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# Spatial Distribution of Drunk Driving Cases in Nakhon Pathom Province

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**ABSTRACT**

This research study utilized Geostatistics to examine the spatial data on drunk driving incidents in Muang Nakhon Pathom from 2013 to 2017. The study collected data on 685 drunk driving cases and 1,096 Facebook statuses geotagged to entertainment venues. This study aimed to investigate the pattern of drunk driving incidents, analyze hot spots, study the directional distribution of drunk driving cases, and explore the relationship between drunk driving cases and social aspects. The findings revealed that the drunk driving cases were clustered, with the highest number of cases occurring in Sanam Chan sub-district, where alcohol stores and entertainment venues are located. The cases were mostly directed towards the eastern part of Nakhon Pathom, and the study found a positive correlation between drunk driving and geotagged statuses with statistical significance as *p*-value = 0.05. The outcomes of this research can be used to inform policy-making and decisions related to public posts about drinking-related activities.

**Keywords:** Drunk driving; Getis Ord Gi*; Latent dirichlet allocation; Moran's I spatial autocorrelation; Sentiment analysis; Standard deviational ellipse

## 1. Introduction

According to the World Health Organization's report in 2020, consuming alcohol not only harms health but also increases the likelihood of accidents and crime. Moreover, there is a growing trend of alcohol consumption among younger individuals due to socialization, parties, gatherings, and easy access to alcohol. These factors, combined with age-related values, contribute to the increase in alcohol use among the younger generation (Thai Health Promotion Foundation, 2022). Although policies were limiting the area and time of sale and group of buyers of alcohol, setting higher

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prices, or even limiting the posting of images or texts inducing alcohol consumption (Department of Disease Control, 2019), there were violations and circumvention of such control measures (Saelim & Moopayak & Suwonnaroop, 2017).

In Thailand, Nakhon Pathom showed high access to alcohol among adolescents and the number one record for alcohol-related accidents (Saelim & Moopayak & Suwonnaroop, 2017). One of the reasons is the number of licensed and unlicensed liquor stores. According to the criminal case statistics reported from Muang Nakhon Pathom Police Station between 2013 and 2017, the number of drunk driving cases was the province's third crime case and often occurred in conjunction with other offenses. Furthermore, drunk driving cases are more common on weekends and holidays and are more likely to occur in urban areas (Tunneekul & Pattarakul, 2017).

The perceptions of alcoholic beverage advertising on information interpretation and alcohol consumption decisions among adolescents aged 12-18 years using in-depth group interviews discovered that product placement of alcoholic beverages on social media influenced drinking decisions (Thai Health Promotion Foundation, 2014). The Ministry of Digital Economy and Society also reported that the most popular social media platform was Facebook, with 93.3% of total social media users. (Jaikla, 2021 & Marketingoops, 2019) The use of artificial intelligence to study alcohol marketing trends on the Internet illustrated that the majority of alcohol-related statuses were posted by restaurants, entertainment spots or entertainment venues, reviewers, influencers, wholesale and retail alcohol stores, in which the statuses indicated sale location or the content comparing prices and promotions for marketing purposes (Jaikla, 2021, and WHO, 2022). Alcoholic beverages were often consumed among large crowds, such as at festivals and carnivals (Tunneekul & Pattarakul, 2017), entertainment venues, on-premise liquor stores, and football stadiums (Ristea et al., 2018), influencing crime attempts. In addition, the analysis of geotagged statuses via Twitter using the Sentiment Analysis algorithm and Latent Dirichlet Allocation (LDA) analysis, and the crime prediction using linear or logistic models in conjunction with police crime records showed that social media platforms used with the violence statuses have a spatial correlation with crime intensity (Ristea et al., 2018).

Geostatistics is a great tool for investigating the spatiotemporal relationship between crime data and physical and social aspects. Yiampisan and Srivanit (2010) studied crime data, including murder, bodily harm, rape, theft and sSnatching, and drug-related, using this tool to obtain an overview of crime patterns and crime-prone areas. Srithamrong (2017) estimated burglary in Banpong district using geostatistics including Moran's I, Getis Ord Gi*, and Standard Deviational Ellipse to obtain the prevalence and distribution of burglary. Wongpanya and Witchuvanit (2017) evaluated the density of car robberies in Nakorn Pathom Province using a Geographic Information System.

Geostatistics illustrates the spatiotemporal overview of patterns and hotspots of crime. The relationship between crime incidents and social media posts was analyzed using Latent Dirichlet Allocation (LDA) or topic modeling to determine the meaning and grouping of relevant terms. In addition, topic modeling is applied to the analysis and classification of topics of articles or papers to facilitate search grouping. For example, it is used to determine the meaning, weighting, and clustering of terms to expand keywords in searches from Twitter excerpts (Numak & Sodanin, 2016) or used to measure the tourism website content level according to the needs of tourists through an analysis of the text on the website to examine the content quality of tourism-related websites (Jantarath, 2018). This includes its use in developing more accurate and relevant information provision and questions and answers by

Chatbot using topic modeling and clustering with the Latent Dirichlet Allocation technique to determine the relevant terms. In addition, it is used in the classification of topics in the texts related to pregnancy, sexual intercourse, and contraception (Thongploy, 2020). The aim of this research was to (1) investigate spatiotemporal phenomena of crime related to drunk driving cases, (2) analyze hot spots of drunk driving cases, (3) predict the directional distribution of crime related to drunk driving cases, and (4) study the relationship between public social posts and crime related to drunk driving cases using a Sentiment Analysis algorithm and Latent Dirichlet. Mueang Nakhon Pathom District was designated as the study area.

## 2. Objectives

2.1 To investigate the pattern of drunk driving cases using Moran's I spatial autocorrelation statistic.
2.2 To analyze hot spots of drunk driving using Getis-Ord Gi* statistics analysis.
2.3 To study the directional distribution of drunk driving cases using the Standard Deviational Ellipse tool.
2.4 To discover the spatial relationship between drunk driving cases and social aspects.

## 3. Materials and Methods

### 3.1 Materials

The data used in this study (as shown in Table 1) consists of
1. The number of drunk driving cases in the jurisdiction of Mueang Nakhon Pathom Police Station. The data includes 137 cases in 2013, 89 cases in 2014, 213 cases in 2015, 99 cases in 2016, and 147 cases in 2017.
2. Entertainment venue geotagged Facebook statuses in Muang Nakorn Pathom: 365 statuses in 2015, 366 in 2016, and 365 in 2017.

### 3.2 Methods

The methodology of this paper is composed of 2 steps: 1) the spatiotemporal analysis of drunk driving includes Moral's I, Getis Ord Gi*, and Standard Deviational Ellipse tool (SDE). The spatial patterns of drunk driving were analyzed using Moran's I spatial autocorrelation statistic. The Moran's I correlation ranges from -1 to +1. The positive Moran's I correlation indicates clustered crime incidence; the negative Moran's I correlation indicates dispersed crime incidence and zero indicates uncertain crime incidence pattern. The hot spot analysis was then performed using the Getis Ord Gi* statistic and the directional distribution of drunk driving cases was assessed using the Standard Directional Distribution tool. 2) The relationships between drunk driving cases and social factors such as Facebook statuses with entertainment venues selling liquor geotagging were analyzed using the Sentiment Analysis algorithm with a pre-trained WangchanBERTa model and the dataset from Wisesight-Sentiment was used to classify each status. The positive results were then analyzed using Latent Dirichlet Allocation. The LDA technique was applied to classify topics and to determine the probability of the topic appearing in each status post. After that, Pearson's correlation coefficients of the statuses and drunk driving cases were determined. The Pearson's correlation coefficient ranges from -1.0 to +1.0. The coefficient approaching 1 indicates a strong or positive relationship between two variables. The coefficient approaching 0 indicates no relationship between the two variables. The coefficient approaching -1 indicates a weak or inverse relationship between two variables, as shown in Fig. 1.

**Table 1.** Data used in this study.

| Data | Description | Source |
|---|---|---|
| Crime case statistics of Mueang Nakhon Pathom Police Station between 2013 and 2017 | Drunk drinking Case Charges, location of arrest, and date and time of incident and arrests | Criminal case records of Mueang Nakhon Pathom Police Station (2013 -2017) |
| Facebook statuses related to entertainment venues and alcohol shops geotagging between 2015 and 2017 | Facebook statuses related to entertainment venues and alcohol shops are geotagging from the Muang Nakhon Pathom Police Station entertainment venues database. | Facebook Platform (2015 – 2017) |
| Administrative boundary | Administrative boundary of Mueang Nakhon Pathom District, Nakhon Pathom Province scale 1:25,000 (.shp) | Department of Land Development, 2015 and 2017 |

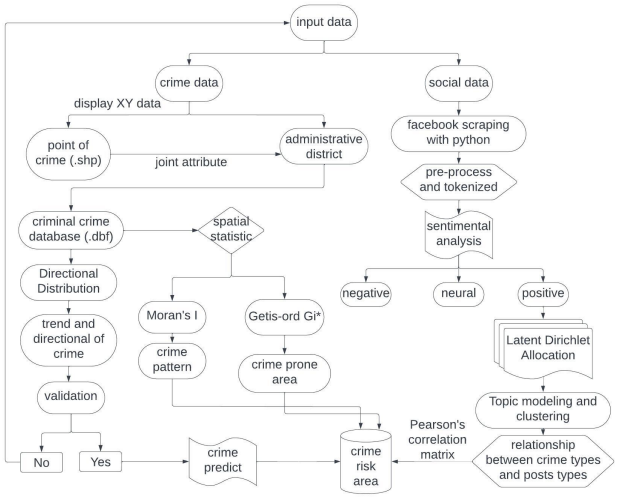


**Fig. 1.** The methodology.

## 4. Results and Discussion

This analysis consists of 2 parts: 4.1) spatiotemporal analysis results of drunk driving, and 4.2) the relationship between Facebook statuses and drunk driving incidence as described below.

### 4.1 Spatial patterns of drunk driving incidence

The analysis of drunk driving patterns from 2013 to 2017 indicated the concentrated incidence with Moran's I of 0.44, 0.31, 0.99, 0.38, and 0.54, as shown in Figs. 2-6, respectively. The analysis results showed the concentration of drunk driving incidence in Sanam Chan Sub-district, Phra Pathom Chedi Sub-district, and Huai Chorakhe Sub-district from 2013 to 2017 cover Sanam Chan Sub-district, Phra Pathom Chedi Sub-district and Huai Chorakhe Sub-district where many entertainment venues, on-premise, and Off-premise alcohol stores are located.

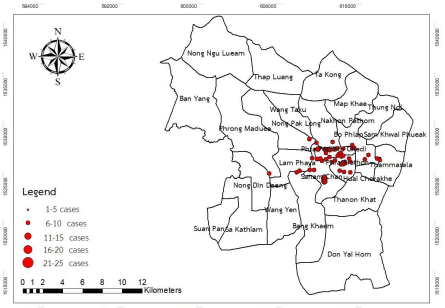


**Fig. 2.** Number of drunk driving cases in 2013.

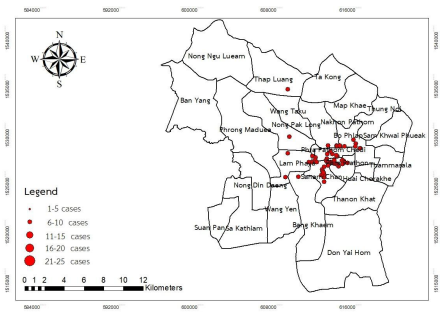


**Fig. 3.** Number of drunk driving cases in 2014.

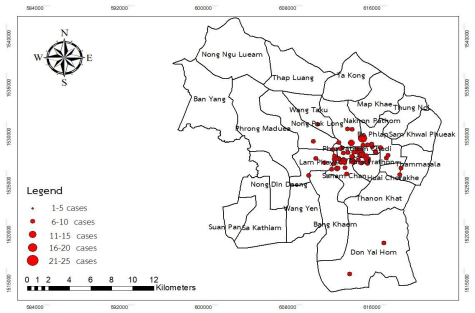


**Fig. 4.** Number of drunk driving cases in 2015.

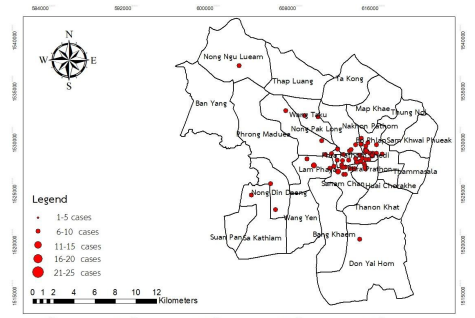


**Fig. 5.** Number of drunk driving cases in 2016.

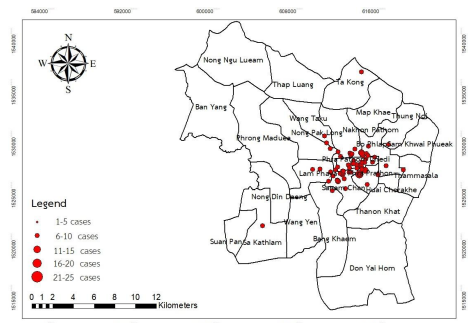


**Fig. 6.** Number of drunk driving cases in 2017.

## 4.2 Crime-prone areas for drunk driving cases

The hot spots analysis of drunk driving cases from 2013 to 2017 using Getis-Ord Gi* statistic showed that the area with the highest number (GiZscore more than 1.65) of drunk driving cases in 2013, 2015, and 2016 was Sanam Chan Sub-district. The areas with the highest number of drunk driving cases in 2014 were Huai Chorakhe Sub-district, Sanam Chan Sub-district, and Bo Phlap Sub-district, while the area with the highest number of drunk driving cases in 2017 was Nakhon Pathom Sub-district. This is because Sanam Chan Sub-district is the location of a large university surrounded by several establishments, and both licensed and unlicensed liquor stores. Therefore, there are many alcohol checkpoints in this sub-district. Bo Plub Sub-district, Nakhon Pathom Sub-district, and Huai Chorakhe Sub-district also had a high number of drunk driving cases as there are many alcohol checkpoints in these sub-districts, as shown in Figs. 7-11, respectively.

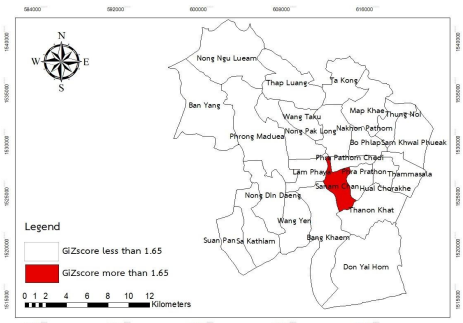


**Fig. 7.** Hot spots analysis of drunk driving cases in 2013.

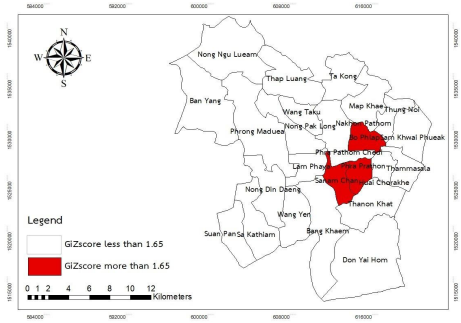


**Fig. 8.** Hot spots analysis of drunk driving cases in 2014.

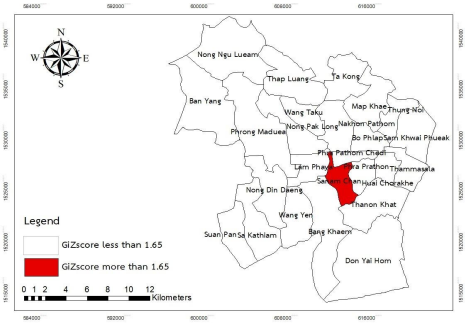


**Fig. 9.** Hot spots analysis of drunk driving cases in 2015.

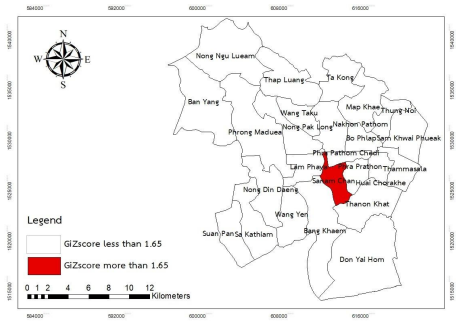


**Fig. 10.** Hot spots analysis of drunk driving cases in 2016.

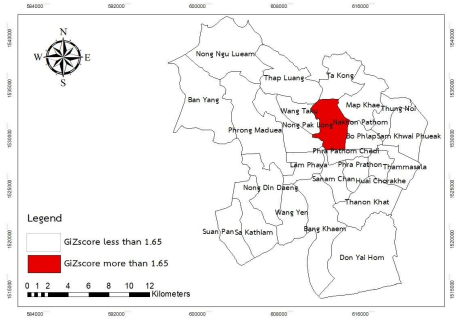


**Fig. 11.** Hot spots analysis of drunk driving cases in 2017.

### 4.3 Directional distribution of drunk driving cases

The directional distribution of drunk driving cases was analyzed using the Standard Deviational Ellipse tool. The analysis of the directional distribution of drunk driving cases in 2013 (see Fig. 12) showed a rotation of 65.08 degrees with the directional distribution in the East covering Sanam Chan Sub-district, Phra Pathom Chedi Sub-district, and Nakhon Pathom Sub-district. In 2014, the rotation was 70.35 degrees, with the directional distribution in the East covering the same districts (see Fig. 13) as found in 2013. In 2015, the rotation was 14.35 degrees, with the directional distribution in the South covering Nakhon Pathom Sub-district, Sanam Chan Sub-district, Phra Pathom Chedi Sub-district, and Huai Chorakhe Sub-district as seen in Fig. 14. Fig. 15 illustrates the directional distribution of drunk driving cases predicted in 2016. It was predicted that drunk driving cases would be towards the eastern part of the study area with a 90.98-degree rotation with the directional distribution in the East, covering Huai Chorakhe Sub-district, Sanam Chan Sub-district, Nakhon Pathom Sub-district, Lam Phaya Sub-district, and Phra Pathom Chedi Sub-district. In 2017, the rotation was 59.27 degrees with the directional distribution in the East, covering Huai Chorakhe Sub-district, Sanam Chan Sub-district, Phra Pathom Chedi Sub-district, and Nakhon Pathom Sub-district as shown in Fig. 16. Sanam Chan Sub-district, Phra Pathom Chedi Sub-district, Huai-Chorakhe Sub-district, Lam Phaya Sub-district, and Nakhon Pathom Sub-district are surrounded by areas of entertainment venues, off-premise and on-premise alcohol store, and alcohol checkpoints.

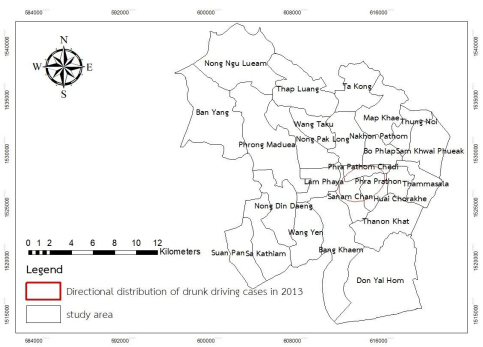


**Fig. 12.** Directional distribution of drunk driving cases in 2013.

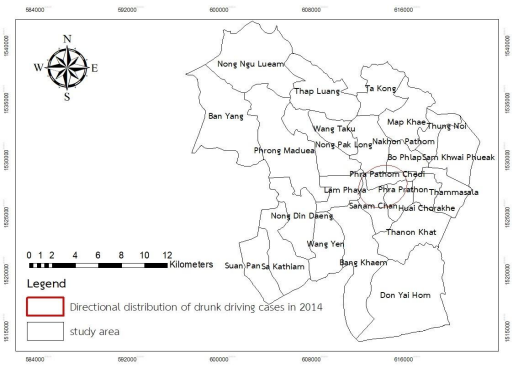


**Fig. 13.** Directional distribution of drunk driving cases in 2014.

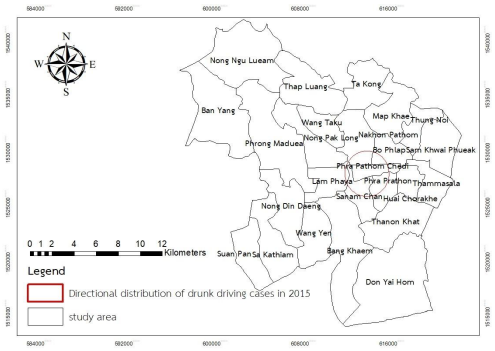


**Fig. 14.** Directional distribution of drunk driving cases in 2015.

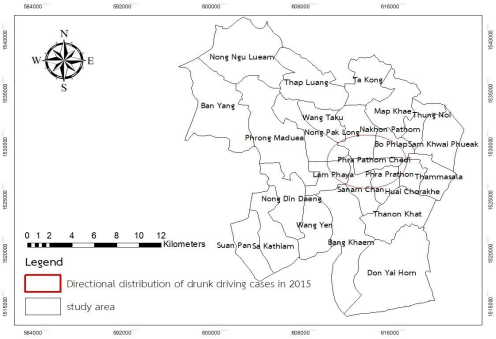


**Fig. 15.** Directional distribution of drunk driving cases in 2016.

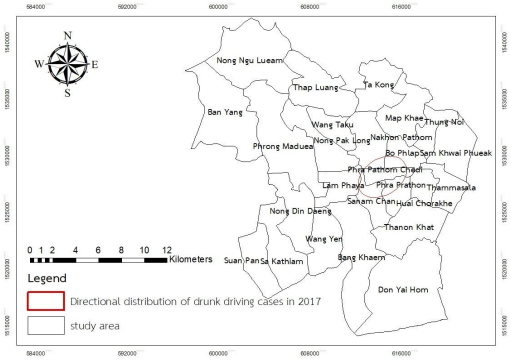


**Fig. 16.** Directional distribution of drunk driving cases in 2017.

**Table 2.** Analysis of drunk driving cases using the Standard Deviational Ellipse tool.

| Year | Rotation |
|---|---|
| **2013** | 65.06 |
| **2014** | 70.35 |
| **2015** | 14.35 |
| **2016** | 90.98 |
| **2017** | 59.27 |

### *4.3.1 Validation of drunk driving case predictions*

The validation of drunk driving case prediction was performed using the average rotations for five years (2013-2017) and rotation of drunk driving incidence in 2018. The results explained that the prediction for 2018 was 60.02, with the directional distribution in the East. Compared to the directional distribution of observed drunk driving cases in 2018, it was found that the rotation was 36.25 with the directional direction in the East while the deviation of estimated rotation was 23.77 degrees, representing an accuracy of 97.6%, as shown in Fig. 17 and Table 3.

**Table 3.** Validation of drunk driving case predictions.

| Year | Directional distribution (degrees) |
|---|---|
| predict cases in 2018 | 60.02 |
| Observed cases in 2018 | 36.25 |

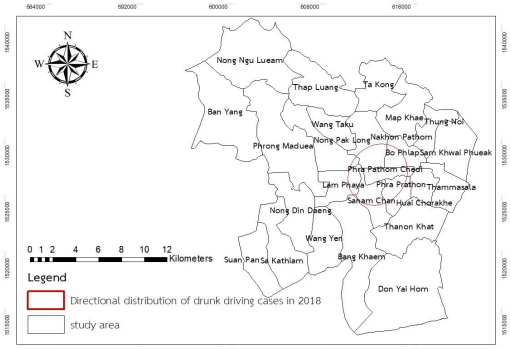


**Fig. 17.** Directional distribution of observed drunk driving cases in 2018.

### 4.4 The analysis of the relationships between Facebook posts related to geotagged entertainment venues and the incidence of drunk driving cases

The analysis of the relationships between Facebook posts related to geotagged entertainment venues and the incidence of drunk driving cases showed positive correlations between the incidence of drunk driving cases with the posts mentioning social gatherings, music events, and liquor promotion, with the correlation coefficients of

0.41 and 0.30, respectively. In Table 4, it elaborated that with more of posts mentioning liquor promotion and music events, there would be a lot of drunk driving cases.

**Table 4.** Relationships of incidence of drunk driving cases and Facebook posts with geotagged entertainment venues.

| Posts mentioning /Case | Drug | Drunk driving | Gambling | Possession of weapons | sexual assault | Robbery |
|---|---|---|---|---|---|---|
| **Event and ticket** | 0.03 | 0.16 | 0.08 | 0.01 | 0.00 | 0.00 |
| **music events** | -0.08 | 0.41 | 0.03 | -0.07 | 0.15 | 0.06 |
| **liquor promotion** | 0.01 | 0.30 | 0.05 | -0.11 | -0.03 | -0.02 |
| **Chill and relax** | -0.12 | 0.12 | 0.02 | -0.04 | 0.00 | 0.06 |
| **Total** | -0.08 | 0.37 | 0.07 | -0.07 | 0.05 | 0.06 |

Note: Row 1 shows crime incidence related to liquor surrounding Muang Nakorn Pathom between 2015 and 2017; column 1 shows the posts mentioning terms in Facebook statuses between 2015 and 2017; Columns 2-7 show the correlation coefficients between 2 variables. The coefficient approaching -0.1 indicates the reverse relationship between the two variables. The coefficient approaching +1.0 indicates a positive relationship between the two variables. The coefficient approaching 0 indicates no relationship between the two variables. The coefficient approaching -1 indicates a weak relationship between two variables in opposite directions.

**Table 5.** *P*-value and statistical significance of the correlation between the incidence of drunk driving cases and Facebook statuses related to liquor promotion and music events.

| *P*-value (alpha = 0.05) | Drug | Drunk driving | Gambling | Possession of weapons | Sexual assault | Robbery |
|---|---|---|---|---|---|---|
| **Event and ticket** | 0.60 | 0.00 | 0.14 | 0.92 | 0.97 | 0.95 |
| **Music festival** | 0.18 | 0.00 | 0.56 | 0.22 | 0.01 | 0.31 |
| **Liquor promotion** | 0.80 | 0.00 | 0.43 | 0.05 | 0.63 | 0.72 |
| **Chill and relax** | 0.04 | 0.03 | 0.72 | 0.48 | 0.98 | 0.31 |
| **Total posts** | 0.16 | 0.00 | 0.25 | 0.20 | 0.36 | 0.28 |

Note: Column 1 shows the terms in Facebook statuses, while Columns 2-7 show the p-value of correlation. In the hypothesis test, the p-value less than the significance level (alpha) at 0.05 indicated a significant relationship between the two variables.

## 5. Conclusion

Based on our research, we found a high number of drunk driving cases in the area around the university campus and business district. This is due to the large number of entertainment spots, liquor shops, and venues, as well as sobriety checkpoints in this sub-district. The percentage of drunk driving cases in Sanam Chan Sub-district is 41.23%, but it rises to 92.42% in the university campus and economy area. This area has many licensed and unlicensed establishments that sell liquor, and it also has the highest number of drunk driving cases in Sanam Chan Sub-district. Our analysis of the directional distribution of drunk driving cases showed that this problem is prevalent in Sanam Chan Sub-district and Phra Pathom Chedi Sub-district, which both have many entertainment venues with music performances and liquor sales. The study used Sentiment Analysis and Latent Dirichlet Allocation (LDA) techniques to investigate the relationship between geotagged Facebook statuses and drunk driving cases. The analysis found that most Facebook posts conveyed positive or neutral feelings. However, terms such as party, music, liquor, and promotion showed a significant positive correlation with drunk driving incidents, with statistical significance at $p = 0.05$. The study also found that the more terms related to alcohol consumption that appeared in Facebook posts, the higher number of drunk driving cases. However, this correlation was not strong as these terms are not exclusively used on Facebook. It's important to note that the study only analyzed public posts with geotagged establishments selling liquor and therefore, does not represent the total number of terms used. Additionally, the study did not consider other social media content such as images, stories, and emoji icons. It's worth mentioning that social media data may have biases towards certain groups, but its popularity makes it a valuable source of information. Therefore, this research aimed to explore the factors that may cause drunk driving related to social media.

Lastly, it's important to consider that Sentiment Analysis and Latent Dirichlet Allocation (LDA) are complex techniques, and their findings may vary depending on the parameters used. It is recommended that future studies cover other platforms, various factors, other methods with different parameters, and other study areas as the findings of this study are based on a single province in Thailand and may not be applicable to other populations or settings. Relevant agencies can use the results of this study to plan prevention measures and improve crime control policies. Law enforcement agencies can implement targeted patrols in areas with high concentrations of drunk driving cases based on this information. Additionally, public health campaigns can be developed to target specific groups, such as university students.

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