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Correlation Analysis between Building Damage Cost and Major Factors Affected by Typhoon

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Abstract: Currently, according to the climate change, serious damage by Typhoon has been occurred in the world. In this respect, the research on the damage prediction model to minimize the damage from various natural disaster has been conducted in several developed countries. In the case of U.S, various damage prediction models of buildings from natural disasters have been used widely in many organizations such as insurance companies and governments. In South Korea, although studies regarding damage prediction model of hurricane have been conducted, the scope has been only limited to consider the property of hurricane. However, it is necessary to consider various factors such as socio-economic, physical, geographical, and built environmental factors to predict the damages. Therefore, to address this issue, correlation analysis is conducted between various variables based on the data of hurricane from 2003 to 2012. The findings of this study can be utilized to develop for predicting the damage of hurricane on buildings.

Keywords: Hurricane; Correlation Analysis; Natural Disaster; Building Damage Cost

I. INTRODUCTION

Currently, according to the climate change, serious damage by typhoon has been occurred in the world. In the case of South Korea, the costs due to damage from Lusa in 2002, Maemi in 2003 had reached by 5,147 and 4,222 billion won respectively. Therefore, the studies are necessary to minimize the damage from various natural disaster. In the case of U.S.A, the Hazus-Multi Hazard (HAZUS-MH) was developed from Federal Emergency Management Agency (FEMA) to manage risk according to the various natural disaster such as flood, earthquake, typhoon, etc. In addition, in Florida, Florida Public Hurricane Loss Model (FPHLM) has been utilized to estimate insurance rate in various insurance companies. However, In South Korea, the prediction model to prevent the damage from natural disasters does not develop yet.

Therefore, the objective of this study is to conduct correlation analysis to suggest the influence factors in building damage cost when typhoon is occurred in South Korea. To achieve the objective, variables are classified to four factors such as typhoon information, geography, construction environment, and socio-economy. The findings of this study can be utilized to develop damage prediction model of typhoon in South Korea.

Fig. 1 shows the methodology of this study. First, as a dependence variable, the building damage costs are collected by typhoon from 2003 to 2012. Second, as independence variables, the data of four factors are collected. Third, based on the collected data, the correlation analysis are conducted between dependent and independent variables. The data of this study are collected from the national emergency management agency annual report. In addition, the data from regional metrological office and national statistical office are collected.

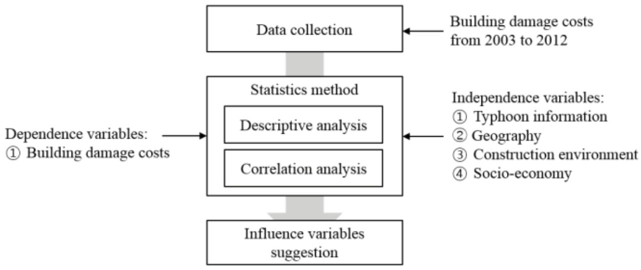

FIGURE 1. METHODOLOGY

II. DATA COLLECTION

A. *Dependent variable*

As shown in Table 1, the region code are divided into 16 regions such as Seoul, Pusan, Ulsan, etc. In terms of typhoon, from the national emergency management agency annual report, 15 typhoons are selected among total 28 typhoons since the rest of them are caused to little damage in South Korea.

TABLE 1. REGION AND TYPHOON CODE

Code	Region	Typhoon
1	Seoul	Bolaven
2	Busan	Sanba
3	Daegu	Muifa
4	Incheon	Dianmu
5	Gwangju	Kompasu
6	Daejun	Malou
7	Ulsan	Kalmaegi
8	Gyeonggi	Man-yi
9	Gangweon	Nari
10	Chung-bug	Shanshan
11	Chung-nam	Nabi
12	Jeon-bug	Mindulle
13	Jeon-nam	Megi
14	Gyeong-bug	Soudelor
15	Gyeong-nam	Maemi
16	Jeju	

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B. *Independent variable*

Table 2 shows the independent variables of this study. To suggest the influence factors to building damage cost, the factors are divided into four factors such as typhoon information, geography, construction environment, and socio-economy.

TABLE 2. INDEPENDENT VARIABLES

Factor		Unit	Description
Typhoon information	Moving speed	km/h	moving speed per hour
	Pressure	hPa	central pressure
	Wind speed	m/s	maximum wind speed
	Wind radius	km	typhoon wind radius
	Rainfall	mm/day	maximum rainfall per day
Geography	River	ea	number of river
	Length	km	length of river
	River rate	%	complete improvement rate
	Forest	km^2	forest area
	Coastline	km	coastline length
Construction environment	Buildings	ea	buildings over fifteen years
	Park	km^2	urban park area
	Dam	ea	number of dam
	Slope	ea	number of cutting slope
	High-rise building	ea	buildings over eleven floor
Socio-economy	Population density	pop./km^2	population per km^2
	Basic living	person	basic living recipient
	Income	10,000 won	ordinary income
	GRDP	mil. won	gross regional domestic product
	Crime	ea	number of regional crime

III. CORRELATION ANALYSIS

Table 3 shows the correlation result between building damage cost and typhoon information. As shown in Table 3, the building damage cost is affected by the variables such as pressure, wind speed, wind radius, and rainfall. However, the moving speed is not related to the cost.

TABLE 3. CORRELATION ANALYSIS: TYPHOON INFORMATION

		Cost	Moving speed	Pressure	Wind speed	Wind radius	Rainfall
Cost	Coff.	1	.079	-288	.192	.129	.173
	Sig.		.224	.000	.003	.046	.007
	N	239	239	239	239	239	239

Table 4 shows the correlation result between building damage cost and geography factor. As shown in Table 4, the building damage cost is affected by the variables such as length, river rate, forest, coastline land and island. However, the river variable is not related to the cost. In detail, the length of river, complete improvement rate, forest area and coastline length of land and island influences on the building damage cost.

TABLE 4 CORRELATION ANALYSIS: GEOGRAPHY

		Cost	River	Length	River rate	Forest	Coast (land)	Coast (island)
Cost	Coff.	1	.118	.175	-.120	.227	.147	.157
	Sig.		.039	.007	.034	.000	.023	.015
	N	239	239	239	239	239	239	239

Table 5 shows the correlation result between building damage cost and construction environment factor. As shown in Table 5, the building damage cost is affected by the variables such as building, dam, and slope. However, the park and high-rise building variables are not related to the cost.

TABLE 5. CORRELATION ANALYSIS: CONSTRUCTION ENVIRONMENT

		Cost	Buildings	Park	Dam	Slope	High-rise building
Cost	Coff.	1	.110	.026	.194	.160	-.103
	Sig.		.042	.686	.003	.013	.114
	N	239	239	239	239	239	239

Table 6 shows the correlation result between building damage cost and socio-economy factor. As shown in Table 6, the building damage cost is affected by the variables such as basic living, income, and GRDP. However, the population density variable is not related to the cost.

TABLE 6. CORRELATION ANALYSIS: SOCIO-ECONOMY

		Cost	Population density	Basic living	Income	GRDP	Crime
Cost	Coff.	-.095	-.008	-.065	-.087	.158	.173
	Sig.	.031	.897	.021	.018	.014	.007
	N	239	239	239	239	239	239

IV. CONCLUSION

Currently, building damage costs affected by typhoon have been incredibly increased because of various climate change. Although, in the case of South Korea, many research have been focused on the prediction models, almost research have been considers only the property of typhoon. However, the model should be considered various factors such as socio-economy, geography, construction environment etc. Therefore, the objective of this study is to conduct the correlation analysis between building damage cost and various factors affected by typhoon. To achieve the objective, first, the factors are divided into four groups such as information, geography, construction environment and socio-economy factors. Second, correlation analysis conducted between building damage cost and four factors. In the future, the findings of this study can be utilized as a basic material to develop the building damage prediction model affected by typhoon in South Korea.

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