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RISK ASSESSMENT WITH MONTE CARLO SIMULATION METHOD IN A HOSPITAL CONSTRUCTION

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ABSTRACT

Risk assessment and hazard identification are important concepts that must be addressed in the field of occupational health and safety. The purpose of this study is to determine the hazards that may arise in the construction of a hospital and assess the risks that may be encountered terms of occupational health and safety. In order to achieve this purpose, any potential damage or damage that may occur during the construction of the hospital or that may affect the worker or the workplace may be observed and assessed using the Monte Carlo simulation method. These findings obtained by Monte Carlo method will be discussed. Future hospital construction will be accompanied by proposals that could prevent hazards that may arise in terms of occupational health and safety.

INTRODUCTION

Occupational health and safety is becoming more and more important. Especially, firms take some precautions for employee's safety. Hazard determination and risk assessment have an important place in industrial processes and occupational health and safety.

A Monte Carlo simulation is an effective method for characterizing risks and uncertainty in an awful amount of data. Monte Carlo Simulation-based risk assessment are providing more information, such as cumulative distribution functions and probability distribution functions (Jiang et al.,2013).

Chen et al.(2014) developed the risk simulation model of aero engine failure based on Monte Carlo method. The failure risk of aero engine is predicted and evaluated by this model. Li et al.(2008) proposed hybrid method of fuzzy set and Monte Carlo simulation for risk assessment. Mangla et al.(2014) deal with green supply chain risk assessment with Monte carlo simulation method.

The aim of this study is to determine the hazards that may arise in the construction of a hospital and assess the risks that may be encountered in terms of occupational health and safety. In order to achieve this purpose, any potential damage or damage that may occur during the construction of

the hospital or that may affect the worker or the workplace may be observed and assessed using the Monte Carlo simulation method.

THE CASE STUDY

The study was carried out in Adana City Hospital. The risks encountered during the construction of the Adana City Hospital were identified and the risks that could be encountered were assessed.To do this, hospital construction was observed, and the hazards were analyzed. For 2 years, the construction site was examined. The hazards were identified and analyzed.
Frequencies of accidents were recorded daily for 2 years. Since the number of accidents occurring on a daily basis is usually small, such as 0,1,2, the hypothesis is that the data fit the poisson distribution. The histograms found in SPSS program also confirm that very few accidents have occurred. The hypothesis was accepted. Because all asymp. sig. -2-tailed (p-values) higher than 0.05 in the Kolmogorov-Smirnov test. The hypothesis is true and all datas fit the poisson distribution. Later numbers were generated with MATLAB. Thus, the chances of accidents occurring for a year were obtained.
Briefly, It has been determined how many times each day the hazards are exposed for 2 years. Probability distributions of these data were found by SPSS program. This number was then used to generate numbers in Matlab. So we estimated the probabilities.
According to the total realization values of the hazards, the probability values from 1 to 5 are assigned to the hazards. For example; Exposure to extreme temperatures has occurred once a year. Since 1 is a small value, 1 probability value is assigned. Later, according to the accident follow-up report, violence values were assigned according to the damage cases or lost work days created by people after the accident.
The study was conducted as a result of the examination of Adana City Hospital for 2 years.All data were recorded during hospital construction. These datas are; hazards encountered during construction for 2 years, what are the consequences of these hazards and the frequency of these hazards. The values assigned according to the data obtained as a result of the simulation are shown in Table 1. Risk score is obtained by multiplying probability and intensity values. Table 1 shows the risk values obtained by multiplying these two values. Table 2 shows Kolmogorov-Smirnov test results. Table 3 shows the risk assessment (severity*likelihood) matrix.
Many hazards have been identified and listed below.
Exposure to extreme temperatures
Pressure swing
Crumbling / Tipping
Others
Exposure to smoke or gas
Hand tool use
Hand tool use +Jamming between two objects
Hand tool use + Contact with sharp, pointed objects
Electric shock
Using the Display Screen
Something went into your eye
Striking a moving appliance
Jamming between two objects
Jamming between two objects +Striking a moving appliance
Working with engineering vehicle

Slip, hang, fall at the same level
Slip, hang, fall at the same level +Contact with sharp, pointed objects
Slip, hang, fall at the same level + Contact with sharp, pointed objects +Striking a moving appliance
Exposed to UV light
Press nail or sharp, pointed objects
Contact with sharp, pointed objects
Material drop
Material drop +Contact with sharp, pointed objects
Material drop +Falling from high
Striking a stationary appliance
Striking a stationary appliance + Repeat works / Activities
Repeat Works / Activities
Transport / Vehicle movement
Fire / Explosion
Falling from high

Table.1. Risk Scores Results

HAZARDS	LIKELIHOOD	SEVERITY	RISK SCORE
Exposure to extreme temperatures	1	3	3
Pressure swing	1	2	2
Crumbling / Tipping	3	5	15
Others	3	3	9
Exposure to smoke or gas	2	3	6
Hand tool use	3	3	9
Hand tool use + Jamming between two objects	1	4	4
Hand tool use + Contact with sharp, pointed objects	1	4	4
Electric shock	2	5	10
Using the Display Screen	1	2	2
Something went into your eye	4	3	12
Striking a moving appliance	4	4	16

Jamming between two objects	4	4	16
Jamming between two objects+ Striking a moving appliance	1	5	5
Working with engineering vehicle	3	2	6
Slip, hang, fall at the same level	3	3	9
Slip, hang, fall at the same level + Contact with sharp, pointed objects	1	4	4
Slip, hang, fall at the same level + Contact with sharp, pointed objects + Striking a moving appliance	1	5	5
Exposed to UV light	1	3	3
Press nail or sharp, pointed objects	1	4	4
Contact with sharp, pointed objects	5	3	15
Material drop	5	4	20
Material drop + Contact with sharp, pointed objects	1	5	5
Material drop + Falling from high	1	5	5
Striking a stationary appliance	3	2	6
Striking a stationary appliance + Repeat Works / Activities	1	2	2

Repeat Works / Activities	1	1	1
Transport / Vehicle movement	1	2	2
Fire / Explosion	2	5	10
Falling from high	3	5	15

Table.2. Kolmogorov-Smirnov Test Results

One-Sample Kolmogorov-Smirnov Test

	N	Poisson Parameter[a,b] Mean	Most Differences Absolute	Most Differences Positive	Most Differences Negative	Extreme Kolmogorov-Smirnov Z	Asymp. Sig. (2-tailed)
	766	,0039	,000	,000	,000	,000	1,000
	766	,0026	,000	,000	,000	,000	1,000
	766	,0352	,002	,002	-,002	,055	1,000
	766	,0444	,001	,001	-,001	,027	1,000
	766	,0104	,003	,003	-,001	,071	1,000
	766	,0431	,002	,002	-,002	,047	1,000
	766	,0013	,000	,000	,000	,000	1,000
	766	,0026	,000	,000	,000	,000	1,000
	766	,0078	,000	,000	,000	,001	1,000
	766	,0013	,000	,000	,000	,000	1,000
	766	,1201	,026	,026	-,018	,711	,692
	766	,0744	,009	,009	-,007	,250	1,000
	766	,1345	,013	,012	-,013	,349	1,000
	766	,0013	,000	,000	,000	,000	1,000
	766	,0405	,004	,004	-,003	,122	1,000
	766	,0836	,001	,001	-,001	,022	1,000
	766	,0026	,000	,000	,000	,000	1,000
	766	,0013	,000	,000	,000	,000	1,000
	766	,0196	,004	,004	-,004	,103	1,000
	766	,0131	,000	,000	,000	,002	1,000
	766	,1775	,019	,019	-,009	,528	,943
	766	,2102	,012	,012	-,004	,333	1,000
	766	,0013	,000	,000	,000	,000	1,000
	766	,0013	,000	,000	,000	,000	1,000
	766	,0248	,000	,000	,000	,008	1,000
	766	,0013	,000	,000	,000	,000	1,000
	766	,0013	,000	,000	,000	,000	1,000
	766	,0104	,001	,001	-,001	,035	1,000
	766	,0131	,000	,000	,000	,002	1,000

	766	,0561	,006	,006	-,004	,174	1,000

Table.3. Risk Assessment Matrix(Afefy,2015)

SEVERITY	CONSEQUENCES				LIKELIHOOD				
	People	Asset	Environment	Reputation	1 Very Unlikely	2 Unlikely	3 Possible	4 Likely	5 Very Likely
1	No/ Slight Injury	No/ Slight damage	No/ Slight effect	No/ Slight Impact	Low	Low	Low	Low	Low
2	Minor Injury	Minor damage	Minor effect	Limited Impact	Low	Low	Low	Medium	Medium
3	Major Injury	Local damage	Local effect	Major Impact	Low	Low	Medium	Medium	High
4	Fatality	Major damage	Major effect	Nat. Impact	Low	Medium	Medium	High	High
5	Multiple fatalities	Extensive damage	Massive effect	Internat. Impact	Medium	Medium	High	High	High

CONCLUSION

Monte Carlo Simulation method is used to assess the risks. Dangers with excess and low risk scores have been identified. Crumbling / tipping, striking a moving appliance, jamming between two objects, contact with sharp or pointed objects, material drop,falling from high emerged as the most important risks. These risks are also considered as high risks. It was emphasized that the firm should attach importance to such risks. The Firm should take action against such risks. Firms should take precautions against such hazards that may pose a great risk to occupational health and safety.

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