

Road Physical Factors Contributing to Traffic Accidents Case Study: Klong Chan Sub-district Bangkok District Bangkok, Thailand

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Abstract— The objective of this research is to study the pattern of traffic accident distribution in Klong Chan Sub-district, Bangkok District, Bangkok, and to analyze the road physical factors that cause traffic accidents. Data used in the analysis is the primary spatial data of locations obtained from field surveys by utilizing Global Position System or GPS, as well as the secondary data of traffic accident cases in 2014. Area units observed for this analysis consist of six major roads in Klong Chan Sub-district, Bangkok District, Bangkok. Techniques and methods used for data analysis are mathematical calculation and spatial statistics of the Nearest Neighbor Index (NNI) and the Multiple Regression Analysis.

After examining the distribution form of locations that traffic accidents occurred in 2014 in Klong Chan Sub-district, Bangkok District, Bangkok, the calculation result indicates that the nearest neighbor index is 1.1031523, suggesting a uniform distribution pattern. In this regard, Ladprao Road has the highest number of accidents with 33% ($R = 1.145327$), suggesting a uniform distribution pattern. Nawamin Road ranks second with 25% ($R = 0.949936$), suggesting a random distribution pattern. Ladprao 101 Road ranks third with 18% ($R = 0.754796$), suggesting cluster distribution pattern. Pho Kaew Road ranks fourth with 11% ($R = 0.962824$), suggesting a random distribution pattern. Happy Land Road ranks fifth with 10% ($R = 1.54356$). Seri Thai Road ranks sixth with 3% ($R = 1.262481$), suggesting a uniform distribution pattern.

Analysis of road physical factors contributing to traffic accidents reveals that conflict point is the only factor of traffic accidents in Klong Chan Sub-district, Bangkok District, Bangkok. Moreover, factors relating to conflict point can explain the change in traffic accident scale to 72.60% ($R^2 = 0.726$). Multiple regression summation analysis was $Y = 15.429 + 2.575 X_4(\text{junction})$

Keywords— Road Physical Factors, Traffic Accidents, Klong Chan Sub-district

I. INTRODUCTION

WHILE Thailand is in the midst of economic, political and social advancement, urbanization has occurred and grown continuously in Bangkok and vicinity, resulting in disproportionate land uses because certain areas are utilized to serve this urban growth. Consequently, traffic congestion and traffic accident are two critical and unavoidable problems. Traffic accident is an important issue that causes relatively high dead tolls. According to the statistics reports gathered from The Royal Thai Police, State Railway of Thailand, Marine Department and Department of Civil Aviation in 2014,

there are 61,323 traffic accidents, 20,906 casualties and 7,364 fatalities.

Located in the inner part of Bangkok, Klong Chan Sub-district, Bangkok District, Bangkok, is one of the fast-growing areas in terms of economy as the land in this zone has been fully utilized. It is a densely crowded community and a prime location for large businesses that help create jobs and income. Moreover, populations have migrated to this area in response to rapid urbanization. In fact, Klong Chan Sub-district is regarded as a key commercial center consisting of department stores, shops, restaurants, entertainment complexes and government agencies. As a result, the traffic in this zone has been so congested that it becomes one of the sub-districts with the greatest number of accidents. Ladprao Road, in particular, is one of the top five roads that traffic accidents often take place.

Previously, a number of studies were conducted to identify the cause of traffic accidents. However, they were analyzed by using considerable amount of traffic accident data that focus merely on human factor and neglect other relevant factors, especially the spatial factors. Therefore, the researcher aims to study about the road physical factors contributing to traffic accidents, as well as presenting the findings that would not only be beneficial for traffic safety planning organizations, communities and general public, but also provide another alternative for reducing the number of traffic accidents. Moreover, this study aims to prepare a plan to solve severe issues leading to potential risks of traffic accidents while enhancing clear and correct understanding about the forms, characteristics and locations of traffic accidents that would ultimately prevent and reduce the intensity of traffic accidents.

II. OBJECTIVES OF STUDY

1. To study the distribution pattern of traffic accident locations in Klong Chan Sub-district, Bangkok District, Bangkok
2. To analyze the road physical factors contributing to traffic accidents in Klong Chan Sub-district, Bangkok District, Bangkok

III. METHODOLOGY AND DATA ANALYSIS

This In this study, the researcher has conducted a new data by dividing an analysis method into two steps as follows;

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Step 1: Study the distribution pattern of traffic accident locations in Klong Chan Sub-district, Bangkapi District, Bangkok by examining and gathering data as follows;

1.1 For the primary spatial data of locations obtained from field surveys, geospatial technology is utilized as a tool to collect, analyze and demonstrate the result in map and statistics, which support descriptive statistics. In this regard, Global Position System (GPS) is used in field surveys to collect the coordinates for supporting satellite image interpretation. In addition, the researcher executes post classification and data observation in order to analyze the correlation with other statistics.

1.2 Analyze the distribution pattern of the data gained from by applying mathematical calculation and spatial analysis technique using the nearest neighbor index to explain the distribution pattern of the phenomenon in the area of study. The nearest neighbor index is a method of determining spatial relationship between each traffic accident point and the closest other point. The expected distance is the average distance between neighbors. The formula is as follows;

$$R = \frac{d_{obs}}{d_{ran}}$$

where:

R = Nearest Neighbor Index

dobs = Observed mean nearest neighbor distance

dran = Expected mean nearest neighbor distance

where:

$$dobs = \frac{\sum_{i=1}^n d}{n}$$

$$dran = 0.5 \sqrt{\frac{A}{n}}$$

where:

d = distance

N = number of points

A = area

After interpreting the spatial distribution pattern of traffic accident spots in Klong Chan Sub-district, Bangkapi District, Bangkok, by using the nearest neighbor index, the result shows that R = 0 - 2.5. Detail is as follows;

Table 1: Interpretation of the nearest neighbor index

Nearest Neighbor Index (R)	Interpretation	Distribution Pattern
1.61-2.50	More than 1	Uniform
0.81-1.60	Close to or equal to 1	Random
0.00-0.80	Less than 1	Cluster

Step 2: Analyze the road physical factors contributing to traffic accidents in Klong Chan Sub-district, Bangkapi District, Bangkok, by performing the following research methodology and data collection;

2.1 Convert the secondary spatial data into a statistical unit which will be used in the calculation of a relationship of variables used in the study to determine if it is a positive, negative or nonexistent relationship.

2.2 Apply the data gained from to analyze the road physical factors contributing to traffic accidents with a number of traffic accident cases as dependent variable and other factors as independent variable. Variables used to analyze the impactful road physical factors are as follows;

Y = Scale and number of traffic accident cases in 2014 occurring on each road in Klong Chan Sub-district, Bangkapi District, Bangkok, are used as measurement criteria

X = Derived from theory of road physical factors

X₁ = Factor of road width on each road as measurement criterion

X₂ = Factor of traffic distance using the length of road as measurement criterion

X₃ = Factor of traffic control equipment using traffic light of each road as criterion

X₄ = Factor of conflict points using total amount of junctions and merging lanes of each road as criterion

X₅ = Factor of lighting using lights that operate normally as criterion

X₆ = Factor of travel frequency of each household in the community situated about 10 meters of each road as criterion

Statistic and quantity technique used in data analysis

The Correlation Analysis Method is used to find coefficient, Pearson-Product Moment Correlation Coefficient as follow :

$$r = \frac{n(\sum XY) - (\sum X)(\sum Y)}{\sqrt{[N(\sum X^2) - (\sum X)^2][N(\sum Y^2) - (\sum Y)^2]}}$$

where:

r = correlation between variable XY

$\sum X$ = total result data from variable X

$\sum Y$ = total result data from variable Y

$\sum XY$ = data from X and Y

$\sum X^2$ = total data of both data from X

$\sum Y^2$ = total data of both data from Y

N = amount of data

The Analyze Multiple Regression Analysis by Stepwise method as follow :

$$Y = b_0 + b_1x_1 + b_2x_2 + \dots + b_nx_n + e$$

where:

Y = followed variables

b₀ = fix value

b₁ - b_n = regression coefficient

e = inconsistent

IV. AREAS STUDIED

This study was conducted in Klong Chan Sub-district, Bangkok District, Bangkok. The areas of the study consisted of six roads under the responsibility of Ladprao Police Station, i.e. three main roads and three minor roads as follows;

- Three main roads:

1. Ladprao Road
2. Nawamin Road
3. Seri Thai Road

- Three minor roads:

1. Pho Kaew Road
2. Ladprao 101 Road
3. Happy Land Road

V. RESULT AND ANALYSIS

1. To study the distribution pattern of traffic accident locations in Klong Chan Sub-district, Bangkok District, Bangkok

After examining the distribution pattern of traffic accident locations in Klong Chan Sub-district, Bangkok District, Bangkok, the result reveals the following information regarding traffic accidents. For the total number of traffic accidents, Ladprao Road ranks top (243 cases) while Nawamin Road ranks second (183 cases). Seri Thai Road has 23 accident cases. Ladprao 101 Road has 131 accident cases. Happy Land Road has 77 times accident cases. And Pho Kaew Road has 82 accident cases. Moreover, after studying the distribution of traffic accidents by applying the nearest neighbor index for traffic accident locations which help indicates spatial distribution of area from average distance between each point and the nearest neighbor. The result reveals three types of patterns as shown in Table 2-3

Table 2: examining the distribution pattern of traffic accident locations

Areas of the study	A	N	N/A
Ladprao Road	48,960	243	0.00496
Nawamin Road	105,000	183	0.00174
Seri Thai Road	20,400	23	0.00113
Ladprao101Road	42,000	131	0.00312
HappyLand Road	32,011	77	0.00241
Pho Kaew Road	42,000	82	0.00195
Total	290,371	743	0.01531

Table 3: The result of the nearest neighbor index of the traffic accident locations

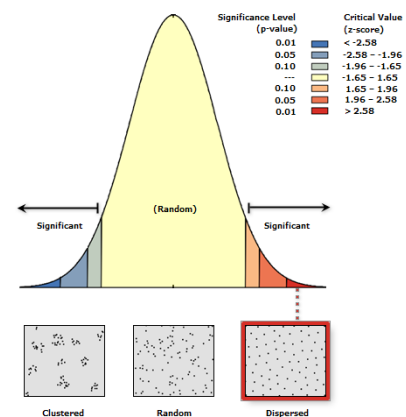
Areas of the study	Dobs	Dran	R
Ladprao Road	0.04033841	0.03522	1.145327
Nawamin Road	0.01980616	0.02085	0.949936
Seri Thai Road	0.02122230	0.01681	1.262481
Ladprao101Road	0.02108	0.02793	0.75479
HappyLand Road	0.03789	0.02455	1.54356
Pho Kaew Road	0.02126	0.2208	0.96282
Total	0.16159687	0.14744	1.103123

Klong Chan Sub-district, Bangkok District, Bangkok, only the area under the responsibility of Ladprao Police Station, accounts for 290,371 square kilometers. According to the traffic accident data in 2014 which recorded 739 traffic accident locations, the result of the nearest neighbor index is 1.1031523, suggesting a uniform distribution pattern. This means that, for the areas with the nearest neighbor index of more than 1, the traffic accident locations are thoroughly dispersed and almost equally spaced apart from each other. The analysis of distribution pattern of traffic accident locations in Klong Chan Sub-district, Bangkok District, Bangkok, is shown in Table 4.

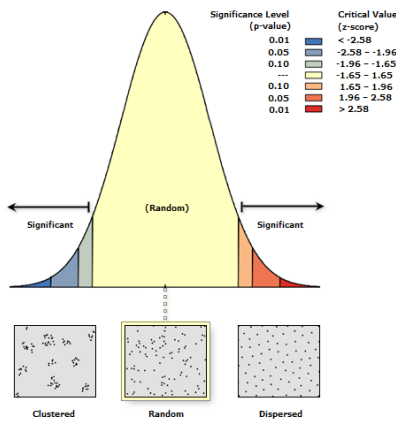
Table 4: distribution pattern of traffic accident locations

Areas of the study	Area (Kms) ²	traffic accident cases	NNI	Pattern distribution
Ladprao Road	48,960	243	1.14533	Uniform
Nawamin Road	105,000	183	0.94994	Random
Seri Thai Road	20,400	23	1.26248	Uniform
Ladprao101Road	42,000	131	0.75479	Cluster
HappyLand Road	32,011	77	1.56356	Uniform
Pho Kaew Road	42,000	82	0.96282	Random
Total	290,371	739	1.10315	Uniform

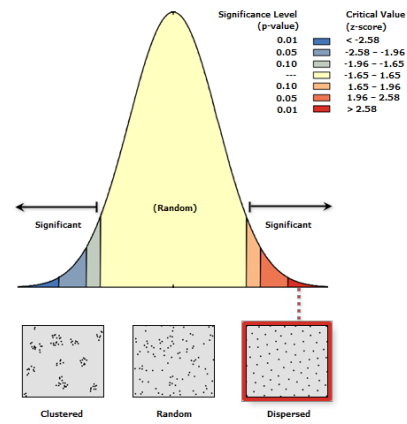
Ladprao Road covers an area of 48,960 square kilometers. There are 243 traffic accident cases ($R = 1.145327$), suggesting a uniform distribution pattern. Therefore, accidents occurring on Ladprao Road are uniformly dispersed.



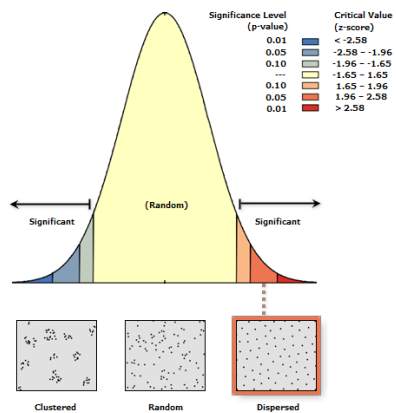
Nawamin Road has an area of 105,000 square kilometers. There are 183 traffic accident cases ($R = 0.949936$), suggesting a random distribution pattern. Therefore, accidents occurring on Nawamin Road are randomly dispersed.



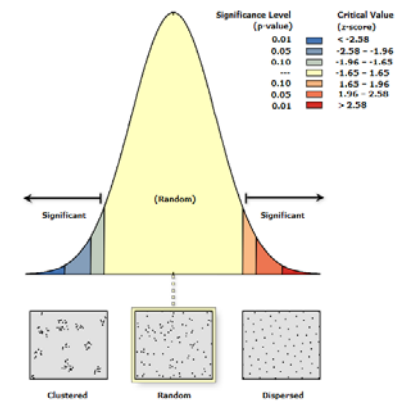
Seri Thai Road covers an area of 20,400 square kilometers. There are 23 traffic accident cases ($R = 1.262481$), suggesting a uniform distribution pattern. Therefore, accidents occurring on Seri Thai Road are uniformly dispersed.



Pho Kaew Road has an area of 42,000 square kilometers. There are 82 traffic accident cases ($R = 0.962824$), suggesting a random distribution pattern. Therefore, accidents occurring on Pho Kaew Road are randomly dispersed.



Ladprao 101 Road has an area of 42,000 square kilometers. There are 131 traffic accident cases ($R = 0.754796$), suggesting a cluster distribution pattern. Therefore, accidents occurring on Ladprao 101 Road aggregate in certain areas.



Happy Land Road covers an area of 32,011 square kilometers. There are 77 traffic accident cases ($R = 1.54356$), suggesting a uniform distribution pattern. Therefore, accidents occurring on Happy Land Road are uniformly dispersed.

2. To analyze the road physical factors contributing to traffic accidents in Klong Chan Sub-district, Bangkok District, Bangkok

The Multiple Regression Analysis and the Stepwise Regression is used to select variables that are the factor of the frequency of travel. It is the only one that has regressive summation and has Coefficient of Multiple Correlation or R value equals to 0.852 or R^2 is equal to 0.726 which means frequency of travel can explain the change or scale alteration of traffic accidents to 72.60% of total value of factors. The remaining 27.40% came from other factors that are not considered after the adjustment of R^2 to R^2_{adj} (Adjusted R Square) or equal to 0.658. It was shown that after adjustment of R^2 , the factor of frequency of travel has impact on the scale of accidents in high level as shown in Table 5.

TABLE 5
MODEL SUMMARY IN MULTIPLE REGRESSION

Model	R	R ²	Adj R ²	Std. Error
1	0.852	0.726	0.658	46.69146

TABLE 6
COEFFICIENT IN MULTIPLE REGRESSION

Model	Unstandardized Coefficients		standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
Constant	15.429	38.169		0.404	0.707
X4	2.575	0.790	0.852	3.258	0.031

Table 6 showed Multiple Regression Coefficient: B of summation, is(b_0) = 15.429 coefficient of variables X_4) b_1)=2.575); therefore, regression summation will be as follow (3):

$$Y = 15.429 + 2.575X_4$$

VI. SUMMARY OF RESEARCH

According to the analysis of road physical factors contributing to traffic accidents in Klong Chan Sub-district, Bangkok District, Bangkok, it has been found that traffic conflict point is the only factor affecting the scale of traffic accidents. It is also obvious that the distribution pattern and road physical factors contributing to traffic accidents are coherent and rational. According to an interview with the traffic police officer of Ladprao Police Station, traffic accidents occurred repeatedly because there were traffic congestion on Ladprao Road as a result of urbanization. The zone is not only a center of economic growth where department stores, shops, restaurant, entertainment complexes and government agencies are located, but also features several forms of land use. Therefore, traffic conflict points increase subsequently. In addition, as people frequently pass the junctions and merging lanes on Ladprao Road while travelling to each location of land uses, traffic conflicts usually occur to various road users and vehicles, ranging from pedestrians, bicycles, motorcycles, personal cars, public vehicles to trucks. As a result, this condition disturbs the tempo of traffic by making it too slow or too rapid, thus reduces the efficiency in transportation and increases the risk of accidents. The principle of land acquisition of Road Safety Directly Center (2011) indicates that there should be strict control of permission for nearby lands to connect directly to main roads, or minimize the number of direct connection to main roads, as well as allocating irrelevant land uses from traffic in order to lessen transportation conflicts. In addition, this is in accordance with the study of Greibe (2003) who develop a traffic accident model based on Poisson Regression analysis to predict the amount of accident cases on highways and urban junctions in Italy. The study covers the length of 142 kilometers of road and utilizes a myriad of variables, i.e. speed limit, traffic amount, road width, number of lanes, speed reduction measures, central city characteristics, public parking space, land usage and facilities for road users. The result of study shows that the prime factors causing the highest risk of accidents are traffic amount, speed limit, land usage and the number of secondary ways in the area respectively.

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