

Modeling the Qualitative Relationship among Risks Associated with Occupational and Workplace Hazards in Seaport Environments: the Case of Apapa Port, Nigeria

Modeliranje kvalitativnog odnosa među rizicima povezanim s opasnostima na radu i radnom okolišu u morskim lukama: slučaj luke Apapa u Nigeriji

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Summary

The aim of the research is to establish the quantitative relationship and impacts of risks associated with various categories of occupational and workplace hazards in the Nigerian seaports. It was carried out by obtaining time series statistical data of 7 years from hazard identification and risk assessment report of Nigerian Ports Authority (NPA) Apapa, western port headquarters. The variables considered are the associated risks of various types of occupational and workplace hazards to which seaport workers were exposed from 2009-2014. The overall level of associated risks of occupational and workplace hazards represent the cumulative of various hazards and were treated as the dependent variable 'Y'. The exposures to the risks of mechanical hazards, ergonomic hazards, physical hazards, noise/environmental hazards were symbolized as X1, X2, X3, and X4 respectively and treated as independent variables. The method of multiple regression analysis was used to analyze the time series data. T-test was used to test the hypotheses. It was found that risks associated to mechanical hazard, ergonomic hazards, noise/vibration hazard, physical hazards, all have significant impact on the overall level of risk of exposure to occupational and workplace hazards in Nigerian seaport environment. It was recommended that proactive investment in safety inspection and management system is needed to limit the level of exposure of seaport staff to occupational hazards.

Sažetak

Cilj je istraživanja utvrditi kvantitativan odnos i utjecaj rizika povezanih s različitim kategorijama opasnosti na radu i radnom okolišu u nigerijskim morskim lukama. Ono je provedeno dobivanjem statističkih podataka za sedmogodišnje razdoblje iz izvješća o opasnosti i procjeni rizika nigerijske Lučke uprave Apapa (NPA) – sjedišta zapadnih luka. Razmotrone su varijable povezane rizici raznih vrsta opasnosti na radu i radnom okolišu kojima su radnici u morskim lukama bili izloženi od 2009. do 2014. Ukupna razina povezanih rizika od opasnosti na radu i radnom okolišu predstavlja ukupan zbroj različitih opasnosti i tretira se kao zavisna varijabla „Y“. Izloženosti rizicima mehaničkih, ergonomskih, fizičkih i opasnosti od buke i za okoliš označene su simbolima X1, X2, X3 i X4 te se tretiraju kao nezavisne varijable. Metoda višestruke regresije koristila se za analizu podataka vremenske serije. T-testom provjeravala se hipoteza. Utvrđeno je da rizici povezani s mehaničkim, ergonomskim, fizičkim i opasnostima od buke i vibracija imaju značajan utjecaj na ukupnu razinu rizika od izloženosti opasnostima na radu i radnom okolišu u nigerijskim morskim lukama. Preporučuje se proaktivno ulaganje u sustav nadzora i upravljanja sigurnosti kako bi se ograničila razina izloženosti osoblja luke opasnostima na radu.

KEY WORDS

modeling
relationship
workplace-hazards
seaport
environments

KLJUČNE RIJEČI

modeliranje
povezanost
opasnosti u radnom okolišu
morske luke
okoliši

1. INTRODUCTION / Uvod

Talley (2009) defines a seaport as a place where transport of cargo and passengers from waterway and shores occurs, to and from vessels. The seaport may be a cargo port, handling only the transfer of cargo, a passenger port, handling only the transfer of passengers, or a combination cargo/passenger port, handling the transfer of both cargo and passenger (Talley, 2009). Supporting Talley's (2009)

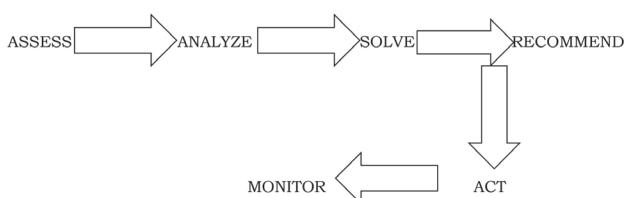
definition of seaports, Ndikom (2006) views seaports as places where vessels receive services and are loaded and offloaded, enabling cargo/passenger transfers across transport modes. Seaports consist majorly of the human resources (people) and non-human (e.g: port infrastructures and materials) components, with the human resource component usually referred to as port personnel being

responsible for managing and harnessing the non-human, i.e. port infrastructural facilities and materials for optimum realization of the objectives of the port operators (Nwokedi, Emeghara and Ikeogu, 2015). The human resource component of the seaports which represents the seaport employees extending from public port Authority employees, dock workers and stevedores, employees of private terminal operators, shipping companies staff, employees of other port service providers and port users whose work schedule engage them in the seaport from day –to–day get exposed on a near frequent basis to occupational and workplace health hazards of various forms prevalent in the seaports (Okon, 2010). Agu (2008) observes in the same manner as above, that the job of seaport workers differs from category to category, ranging from apex management and administrative staff down to the causal–workers/stevedores. These differing seaport workers categories get exposed to similar, but varying types and varying degrees of occupational and workplace hazards with subsequent health risks.

OSHA (2010) explains occupational and workplace hazards to include unsafe workplace conditions or practices (dangers) that could cause injuries or illness (harm) to employees. A hazard may be an object (tools, equipment, machinery, materials) or a person (when distracted, mental or physical incapacity). Since a hazard is only one part of the accident component, it takes a hazard plus an exposure to it for accident to occur and harm or injury induced. Accident according to OSHA (2010) is defined as hazard plus exposure.

Occupational and workplace hazards of seaport and Maritime workers therefore represent unsafe workplace conditions and practices (dangers) that causes injuries, illness or harm to maritime and seaport employees. Orunmuyi (2015), opines that the occurrence of maritime accident in seaports and offshore rigs are products of employees exposure to hazards and perils of the marine environment. Exposure to hazard in this sense has to do with the position of the employee relative to a hazard. OSHA (2010) identifies three forms of employee exposure to hazard which could cause accident to include; physical exposure, which exists if any part of the employees body is injured as a result of proximity to the danger. Environmental exposure; an employee in the maritime industry may suffer from environmental exposure no matter how far from the hazard the employee may be. For example, the use of heavy equipments and loud machines in the seaport exposes every seaport employee to hazardous levels of noise irrespective of their non physical closeness to the machine. The third type of exposure to hazard is the potential exposure which could occur as a result of work pattern, circumstances or anticipated work requirement (OSHA, 2010).

Idoro (2008) notes that since workplace hazards are major causal factors of industrial accident, a strategy to systematically identify and analyze all workplace hazards would be useful in industrial hazard control processes OSHA (2012); OISH (2008) further identifies six step hazard control process as follows:



Source: OSHA (2010), hazard Identification and Control.

Orunmuyi (2015) supported by Owuallah (2006) observes that the Nigeria Port Authority (NPA, APAPA) risk assessment and job hazard analysis report in the seaport environment from 2009 to 2015 (September) indicates that levels of risks associated with physical hazards, ergonomic hazards, Noise/vibration/environmental hazards and mechanical hazards constitute above 55% of total exposure to occupational and workplace hazards that seaport workers are faces annually in Nigeria. Thus, the present study is aimed at modeling the quantitative relationship among the various identified occupational and workplace hazards in the ports.

2. OBJECTIVES OF THE RESEARCH / Ciljevi istraživanja

The major objective of the research is to model the quantitative relationship among different risks associated with various occupational and workplace hazards in Nigerian seaports, other specific objectives are:

- (i). To determine the significance of the impact of risks of mechanical hazards on the overall risk levels of occupational and workplace hazards in Nigeria seaport environments over the period covered by the study 2009-2014.
- (ii). To determine the impact of risks associated ergonomic hazards on the overall levels of risks associated with occupational and workplace hazards in Nigerian seaports.
- (iii). To determine the physical hazards significantly effects the overall levels of risks associated with occupational and workplace hazard in Nigerian seaports.
- (iv). To determine the significance of the impacts noise hazards on the overall occupational and workplace hazard risk levels in Nigeria seaport environments.

3. HYPOTHESES / Hipoteza

- H_{o1} : There is no significant impact of mechanical hazard risks on the overall level of risks of occupational and workplace hazard in Nigeria seaports.
- H_{o2} : There is no significant impact of risks of ergonomic hazards on occupational and workplace hazard risk levels in Nigeria seaports.
- H_{o3} : Risk of physical hazards does not show significant effects on occupational and workplace hazard risk levels in Nigeria seaports environment.
- H_{o4} : There is no significant effect of risk associated to Noise on occupational and workplace hazard risk levels in Nigerian seaport environment.

4. METHODOLOGY / Metodologija

The research was carried out by obtaining time series data of seven(7) years from hazard identification and risk assessment report of Nigerian Ports Authority (NPA), Apapa western port headquarters. The variables are various occupational hazard types associated with health and injury risks to which the seaport staffs were exposed over the period from 2009 to 2014. The overall level of exposure to occupational and workplace hazard risk is the cumulative of various hazard risks identified in the hazard assessment report by the Nigerian Ports Authority[NPA]. This was treated as the dependent variable 'Y'. Levels of exposure to mechanical hazards, ergonomic hazards, physical hazards, noise/environmental hazards were symbolized as X_1 , X_2 , X_3 , and X_4 respectively and treated as independent variables. The method of multiple regression analysis was used to analyze the time series data to obtain a model of the form shown below.

$$Y = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + \dots$$

Where Y = overall level of exposure to risk of occupational and workplace hazards,
 a = intercept parameter
 b_1, b_2, b_3, b_4 = coefficients

X_1 = risk associated with mechanical hazards
 X_2 = risks associated with physical hazards
 X_3 = risk associated with ergonomic hazards
 X_4 = risk associated with noise/environmental hazards
 X_5 = other forms of risk not specified.

4.1. Data presentation / Prikaz podataka

Table 1 Table of NPA hazard identification and risk assessment report showing levels of exposure to various risks of occupational and work place hazard types from 2009 – 2014

Tablica 1. Tablica iz izvješća o identifikaciji opasnosti i procjeni rizika nigerijske lučke uprave koja pokazuje razine izloženosti različitim rizicima od opasnosti na radu i u radnom okolišu od 2009. do 2014.

S/ NO	YEAR	MECHANICAL HAZARD	PHYSICAL HAZARDS	ERGONOMIC HAZARD	NOISE/VIBR HAZARDS	OTHERS HAZARD	OVERALL
		X_1	X_2	X_3	X_4	X_5	X_5
1	2008	20	27	15	20	30	80
2	2009	8	12	10	10	29	70
3	2010	15	11	5	15	9	65
4	2011	11	14	20	5	26	60
5	2012	9	16	7	7	12	30
6	2013	10	10	6	6	23	70
7	2014	15	20	10	10	20	75

Sources: NPA Western Ports Headquarters, Apapa, Lagos safety department hazard identification and risk assessment reports (Curled from Orunmuyi, 2015).

5. DATA ANALYSIS AND RESULTS / Analiza podataka i rezultati

Regression

Descriptive Statistics

	Mean	Std. Deviation	N
TOTAL	67.1429	9.94030	7
PHYSICAL	15.7143	6.01981	7
MECHAZARD	12.5714	4.27618	7
NOISEVIB	6.7143	2.49762	7
GHAZARD	104286	5.38074	7
OTHERS	21.2857	8.15913	7

Correlations

		TOTAL	PHYSICAL	MECHAZARD	NOISEVIB	GHAZARD
Pearson Correlation	TOTAL	1.000	-.002	.633	.129	.369
	PHYSICAL	-.002	1.000	-.349	-.538	-.582
	MECHAZARD	.633	-.349	1.000	.033	.654
	NOISEVIB	.129	-.538	.033	1.000	.693
	GHAZARD	.369	-.582	.654	.693	1.000
	OTHERS	.556	-.052	.028	-.233	-.330
Sig. (1 -tailed)			.498	.064	.391	.207
TOTAL	PHYSICAL	.498		.222	.106	.085
	MECHAZARD	.064	.222		.472	.056
	NOISEVIB	.391	.106	.472		.042
	GHAZARD	.207	.085	.056	.042	
	OTHFRS	.097	.456	.476	.308	.235
N		7	7	7	7	7
TOTAL						
PHYSICAL		7	7	7	7	7
MECHAZARD		7	7	7	7	7
NOISEVIB		7	7	7	7	7
GHAZARD		7	7	7	7	7
OTHERS		7	7	7	7	7

Correlations

		OTHERS	
Pearson Correlation	TOTAL	.556	
	PHYSICAL	-.052	
	MECHAZARD	.028	
	NOISEVIB	-.233	
	G HAZARD	-.330	
	OTHERS	1.000	
Sig. (1-tailed)	TOTAL	.097	
	PHYSICAL	.456	
	MECHAZARD	.476	
	NOISEVIB	.308	
	G HAZARD	.235	
	OTHFRS		
N	TOTAL	7	
	PHYSICAL	7	
	MECHAZARD	7	
	NOISEVIB	7	
	G HAZARD	7	
	OTHERS	7	

Variables Entered/Removed

Model	Variables Entered		Variables Removed	Method
	1	OTHERS, MECHAZARD, NOISEVIB, PHYSICAL, GHAZARD ^b		

a. Dependent Variable: TOTAL

b. All requested variables entered.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics		
					R Square Change	F Change	df1
1	0.986	0.969	0.966	.66361	.999	269.052	5

Model Summary

Model	Change Statistics	
	df2	St. F Change
1	1	.046

ANOVA^a

	Model	Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	502.417	5	118.483	269.052	.046°
	Residual	.440	1	.440		
	Total	592.857	6			

b. Predictors: OTHERS, MECHAZARD, NOISEVIB, PHYSICAL, GHAZARD

Coefficients

	Model	Unstandardized Coefficients		Standardized Coefficients Beta	t	Sig.
		B	Std. Error			
1	(Constant)	-7.115	2.536	.670	-2.805	.218
	PHYSICAL	1.106	.060		18.351	.035
	MECHAZARD	1.567	.154	.674	10.163	.062
	NOISEVIB	1.913	.264	.481	7.243	.087
	GHAZARD	.438	.177	.237	2.474	.245
	OTHERS	.929	.043	.762	21.635	.029

Sources: Authors presentation of result

7. DISCUSSION OF RESULTS / Rasprava i rezultati

The mean overall level of exposure to occupational and workplace hazard risks in the seaport terminals from 2009 -2014 is 67.14 with standard deviation of 9.94. Exposure to risks of physical hazards, mechanical hazards, noise/vibration hazards and ergonomic hazards have mean averages of 15.71, 12.57, 6.71, and 10.42 respectively with standard deviations of 6.01, 4.28, 2.50, and 5.38 and 8.16 respectively. There exists a positive correlation between risks of ergonomic hazards and all other hazard categories. Risk associated with mechanical hazard also shows a positive correlation all other hazard categories exc.

The multiple R indicating the degree of association between the variables is 0.98, showing a 98% degree relationship among the various occupational and workplace hazard categories, an indication that the totality of the relationship existing among the hazards categories determines the overall levels of exposure to workplace hazards in the seaport environment. The policy implication is safety rules, regulations and policies should target to mitigate and manage all risks categories to limit exposure to each simultaneously, since the strong relationship amongst them suggest that they affect each other. The R square value is 0.96. This shows that 96% of total variation in the overall occupational and workplace hazard risk levels is explained by the model. Thus the hazard categories identified in the research explained 96% of overall exposure to occupational hazard risks in the Nigerian seaport environment.

The model quantifying the relationship between the risks associated with occupational workplace hazard in the seaport environment is thus shown below:

$$Y = -7.115 + 1.567X_1 + 1.106X_2 + 0.438X_3 + 1.91X_4 + 0.929X_5 + e$$

The test of null hypotheses H_{01} , H_{02} , H_{03} , H_{04} showed a t-stat of 10.2, 16, 2.47, 18.33, and 7.2 respectively and t-tables of 1.943 at (n-1) degrees of freedom.

Since t-stat for hypothesis H_{01} is greater than t-table, ie 10, 16 > 1.943, we reject the null hypothesis H_{01} and accept the alternate. Thus, we conclude that "There is significant impact of mechanical hazards on the overall occupational and workplace hazard risk levels in seaport environments over the period covered in the study.

Similarly, t-stats for each of hypotheses H_{02} , H_{03} , and H_{04} is greater than the t-tables, we reject all the null hypotheses and accept the alternates. Thus we conclude that; ergonomic hazards, physical hazards and noise hazards, all have significant effect on the overall exposure levels to occupational and workplace hazards in Nigerian seaport environments.

8. CONCLUSION / Zaključak

It is evident from result of the analysis and test of hypotheses that risks related to mechanical hazards, physical hazards, ergonomic hazards, and noise/vibration hazards all have significant effects on the overall occupational and workplace hazard risk levels in seaports in Nigeria. There equally exists a

positive and fair correlation among the various risks of hazard categories.

9. RECOMMENDATION / Preporuka

It is recommended that compulsory Job Hazard Analysis (JHA), Workplace Hazard Analysis (WHA) and risk assessment (RA) be carried out by the NPA periodically and before assigning employees to work. Such JHA and WHA should dedicate greater attention to the mechanical, ergonomics, physical and noise/vibration hazards to which employees have over the years been significantly exposed, as seen in the earlier result. Hazard control measures cum risk assessment can thus be applied to limit the risk of occurrence of the identified hazards.

Adequate funding of hazard control and safety programmes and equipments is recommended. The volume of fund needed for such funding should be quantitatively related to the volume of reduction in associated risks sort, this will enable better results to be achieved. It is the obligation on the NPA as the employer to implement occupation safety and health standards to render the seaports free from risk of accident from hazards. Personal protective equipments (PPE) must be provided in adequate quantity to be worn in proper form while employees should be trained on hazard control and risk reduction measures. The NPA should show commitment to safety of employees, not only to fulfill fiscal and legal obligations but to as well fulfill social obligation by implementing safety policies that it will take to save lives of maritime and seaport workers in Nigeria. Such investment in safety must however consider as first option those areas of risks and hazards to which employees have been significantly exposed to, over the years.

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