could use this model to make informed and objective decision towards accident prevention on construction site.

**Index Terms**— Behavior, Model, Validation, Workers

## I. INTRODUCTION

The application of high modern technology on construction project in construction industry has made the industry move from 3Ds to 4Ds that is dirty, difficult, and dangerous and death. Construction workers play an important role in execution and completion of construction project. Therefore, it is important for the stakeholders in the construction industry to ensure that adequate protection against injuries and illness is provided to the construction workers safety while at work. The client should also be remaindered of his duty as stipulated in section 17 of the OSHAct. [16], [4] working under poor physical environment, which causes discomfort to construction workers, subsequently reduces their attention on safety behaviors. The concepts of safety culture and safety climate are important contributions from the behavioural and social sciences to workers understanding of occupational safety.

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Safety climate is associated with how employees view the policies, procedures and method relating to implementing safety laws at workplace while safety culture is concern with how an employee’s act within their working environment. What is needed to control the rate of accidents is workers oriented program, popularly known as people-oriented management program, [21] defined people-oriented management as the management with people as the focus, and the main objection of which is to inspire initiative, enthusiasm of workers and to let workers work creatively, and to achieve common development between workers and enterprise. People- oriented management is aimed at promoting and protecting an organization working condition in order to protect the life and health of its workers. In a study conducted in Kuala Lumpur and Selangor by [13], she among others discovered that awareness on the importance of safety management compliance among many construction workers was low. Safety is reflected in good behaviors. Also [9], that many accidents that occur at construction site are due inadequate adherence of workers to work procedures. The awareness and perception of workers toward safety, health and their working environment are important aspect to enhance the building construction to the better condition to the workers themselves [9]. Workers play an important role in accomplishment of the building construction. Also, Safety Manager’s leadership style has a great impact on workers’ safety behaviors on construction sites. Effective leadership styles of Safety managers have been associated with benefits such as: increased operational efficiency; reduction in insurance cost and workers retention and satisfaction. Leadership can be define as a process of modifies the motivation and competencies of others in the group or organization. [3] describe leadership as “a process of social influence in which one person can enlist the aid and support of others in the accomplishment of a common task.” Safety leadership is a subset of general leadership [14]. It can be described as “the process of interaction between leaders and followers, through which leaders can exert their influence on followers to achieve organizational safety goals under the circumstances of organizational and individual factors” [19].

### A. Validation of Model

[7] define model validation as the process of confirming that the proposed model is appropriate, especially in light of the purposes of the investigation. Also [5] define model validation as the process of assessing the ability of the model to do what it sets out to achieve. The validation process tries to ensure that the model represents the characteristics of the general population and not peculiar to the samples used in its estimation [8]. The aim of the validation process is to help establish whether the concepts and methodologies used in developing the model are sound and also to establish whether the findings are reliable. Validation also provides a firm

background against which, the findings could be generalized. Thus, validation is important because it reflects the potential objectivity and reliability of the model. Basically there are two component of validation. They are internal and external validation. Many researchers agree that both internal and external validation is important for validating the research process.

### B. Internal Validation

[15], internal validity has been defined as the degree of validity of statements made about whether  $X$  causes  $Y$  – the primary concern being to rule out plausible rival hypotheses. Internal validation seeks to outline the strength of the model as well as assess the literature search [5]. The key areas to examine in assessing the strength of the model; are the value of  $R$ ,  $R^2$  and adjusted  $R^2$ . The  $R$  represents a measure of the correlation between the observed value and the predicted value of the criterion variable [6], while the  $R$ -square ( $R^2$ ) is a statistic that indicates on a scale of zero to one how variations in a dependent variable are accounted for by particular independent variable such that zero indicates no influence and one indicates 100 percent.  $R^2$  is a measure of how good a prediction of the outcome can be made by knowing the predictor variables [6]. However,  $R^2$  tends to somewhat over-estimate the success of the model when applied to the real world, so an adjusted  $R$ -value is calculated which takes into account the number of variables in the models and the number of observations (i.e. participants) the model is based on [1]. Thus, the adjusted  $R^2$  is useful because its gives an indication of how much of the variance in the outcome is accounted for in the population from which the sample is chosen.

### C. External Validation

The aim of external validation is to gain confidence in the predictive model. It is concerned with robustness of the research and also assessing its generalizability. The process of external validation tries to assess the ability to generalise the applicability and transferability of the model unto other situations with similar characteristics [5], [10]. [10] identified five main techniques for undertaking external validation. These are:

1. The use of independent verification obtained by waiting until the future arrives or through the use of surrogate variables.
2. By splitting the samples and using one part for estimating the model and the other for validation.
3. Re-sampling, taking repeated samples from the original sample and refilling the model each time.
4. Using Stein's equation of re-calculating the adjusted coefficient of determination ( $R^2$ ).
5. Approaching experts to comment on relevant aspects of the model.

As a result of resource constraints most especially financial constraints the using of option 1 could not be pursued in this work. The re-sampling procedure was also discounted due to limited data. Splitting the sample seems to be the easier option but it also sometimes suffers from the same problem as re-sampling if the data are limited. Also, Stein's equation re-calculates the adjusted  $R^2$  and so can be used for validation [10]. But [6], the equation used in calculating the adjusted  $R^2$  in SPSS is somewhat flawed because it does not account for how the regression model would predict an entirely different set of data. Stein's equation addresses this flaw and, thus, reflects how well the model will predict an entirely different

set of data [18]; [6], [10]. That is, Stein's equation is a measure of how well the model can predict scores of different samples from the same population. Stein's equation can also be used to confirm if the model has the potential of predicting quite well difference samples of data from the population. The data collected for this study was limited not very large enough; it was decided to approach some "Experts in the field of construction safety" within and outside the University to comment on the potential relevance of the model. [2] argued that it is this process of validation that transforms research information into knowledge.

## II. MATERIAL AND METHOD

In order to establish the predictive construction workers safety behavior model, a qualitative measure approached was adopted. Qualitative researcher study things in their natural settings, attempting to make sense of or to interpret, and phenomena in terms of the meanings people bring to them". Therefore, qualitative research can be used to inform business decisions policy formation, communication and research focus groups etc. about the extent situation of things (construction workers safety behavior). The study is a criteria – based study, in which certain criteria were outline for the selection of the construction companies and their construction workers. Those criteria are:

1. The construction company must be built/civil engineering, construction.
2. The construction company must have a competent safety officer (safety manager).
3. The construction workers must at least be with the construction company for not less than fifteen (15) years.
4. His qualification must at least not less than secondary school certificates.
5. The location of the study is Abuja, the Nigeria federal capital.

The target construction companies for this study are large size (with more than 100 workforces) with both permanent and temporary construction workers. The reason was that large construction companies tend to have a high degree of safety awareness of the concepts and notions of safety management system. This will provide a clear image about construction workers safety behavior. Five (5) construction companies were identified that meet the study criteria and as such Five (5) of the construction companies were selected for the study. The selection is similar to the work of [20]: [12]. The respondent samples used in the study were drawn from the total population of permanent construction workers in the 5 construction companies selected for the study. The total numbers of permanent construction workers that meet the study criteria in the 5 construction companies are 550 while 226 were selected for the study following the rules of [11]. The research questionnaires were administered on 226 permanent construction workers within the 5 construction companies in Abuja. The analysis of the questionnaires survey data was undertaken using the statistical package for social science (SPSS) version 20. In order to validate the predictive model obtained from the analysis conducted with the SPSS 20. Ten (10) construction safety practitioners (experts) were identified within the study area. This ten (10) make the sample size for the validation exercised for the predictive model on construction workers safety behavior.

The selection is in line with the rule of [11]. This type of approach [17] where participants verify the tentative results of the research generate more confidence in the validity of the findings. This procedure adopted from [17] involved providing participants with a research report in a tabular form and recording their response to it.

### III. RESULT AND DISCUSSION

In order to develop an acceptable model, there is need to know the kind of relationship existing between the two variables. That is safety manager's leadership styles and construction workers safety behavior.

Table 1. Average safety manager's leadership styles (AVGSMLS)

Component	R	P
AVGCWSB	0.532	0.001

listwise N=226

Where,

AVGSMLS = Average Safety Managers Leadership Styles

AVGCWSB = Average Construction Workers Safety Behavior

Table 1 show the result of the correlation analysis used in determining the type and strength of the relationship. Table 1 reveals the correlation of average construction workers safety behavior and its correlation is significant at 0.001 level (2 – tailed), N = 226. The Pearson correlation reveals a positive moderate significant relationship between average safety manager's leadership styles and average construction workers safety behavior. The Pearson correlation (r) from Table 1 is 0.532, while its P < 0.001. This mean as the level of safety manager's leadership styles improves there is corresponding improvement on the construction workers safety behavior. Following the existing positive relationship between the variables, there is need to model the outcome of the variables as such simple linear regression is used. The coefficient of the simple linear regression is provided in Table 2. Table 2 shows the contribution that safety managers leadership styles makes to the construction workers safety behavior, the result reveals that safety managers leadership styles contributes additional benefits of unstandardized coefficient = 0.413, t = 7.101 and P < 0.005. In the model the system (t=7.101, P<0.005) is a predictor of construction workers safety behavior and clearly make a great significant contribution to this model. Based on the fact that the

t-statistic is greater than 2(rule of thumb) is a confirmation of the reliability of the proposed model. The t-test determine whether each  $\beta$  differ significantly.

Table 2 Coefficient Analysis of Simple Linear Regression

a. Dependent Variable: AVGCWSB

Coefficients <sup>a</sup>								
Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.	95.0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	2.331	0.231		10.712	0	2.08	3.111
	AVGSMLS	0.413	0.057	0.356	7.101	0	0.295	0.543

$$AVGCWSB = 2.331 + 0.413AVGSMLS$$

The  $\beta$  – value has an associated standard error which is used to determine whether or not the  $\beta$  – value differ significantly from zero. The t – test associated with  $\beta$  – value is significant at P < 0.005. This means that the predictor is making a significant contribution to the proposed model. According to [6] the smaller the significant value the greater the contribution of the predictor. From the magnitude of the t – statistic, the level of safety manager's leadership styles has a great impact on construction workers safety behavior.

As indicated further in Table 2, the independent variable accounts well for the variation in the level of construction workers safety behavior. The positive  $\beta$  of 0.413 confirms the positive relationship between safety manager's leadership styles and construction workers safety behavior. This result implies that further improvement of safety manager's leadership styles will provide more understanding of safety management system on the construction workers. Furthermore, the Model established from Table 2 need to be validated and for the purposed of this paper, only external

validation will be carried out due to the fact that the data collected are not large enough for internal validation. In order to fulfill the requirement of this paper, a qualitative approach was employed. The relationship identified through the quantitative analysis were presented to the Ten (10) experienced safety practitioners to provide their view on the extent to which such relationship between safety managers leadership styles and construction workers safety behavior actually exist in the construction industry, based on their own experience of working in the industry.

#### A. Analysis of Safety Practitioner Response

In order for a model to be of an acceptable standard, its validation process must generate useful and relevant importance from relevant experts. Table 3 show the summary of response of the 10 responded.

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Table 3 Summary of Response from Experts

Validation	Expert Response									
Criteria	1	2	3	4	5	6	7	8	9	10
Safety managers leadership style influence workers safety behavior	Yes, highly valid	Yes, valid	Yes, valid	Yes, valid	Yes, but not valid	Yes, valid	Yes, valid	Yes, valid	Yes, valid	Yes, valid
Greater impact on safety managers leadership style can improve workers safety behavior	Yes, highly valid	Yes, highly valid	Yes, valid	Yes, valid	Yes, but not valid	Yes, valid	Yes, valid	Yes, valid	Yes, highly valid	Yes, valid
The model demonstrates a benefit on accident prevention.	Yes, benefit	Yes, highly benefit	Yes, benefit	Yes, benefit	Yes, highly benefit	Yes, benefit	Yes, but not benefit	Yes, benefit	Yes, benefit	Yes, highly benefit
The model demonstrates a benefit of construction workers safety behavior	Yes, benefit	Yes, highly benefit	Yes, benefit	Yes, benefit	Yes, highly benefit	Yes, benefit	Yes, but not benefit	Yes, benefit	Yes, benefit	Yes, highly benefit
The model capable of assisting contractors, clients and other stakeholders in decision making.	Yes highly capable	Yes capable	Yes capable	Yes capable	Yes but not sure of it capability	Yes, highly Capable	No, not capable	Yes, capable	Yes, capable	Yes, capable
The model is simple, clear and easy to understand.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Description of the model.	Comprehensive	Comprehensive	Adequate	Adequate	Adequate	Adequate	Poor	Adequate	Adequate	Comprehensive

Researcher Analysis, (2017)

The majority of the responded were in favor of the model indicating that the model is a positive contribution to the subject of construction workers safety behavior in the construction sites. In response as experts in the field of construction safety and health in the construction industry, they found safety managers leadership style influence on construction workers safety behavior as valid. To quote a respondent: *“safety manager’s leadership style is likely to influence construction workers safety behavior on site”*. In response to the question whether safety manager’s leadership styles can improve construction workers safety behavior on site, the respondent’s confirmed this to be valid. To quote a respondent finding: *“when you see construction workers talking and acting safety is as a result of the impact of the safety manager’s leadership”*. In response to the question whether the model on the construction worker safety behavior demonstrate a benefit of accident prevention on site, the respondent’s confirmed this to be of benefit. To quote a respondent finding: *“As long as the model improves workers safety behavior, it will definitely benefit accident prevention on site”*.

As regard to whether the model demonstrates a benefit to construction workers safety behavior on site, the respondent’s confirmed this to be of benefit. To quote a respondent finding: *“when there are reduction in illness and injuries on site, definitely is as results of workers behavior toward safety at the site”*. Regarding the ability of the model in assisting the contractors, client and the construction stakeholders in decision making, the respondents confirmed this to be capable. To quote some respondents finding: *“the organization need to meet its set goal and at the same time prevent the occurrence of accident at workplace”*. Another

respondent finding: *“it ensures the employers to compile with section 17 of the OSH Act”*.

Virtually all the respondents agree that the model is simple, clear and easy to understand. One of the respondent finding: *“the model appear in it’s simply and logical manner”*. Another respondent finding: *“the model contain the expected variables and so clear and easy to understand”*. As regard to comprehensibility of the model, most respondents agree that the model is adequate in comprehensiveness with valuable variables. To quote a respondent finding: *“the model is adequate are contained in it”*. Another respondent finding: *“the expected variables are contained in the model, which is the safety manager’s leadership styles and the construction workers safety behavior”*.

#### IV. CONCLUSION AND RECOMMENDATION

It can be concluded from the opinion of the experts that the model is of an acceptable standard and can be a viable tool for decision making. This, in fact represents a significant contribution to the body knowledge with construction sector. The validation of the model will encourage decision makers in developing efficient and practical health and safety management in the construction industry. In the light of the above, the clients, contractors and the stakeholders can used the model to make appropriate decision, take suitable measures and devote the necessary resources required for accident prevention on construction project. Also the contractors seeking to improve safety and health at their workplace could use this model to make informed and objective decision towards accident prevention on construction site.



REFERENCE

- [1] Brace, N., Kemp, R. & Snelgar, R. (2003) SPSS for Psychologists: A Guide to Data Analysis Using SPSS for Windows.
- [2] Brinberg, D. & McGrath, J. E. (1992) Validity and the research process, Beverly Hills; London, Sage Publication Ltd.
- [3] Chemers, M., (1997). An Integrative Theory of Leadership. Lawrence Erlbaum Associate, Publisher, NJ, USA
- [4] Choudhry, R.M. and Fong, D. (2008). Why operatives engage in unsafe work behaviour – investigating factors on construction sites. *Journal of Safety Science*(46), 556 – 584.
- [5] Egbu, A.U. (2007) Impact of Land Use Planning on Urban Housing Development in Nigeria Unpublished PhD Thesis, University of Wolverhampton.
- [6] Field, A. (2005) Discovering Statistics: Using SPSS for Windows, Sage Publications Ltd, London
- [7] Frees, W. E. (1996) Data Analysis Using Regression Models: The Business Perspective. Prince Hall, Englewood Cliffs, USA.
- [8] Hair, J. F., Anderson, R.E., Tatham, R.L. & Black, W.C. (1998) Multivariate Data Analysis: Upper Saddle River, Prentice Hall, New Jersey. USA
- [9] Hassan, Kamal Halil., (2007). Undang-undang Keselamatan Industri di Malaysia. Kuala Lumpur. Dewan Bahasa dan Pustaka
- [10] Ikpe, E. O. (2009). Development of cost benefit analysis model of accident prevention on construction projects. A thesis submitted in partial fulfillment of requirement of the university of wolverhampton for the degree of Doctor of Philosophy.
- [11] Krejcie & Morgan (1970). Determining Sample Size for Research activities, *Journal of education and psychological measurement* 30, P. 607 – 610.
- [12] Lu, C.S., & Yang, C.S., (2010). Safety Leadership and Safety Behavior in Container Terminal Operations. *Safety Science* 48(2), 123 – 134.
- [13] 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.
- [14] Peter, R., (2001). Leadership Skills for the 21<sup>st</sup> Century. Proceeding of 2001 ASSE Professional Development Conference and Exposition (CD – ROM) Anaheim, CA, USA, Session 631
- [15] Rosenthal, R. & Rosnow, R. L. (1991) Essentials of Behavioral Research: Methods and Data Analysis, New York; London, McGraw-Hill.
- [16] Sawacha, E. Naoum, S. and Fong, D. (1999). Factors Affecting Safety Performance on Construction sites. *International Journal of Project Management*. 17,(5), 309 – 315.
- [17] Silverman, D. (1993) Interpreting Qualitative Data: Methods for Analysing Talk, Text and Interaction, Sage Publication Ltd., London.
- [18] Stevens J.P. (1992) Applied Multivariate Statistics for the Social Sciences 2nd Edition. Hillsdale, NJ: Erlbaum.
- [19] Wu, T.C., Chen, C.H., & Li, C.C. (2007). Correlation among Safety Leadership, Safety Climate and Safety Performance. *Journal of loss prevention process industry*. 6(3), 261 – 272.
- [20] Wu, T.-C., Shu, Y. -H., & Su, G. -W. (2008). Developing a group-level safety culture scale. Paper presented at XVIII Work Congress on Safety and Health at Work (PS01-11). Seoul, Korea.
- [21] Yanbin, R. & Choa, S. (2011). Application of the Concept “People-Oriented” to improve the Working Team Safety Construction. *Procedia engineering*. 26. 2080-2084.

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