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E-PROCEEDING OF

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GREEN & SAFE CITIES
2022**

“Sustaining the
Resilient, Beautiful and Safe Cities
for a Better Quality of Life”

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“ **Sustaining the Resilient, Beautiful and Safe
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CRIME PATTERN ACTIVITIES BASED ON WEATHER CHANGES TOWARDS THE QUALITY OF LIFE

Anis Zulaikha Mohd Zukri¹, Siti Rasidah Md Sakip^{2*}, Suraya Masrom³
*Corresponding Author

^{1,2,3} Department of Built Environment Studies & Technology,
Faculty of Architecture, Planning and Surveying,

UiTM Perak Branch, Seri Iskandar Campus, 32610 Bandar Seri Iskandar, Perak.

³ Faculty of Computer and Mathematical Science,
UiTM Perak Branch, Tapah Campus, Perak.

zulaikhazukri15@gmail

*sitir704@uitm.edu.my.com

suraya078@uitm.edu.my

Abstract

Sustainable Development Goals (SDGs) are often associated with significantly improving the quality of life, encompassing economic, social, and physical well-being and development systems that ensure satisfaction. Furthermore, safety and security are closely linked to and introduced into the SDG planning policy to improve the community's quality of life. The gap in the paper is the weather is widely known to impact the environment. Still, it is uncommon to notice how weather change affects crime activity patterns and quality of life. A few kinds of literature investigating empirical studies have also focused on social consequences, particularly migration and social conflict. However, criminal cases are also one of the factors to the quality of life. Studies linking crime and the environment are tremendously established. Thus, this paper identifies the pattern of criminal activity based on weather changes to address this situation. In addition, according to several previous research studies from various regions around the world, research on weather and crime was found to have a significant correlation. Thus, weather can be used as an instrumental variable to study the impact of crime on various variables, including indices of quality of life, property value and economic growth. In this paper, the research methodology uses quantitative data. The data were gathered from the Royal Malaysian Police (RMP) and the Meteorological Department for Selangor, Kuala Lumpur and Johor from 2011 to 2020. RMP provide a property dataset divided into six categories: theft, vehicle theft, motorcycle theft, van/lorry/truck theft, snatch and burglary. The Meteorological Department provides a temperature and humidity dataset for the weather data. The data were analyzed using SPSS statistical and illustrated in the bar graph method to identify the pattern and relationship between weather and crime. Further research needs to be done to better enhance research results by studying current data and patterns of weather and crime to correlate the relationship between crime and weather towards the quality of life.

Keywords: *Property Crime, Weather, Criminal Activity, Quality of Life*

INTRODUCTION

The factors that drive criminal activity have received much attention. Weather influences illegal activity (Horrocks & Menclova, 2011). Sustainable Development Goals (SDGs) are frequently associated with a better quality of life that incorporates economic, social, safety and security, environmental systems that assure satisfaction, healthy and productive

environment. A small body of literature empirically investigates the relationship between criminal activity patterns based on weather changes and quality of life. The potential role of weather in influencing criminal activity has caught the interest of researchers across the social sciences. There has been much empirical work in the last four decades that supports the idea that weather can be a determinant of criminal activity, though the mechanisms are still questionable (Agnew, 2012; Anderson, 2001; Butke & Sheridan, 2010; Cohen & Felson, 1979; Horrocks & Menclova, 2011; Ranson, 2014; Rotton & Cohn, 2000).

The thought of weather is to have an impact on criminal activity. Most research into the relationship between crime and weather supports the theory that weather impacts criminal activity (Muratya, 2013). In addition, in their study, Horrocks & Menclova (2011) in their study found that the weather could predict criminal activity. Therefore, the crime prediction would be a valuable tool for police in their effort to allocate resources. The gap in this paper is the weather is widely known to impact the environment. Still, it is uncommon to notice how weather change affects crime activity patterns and quality of life. The argument of weather it will increase strain, reduce social control, weaken social support, foster favourable beliefs, contribute to crime traits, increase specific opportunities for crime, and create social conflict (Agnew, 2012). Addressing weather into the patterns of criminal behaviour can provide significant empirical evidence for criminal behaviour models. The weather could also be used as an instrumental variable in studies of the effects of crime on various variables such as property prices, quality of life indices and economic growth. Furthermore, the weather could predict criminal activity, which would be a helpful tool for police in their resource allocation effort.

To answer the research question on how criminal activity changes due to weather changes, this paper aims to identify a pattern of criminal activity based on weather changes to address this situation and determine which variables are empirically verified. This analysis draws on recorded data to estimate crime activity patterns based on weather changes. To support the study, the researcher has constructed a panel dataset that includes yearly and monthly crime and weather data for three states from 2011 to 2020. In addition, the researcher will use quantitative data to be analyzed. Statistical analyses were employed to identify the crime activities pattern between weather conditions and crime. The data on criminal activity are drawn from Royal Malaysian Police (RMP) data. These data, which are based on the yearly and monthly reports from RMP, tabulate offences in six (6) major property crime categories; (1) theft; (2) snatches; (3) vehicle theft; (4) motorcycle theft; (5) van, lorry, and truck theft; and (6) burglary. Next, researchers merge these data with temperature and humidity yearly and monthly dataset records from the Meteorological Department Malaysia of Malaysia. After combining these two data sources, the researcher generates a dataset with year-by-month observations.

This study has a limitation in the context of coverage and data collection. The data covers three states in Peninsular Malaysia: the federal territory Selangor, Kuala Lumpur, and Johor. Due to the limitation, only some locations are related to the weather data and crime. The data collection for crime RMP provided the data according to the area by contingent, meanwhile the data collection for weather that Meteorological Department has provided according to the station. Also were limited to daily data for the crime index.

LITERATURE REVIEW

Crime Theory and Criminal Behaviour

Criminal activity patterns and the factor driving it has received much attention. For example, one factor that is believed to affect criminal activity is the weather. Theories of crime and criminal behaviour have focused on individual personality traits which 'predispose' people to commit the crime while ignoring the situational contexts and the differences between types

of crimes (Cohn, 1990). However, the routine activity theory (Cohen & Felson, 1979) examines the relationship between these variables and criminal behaviour. Routine activity suggests that individuals' activities and daily habits are rhythmic and consist of repeated patterns over time.

Research Routine Activity Theory (RAT) commonly explains the link between weather conditions and crime (Cohen & Felson, 1979). As opposed to other crime theories that explain offender motivations, RAT considers the situational components necessary to create opportunities for crime at a given time and place (Corcoran & Zahnow, 2021). RA theory attributes the crime to three interacting factors: (1) motivated offender, (2) attractive target (for the offender), and (3) the absence of capable guardianship. The weather can modify an individual's routine legitimate activities and alter crime opportunities' spatial and temporal distribution (Corcoran & Zahnow, 2021). In the framework of RA theory, the higher but not extreme temperature is likely to increase mobility and social interaction, increasing the likelihood of a suitable target occurring and hence more possibilities of crimes (Shen et al., 2020).

Weather conditions such as temperature, rain and wind impact participation in outdoor activities that occur in public spaces. Weather changes can influence individuals' propensity to contact others and increase or decrease the potential for opportunistic, interpersonal crimes such as assault (Chen & Ng, 2012, as cited by Corcoran & Zahnow, 2021). However, changes in the surrounding environment may result in changes in behaviour and activities. For example, people tend to spend time outdoors during pleasant weather, resulting in more significant opportunities for personal interaction and increased availability of victims. Thus, it is reasonable to anticipate that "pleasant" weather will be associated with increased property crime and may expect pleasant weather to be associated with more property crime.

On the other hand, inclement weather, such as cold ambient temperature, reduces the number of people available as victims, as people tend to stay off the street during bad weather. Those few individuals outdoors during unpleasant weather are more vulnerable as there are fewer potential witnesses to deter the criminal (Cohn, 1990; Horrocks & Menclova, 2011). The Routine Activity Theory supports the notion that weather affects criminal behaviour to crime.

Temperature and Crime

Several field studies have been conducted over the past twenty years examining the correlation between heat and crimes. The majority of the weather-crime-related studies have focused on the role of temperature affecting crime, particularly violent crime (Habibullah, 2017). For example, earlier studies by Anderson (1989) and Cotton (1986) show that temperature positively affects violent crime and other types of aggressive behaviour. Furthermore, Trujillo & Howley (2021) found a significant correlation between crime and weather since their research matched with other studies. In addition, they stated a significant relationship between temperature and various categories of criminal activity.

On the other hand, Corcoran & Zahnow (2021) found that higher daily temperatures are associated with an increased tendency for assault at the neighbourhood level. Finally, Cohn & Rotton (2000) analyze burglary and theft in Minneapolis over two years using calls for service to measure criminal activity. They find that theft is negatively correlated with temperature, and burglary and robbery are positively correlated with temperature.

In addition, Field (1992) found a positive relationship between higher temperatures and property crime. Field (1992) stated that people tend to stay outside their house to spend more time when the temperature increase. Property crime rates increase when people intend to stay outside more, such as vehicle theft and burglary. Additionally, Horrocks and Menclova (2011) studied the relationship between property crime and weather. They discovered that when the weather is 'good', people are likelier to be absent from their homes, enabling robbery and burglary to occur without a guardian. According to Horrock and Menclova's (2011) study

analysis, criminal activity can also reduce the crime rate in terms of property crime when the weather is in 'bad' condition because criminals are less motivated to perpetrate the crime.

The comprehensive study between temperature and crime showed a positive and significant relationship in criminal activity patterns. However, a few studies do not support the relationship between crime and weather. Ranson (2014) even proposed that the relationship between property crimes (such as burglary and theft) and temperature is highly nonlinear.

Humidity and Crime

Tompson and Browsers (2015) as cited by Habibullah (2017) found that temperature, wind speed, and humidity are significant predictors of robbery during the night shift and weekends Strathclyde region of Scotland. While rain negatively correlates with theft on weekends, people are less likely to venture outdoors when it rains, and travel behaviour is optional.

In addition, Lab & Hirschel (1988) study examined the relationship between humidity and the property crimes that occur during the day. Show the number of property crimes decreases as the humidity increases. However, the property crime that occurs during the night indicates that property crime is more prevalent in low humidity (Lebeau, 1988). Lab and Hirschel (1988) conclude that humidity appears to exert the overriding influence on crime in general.

On the other hand, according to Cohn's study, only Rotton & Frey (1985) appear to have examined the influence of humidity on crime. Although they found no significant relationship between humidity and domestic violence, they found a slight negative correlation between daily humidity and the assault rate.

The Relationship Between Weather and Property Crime

Criminal activity can also reduce the crime rate in terms of property crime. After all, it is challenging to do so in inclement weather. Additionally, properties are more likely to be occupied by the homeowner during the 'bad' weather. It is somewhat ironic that recent research on climate and crime has focused almost exclusively on the crime of violence (e.g., Harries & Stadler, 1983, 1988; Bell, 1992; Cohn, 1993, 1996; Cohn & Rotton, 1997; Anderson & Anderson, 1998) as cited by (Rotton & Cohn, 2000). Unfortunately, very little is known about the relationship between weather and the property crime of burglary, robbery, and larceny-theft. According to Rotton & Cohn (2000), generally inconsistent and sometimes contradictory results characterize climate and property crime literature.

In contrast, another previous study by Lab and Hirschel (1988), as cited by Rotton & Cohn (2000), found a small positive relationship between temperature and property crime (burglary and theft) in Charlotte during the daylight bot, not night-time hours. Lan and Hirschel also found a positive relationship between property crime and humidity.

To summarise, the literature is ambiguous about the effect of temperature and humidity on property crime. The crime and weather literature has consistently shown that weather exerts an essential influence on crime. This relationship varies in direction and strength, dependent on crime types and the specific weather variable under examination. This study emphasizes wanting to see patterns of crime and weather criminal behaviour.

METHODOLOGY

This research methodology included crime and weather variables and used quantitative data approaches. These studies were conducted in three Malaysian states with higher crime indices: The quantitative data used in this research consisted of the information provided by the Royal Malaysia Police (RMP) crime report, which is a statistic crime. The data were obtained yearly and monthly on recorded crimes.

Since 1999 the number of crime indices has continuously increased yearly. Selangor and Kuala Lumpur are the areas that recorded the highest number of crime indices. However, from 2002 to 2004, there was a slight decrease in index crime (Ibrahim & Haji Abd Rahman, 2021). However, after 2004, the crime index continued to rise; one of the reasons for this was population growth and socio-economic changes such as the recession, which increased unemployment and poverty. From 2011 to 2020, the Malaysian crime index is shown in Table 1.

The total index was successfully reduced with the PEMANDU Unit and NKRA from 2011 to 2019 (see Table 1). The Prime Minister's Department is responsible for establishing the *Performance Management and Implementation Unit (PEMANDU)* and *National Key Areas-NKRA*, which aim to reduce crime (Ibrahim & Haji Abd Rahman, 2021). This establishment was established in September 2009. This establishment aims to lead change in the country and ensure a successful national transformation program. However, the number of crimes is declining from the end of 2019 to 2020 due to the global spread of the COVID-19 pandemic, and the Movement Control Order (MCO) required all people to stay at home.

From Table 1, the states of Johor, Kuala Lumpur, and Selangor have the highest crime index out of the 14 states in Malaysia, respectively. The data covering the three states: Johor, Kuala Lumpur, and Selangor, for ten years from 2011 to 2020, and several property crime categories are available.

Table 1

Property Crime Data in Johor, Kuala Lumpur and Selangor

State	Year	Theft	Vehicle Theft	Motorcycle Theft	Lorry/Van/Truck Theft	Snatch	Burglary
Johor	2011	3811	2006	7571	479	76	2598
	2012	2910	1738	7731	590	38	2219
	2013	2322	2188	6754	776	28	1798
	2014	2216	1686	6052	552	40	1603
	2015	1934	1592	5595	473	33	1440
	2016	2073	1443	4686	400	44	1475
	2017	2032	1097	4104	274	11	1211
	2018	2021	1035	3881	278	4	1239
	2019	1908	981	3471	219	4	1364
	2020	1403	802	2347	141	0	1273
Kuala Lumpur	2011	4497	3326	5692	664	951	3480
	2012	3910	3359	5693	549	384	2838
	2013	3391	3281	5459	688	214	2506
	2014	3133	2481	4469	548	593	2118
	2015	2995	2229	4015	524	604	1907
	2016	3595	2104	3864	495	1288	1867
	2017	3121	1548	3328	291	7	1188
	2018	3118	1482	3030	253	3	1104
	2019	2729	1423	2763	254	2	1087
	2020	2057	1000	2200	147	0	949
Selangor	2011	5941	6389	12957	1653	799	8422
	2012	4437	5792	13285	1757	725	6337
	2013	5147	5832	12653	2049	984	7742
	2014	4675	4723	10688	1648	845	6184
	2015	4157	3932	9794	1326	950	5805

2016	4793	3309	8890	1140	983	5497
2017	3951	2586	7945	844	140	4133
2018	3638	2358	6510	654	87	3515
2019	3514	2204	5503	595	3	3679
2020	3753	1544	4337	374	0	3025

Source: Royal Malaysia Police (2022)

Table 1 shows the property crime variable data with different categories of constructed data, namely theft, snatch theft, vehicle theft, motorcycle theft, lorry/van/truck theft and burglary.

The weather variables are essential to measure and organize the different types of crimes committed. Overall, the weather variables used to conduct this research are temperature and humidity. Daily, monthly, and yearly weather data were obtained from the Meteorological Department from 2011 to 2020. Weather variables were collected daily temperature in (°C) and total mean humidity in (%). In addition, crime observation in each district related to this research and a corresponding weather observation had to be found. This was done by matching and merging the police location district to the nearest weather station (s).

While there are many police stations and weather stations in Johor, Kuala Lumpur, and Selangor, finding the appropriate and suitable data was complicated because not all the weather stations matched the location of police station data records.

Our analysis illustrates in a bar graph chart to show the criminal activity pattern. The first researcher illustrates a bar graph between temperature and property crime. Second, the researcher demonstrates of humidity of weather conditions with property crime. Property crime divides into six categories (theft, vehicle theft, motorcycle theft, lorry/van/truck/ theft, snatch, and burglary) according to Royal Malaysia Police record data from 2011 to 2020. For all analyses, researchers used the statistical analysis in SPSS. Kaur et al. (2018) stated that when conducting research statistics analysis, statistical analysis is a first step run before proceeding with inferential statistics.

RESULTS

Statistical analyses are shown in Figures 1 and 2. The researcher initially constructed a figure depicting the relationship between crime and weather over the past ten years of record data. Next, constructed a figure of the criminal activity patterns between mean monthly and yearly temperature and humidity and the proportion of victims in property crime.

The Temperature-Property Crime Activity Pattern

Researchers illustrate the criminal activity pattern between temperature and property crime rates in Figure 1. A bar graph was used to indicate a line of best fit in each case. The first graph in Figure 1(a) shows the relationship between temperature and theft crime. Observation between January 2011 to December 2020 for theft crimes showed a total of 25,928 theft crimes reported during this period. The vehicle theft, there were a total of 18,363 crimes reported, 43,961 crimes reported for motorcycle theft, 4,734 crimes reported for lorry/van/truck theft, 2,608 crimes reported for snatch crime and 22,617 crimes reported for burglary. Researchers observed a relationship between temperature and theft crime (Figure 1 (a)). The researcher observed from the graph analysis that the theft rate is high between 25.0 °C and 28.0 °C with the ambient temperature.

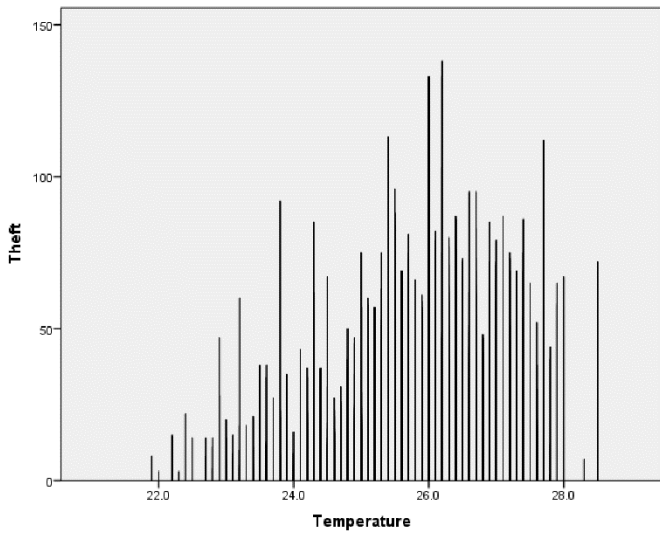


Figure 1(a): Temperature and theft crime pattern

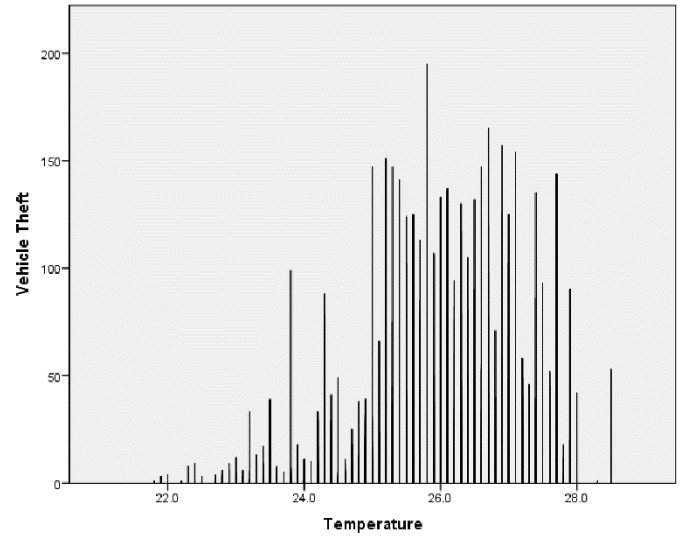


Figure 1(b): Temperature and vehicle theft crime pattern

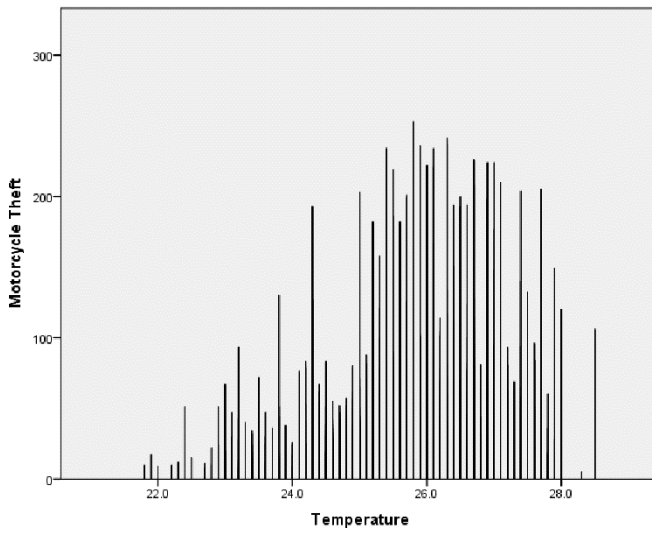


Figure 1(c): Temperature and Motorcycle theft crime pattern

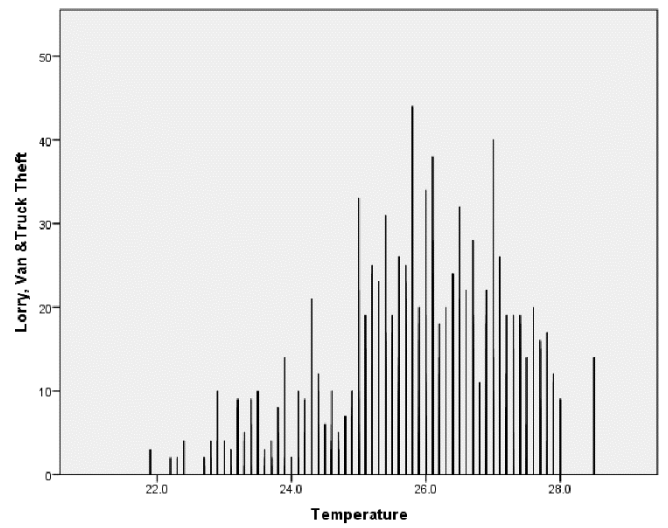


Figure 1(d): Temperature and lorry/van/truck theft crime pattern

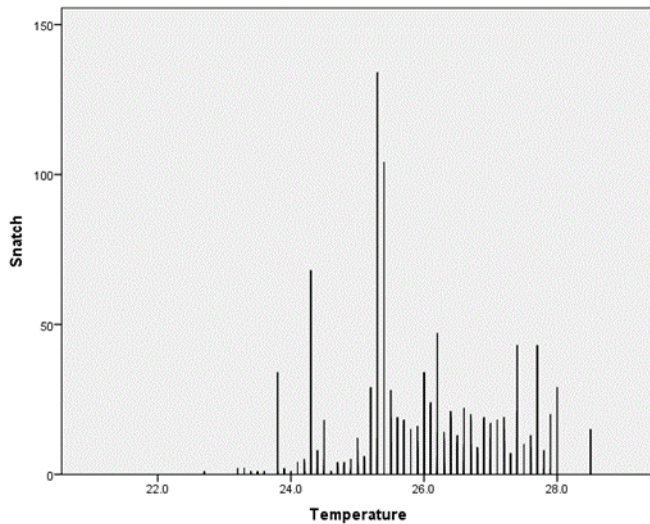


Figure 1(e): Temperature and snatch crime pattern

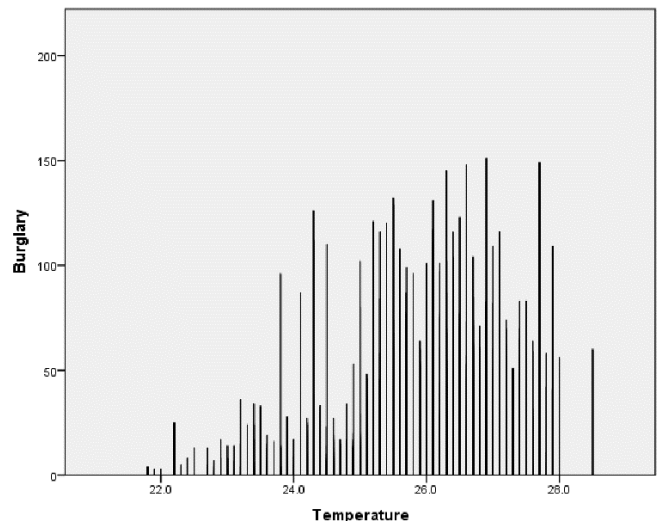


Figure 1 (f): Temperature and burglary crime pattern

Temperature and vehicle theft, motorcycle theft and lorry, van and truck theft were significantly related to ambient temperature. It shows that temperature between 25.0 °C to 28.0 °C influences vehicle theft (Figure 1(b)), motorcycle theft (Figure 1(c)) and lorry/van/truck theft (Figure 1(d)). The graph illustrated the visual of the pattern of crime alongside key weather variables for temperature. In addition, for the snatch crime (Figure 1(e)), based on the figure at the above-described temperature of 25.0 °C snatch rate is higher than other categories of crimes. Meanwhile, there is a relationship between the criminal activity pattern for the temperature and burglary (Figure 1(f)) illustrates the higher number of burglary cases between 26.0 °C and 28.0 °C. Since there is six property crime in the above bar graph, temperature changes can also influence property crime rates. Based on the bar graph above, all types of property crime appeared between temperatures reaching 25.0 °C.

The theft (Figure 1(a)) and burglary (Figure 1(f)) were found to have a relationship with ambient temperature in this study. A study reflects the findings and results of the analysis (Horrocks & Menclova, 2011). In the meantime, only burglary incidents showed a positive correlation between temperature and burglary in the study that Rotton and Cohn (2000) carried out. Their research looked at the relationship between the two variables. This is since there was a negative correlation between temperature and theft crime in the study they carried out.

In addition, the correlation between temperature and snatch produced both nonlinear and inconsistent results. When Anderson and Anderson (1984) examined the daily rate of non-aggressive crime, which included robbery, they found insignificant results when they looked at the overall crime rate. This study was based on their findings. Whereas Hu et al. (2017b) stated a more complex relationship such as nonlinear between temperature and theft.

The Humidity-Property Crime Activity Pattern

The humidity pattern trends of property crime rates are shown in Figure 2. In this figure, property crime rates show uneven but downward trends. We conducted a statistical analysis and found the turning points, namely, 60% to 70% for relative humidity. The statistical analysis is utilized for analyzing the criminal activity pattern trends within six property crime categories. In Figure 2, theft (Figure 2(a)), vehicle theft (Figure 2(b)), motorcycle theft (Figure 2(c)), lorry/van/truck theft (Figure 2(d)), and burglary (Figure 2(f)) show the observed highest

crime rates in between 60% to 70% relative humidity conditions of weather. The snatch shown in figure 2(e) was a turning point for the snatch rate at 59% to 70% of relative humidity.

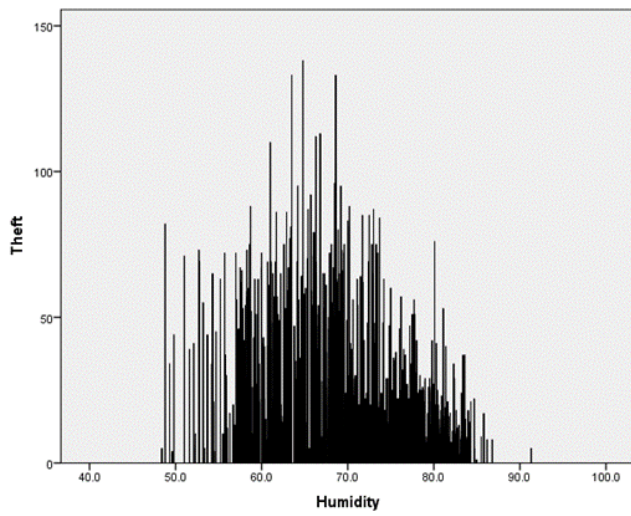


Figure 2(a): Humidity and theft crime pattern

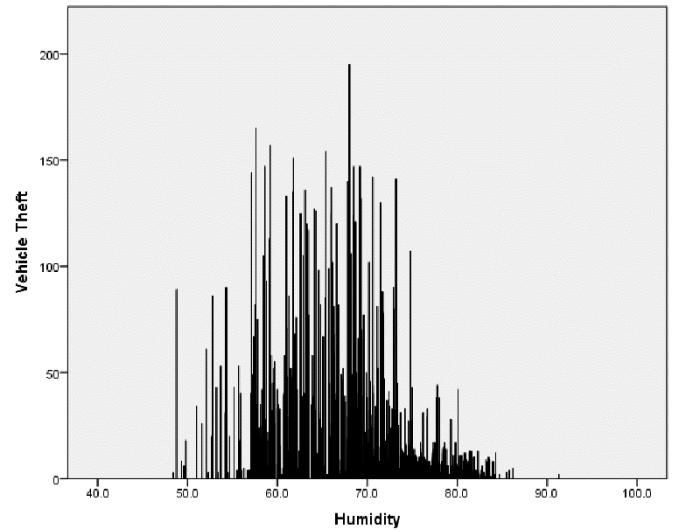


Figure 2(b): Humidity and vehicle theft crime pattern

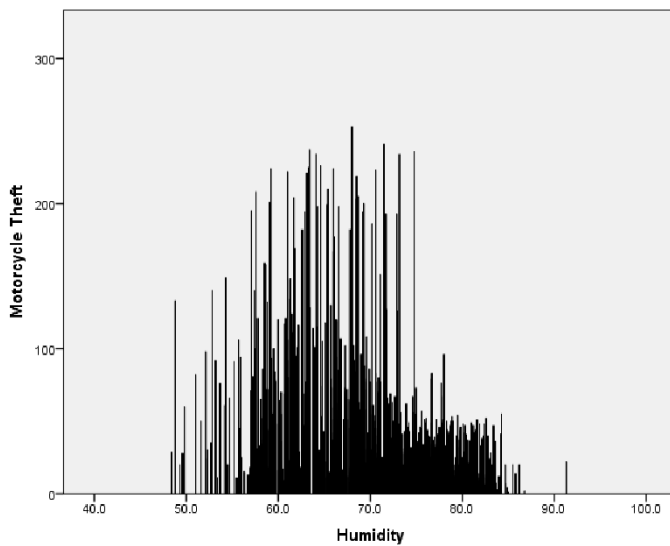


Figure 2(c): Humidity and motorcycle theft crime pattern

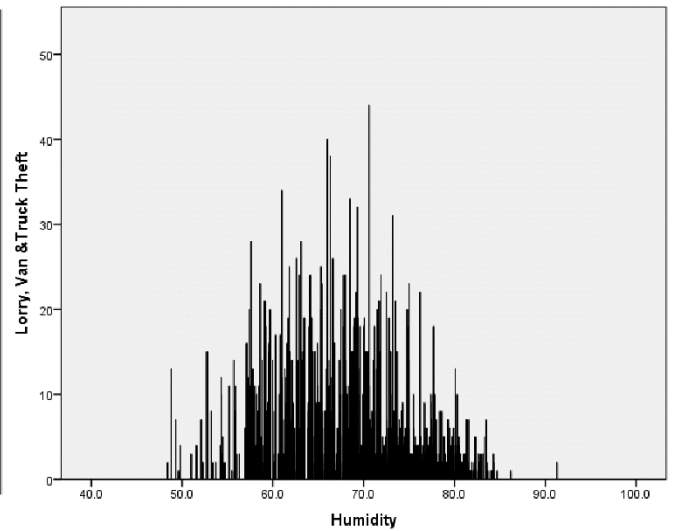


Figure 2(d): Humidity and lorry/van/truck theft crime pattern

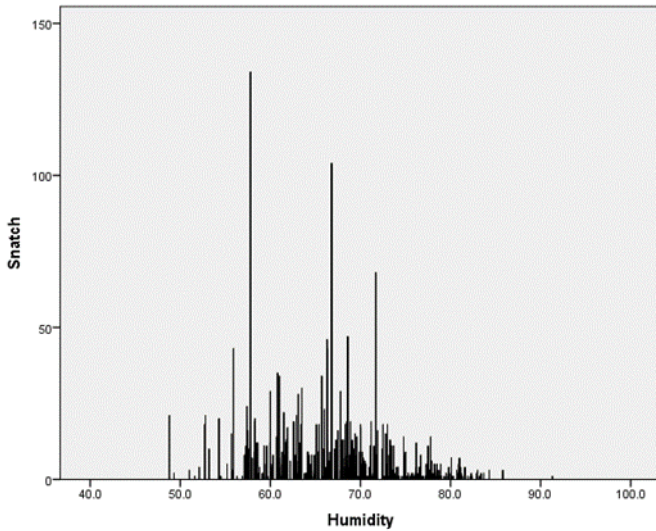


Figure 2(e): Humidity and snatch crime pattern

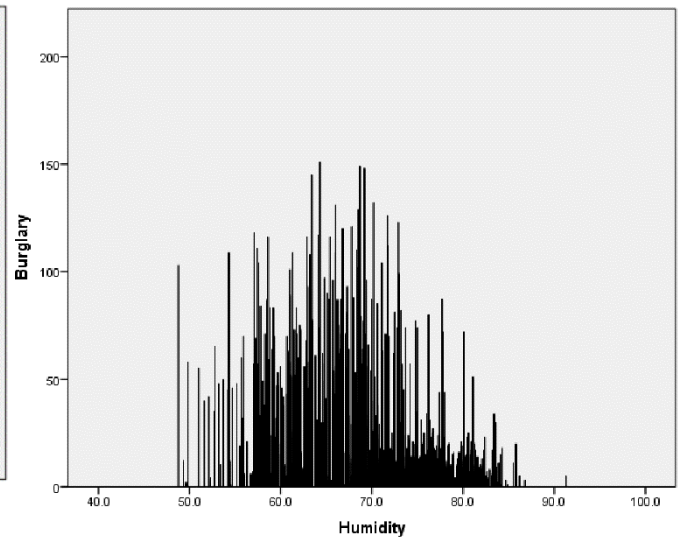


Figure 2(f): Humidity and burglary crime pattern

There has been a growing body of work to support the suggestion that humidity can be an essential factor in explaining variation in criminal activity patterns. However, previous findings relating to humidity and property crime link may not apply to contributions like Johor, Kuala Lumpur, and Selangor (area in the state's urban area where the population growth is the highest among other states in Malaysia). This stands in contrast to the more criminal activity pattern and humidity.

Additionally, there has been a growing body of work to support the suggestion that weather can be an essential factor in explaining variation in criminal activity patterns. However, previous findings relating to a link of weather crime may not apply to contributions like Johor, Kuala Lumpur, and Selangor (area in the state's urban area where the population growth is the highest among other states in Malaysia). This stands in contrast to the more criminal activity pattern and weather changes.

In addition, regarding the contribution of Sustainable Development Goals (SDGs) for this finding in this paper researcher decided to focus on only two related goals and will be used as a guideline, namely SDG number three (SDG-3) for good health and well-being, and SDG number eleven (SDG-11) sustainable cities and communities. The concept of quality is highly relevant when considering sustainable development. It may argue that the quality of life reflects the social dimension for sustainable development. However, it does not imply that quality of life is affected by social conditions only. But also, quality of life may be affected by economic, social, and environmental conditions. Since sustainability implies a balance between environmental, social, and economic equalities, policies that seriously decrease an individual's quality of life can hardly be called sustainable (Serag El Din et al., 2013).

However, people cannot control the weather. Still, we could predict the criminal activity, which would be a helpful tool for police in their resource allocation effort and could improve the quality of life-based on the weather changes.

CONCLUSION

This paper identifies the crime activity patterns based on weather changes on criminal behaviour in response to weather changes and has yielded few conclusions. Theft and burglary appear to be related to temperature. However, they grow at ambient rather than high temperature, at least up to around 28°C. Snatch does not appear to be linked to high

temperatures. In general, most violent crimes against people rise in lockstep with temperature, although property crime is unaffected by changes in temperature.

The research on humidity is related to motorcycle theft, vehicle theft, lorry/van/truck theft and burglary. Meanwhile, criminal behaviour of snatch and humidity is uncertain. However, this study found that non-aggressive and property crimes are less influenced by emotions, explaining why high temperatures do not affect these crime rates.

Our study makes several significant contributions despite limited coverage and data collection. Most importantly, we use an extensive and detailed dataset and demonstrate that the criminal activity patterns between crime and weather remain relevant to different model specifications. Furthermore, our empirical result is consistent with our theoretical framework and previous studies.

This study sets the path for future crime-weather research in various directions. The first would be to discover the relationship between crime patterns and weather for quality of life. The study focuses more on crime and weather on people's quality of life. The second is to develop a framework for crime prediction of criminal acts based on weather towards the quality of life. Future research on the relationship between crime and weather towards the quality of life of people must be theoretically grounded and use measures of crime and weather that are justified by the quality-of-life index theory. The data analysis should employ more advanced statistical techniques, such as correlation analysis and spearman or Pearson.

Currently accepted theories of criminal behaviour support the belief that weather may significantly affect some types of criminal behaviour and pattern. However, more research into the relationship between crime patterns and weather is required to include these variables in new explanations of fluctuating crime rates, improving our ability to predict criminal activities based on weather changes. A recommendation to further enhance the accuracy of this study would be to update the data that has currently been obtained. Studies of this nature are an essential baseline; however, further research needs to be done to better enhance research results by studying current data and patterns of weather and crime to correlate the relationship between crime and weather.

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Tarikh : 20 Januari 2023

Prof. Madya Dr. Nur Hisham Ibrahim
Rektor
Universiti Teknologi MARA
Cawangan Perak



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