Spatio-Temporal and Hotspot Analysis of Crimes in Sharki and Gharbi Police Stations, District Peshawar, Khyber Pakhtunkhwa (2015-2016)

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Abstract

The technological advancement in computer mapping coupled with Geographic Information System (GIS) enables researchers to geo-visualize the spatial and temporal pattern in data. The present study is an attempt to analyze the spatial and temporal distribution of crime in the Sharki (East Cantonment) and Gharbi (West Cantonment) police stations of Peshawar city for 2015-2016. Besides, it also aims to delineate the hot spots. The crime data was collected from the Sharki and Gharbi police stations for 2015 and 2016. The analysis of crimes by type reveals a total of 55 cases of different crimes were reported to Gharbi police station during 2015-16, the majority of which were narcotics and drug-related crimes. In the Sharki police station, a total of 90 crimes of different nature were reported the majority of which were vehicle lifting, followed by snatching. The spatial analysis of crimes suggests that in Gharbi police station most of the crimes were reported from the Saddar area specifically from Peshawar Club and PIA building area. As for as the Sharki police station is concerned, the majority of crimes were reported from the Civil quarters, Dabgri, and ShubaBazar area. The hourly distribution of crimes suggests that most of the crimes were committed from 12 p.m to 4p.m. The seasonal distribution of crime reveals that the majority of crimes in both Gharbi and Sharki police stations were committed in summer. Hot spots analysis suggests two hot spots, in the study area. For effective controlling of crimes, it is recommended that GPS should be provided to Police for collecting exact location data for effective crime mapping and analysis to identify hotspots and increase the policing in those areas to control crimes.

Keywords: Crimes, Spatial Distribution, Temporal Distribution, seasonal distribution, Crime Hotspots, GIS

Introduction

The researcher's interest in the geography of crime is not new. Crime and fear of crime are important aspects of daily life and as such are the domain of human geography (Schurmansand and Maesschalck, 2010; Solymosi et al., 2020). The geography of crime studies the relationship between crime, Space, and society as the occurrence of crime show strong spatial variations. The distribution of crimes has been studied regarding the theories of human ecology, land use, built environment, commercial land use, and pattern of urban agglomerations and management (Yarwood, 2015).

The human ecology viewpoint evolves into more narrowly focused, location-based theories of crime, notably the regular

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activities hypothesis. This hypothesis is useful for explaining the function of location in the prevalence of crime. In the scenario of the target-rich setting for theft, or unsecured goods that may be utilized for illegal activities like drug usage, the site may give an abundance of criminal possibilities. Cohen and Felson presented this idea in 1979, and Brantingham and Brantingham, used it as criminal pattern theory (1993). The site or physical/built environment may impact the social control of the police in two ways: first, the site or physical/built environment can affect the social control of policing, and second, the everyday activities that occur there. High-rise buildings, for example, enhance population density while physically removing residents from street-level surveillance (Newman, 1972). While testing the proximity hypothesis, Roncek and Francik (1981) discover a high crime rate in and near public housing. The analysis shows that the institution itself is a source of crime. 1994). The crime rate increased in regions with target-rich settings, such as car theft from vast parking lots or robberies of consumers in high-traffic areas and commercial districts (Brantingham and Brantingham, 1982). Similarly, abandoned houses and slums can attract illicit drug traffickers (Erk, 1994; ErkandWeisburd, 2015).

Other areas appear to be more prone to crime because of the sorts of individuals they attract and repel. Places with abandoned buildings or dilapidated homes with absentee owners are appealing to illicit drug traffickers searching for steady marketing venues without the worry of owner or neighbor objections (Eck, 1994). Crime is never spread equally or arbitrarily across space (Erk et al., 2005; Paynich and Hill, 2010). Some places see more crime than others, and some areas record a different type of crime than others. Delineating and producing hotspot maps or high crime regions is an important and effective tool for combatting crime and policing (Ratcliffe, 2004). Crime hotspots are areas with a high density of crime. The primary goal of hotspot analysis is to examine crimes in connection to the geographical region in which they occur. There is no standard approach for defining and identifying hotspots; it varies depending on the quantity of data collected and the map's scale (Chainey and Ratcliffe, 2005; Boba, 2009; Solymosi et al., 2015). However, the National Institute of Justice (2010) states that there are two approaches foridentifying a hotspot i.e. through crime analysts in Geographic Information System (GIS) and statistical analysis.

Weather and climate are increasingly being recognized as major factors influencing human behavior (Carleton and Hsiang, 2016). Many scholars have shown a statistical link between climate and violence (Auliciems and DiBartolo, 1995; Miguel, 2005; Bergholt and Lujala, 2012; Ranson, 2014; Burke et al., 2015; Cianconi et al., 2020). Crime is a social activity, and almost every

human action is influenced in some manner by the weather, especially temperature. several weathers and crime-related research show that aggressive crime, such as domestic assaults, suicides, and violent assaults, is more prevalent during the summer (Bushman et al., 2005; Butkeandand Sheridan, 2010; and Brunsdon et al., 2009; Bakhsh et al., 2020).

The current study aims to examine the geographical and temporal distribution of crime in Peshawar's *Sharki* (East Cantonment) and *Gharbi* (West Cantonment) police stations from 2015 to 2016. Furthermore, it seeks to identify hotspots. The Peshawar Cantonment is served by the police stations of *Sharki* (East Cantonment) and *Gharbi* (West Cantonment). Peshawar Cantonment was founded in 1868 and has an area of 1968.45 acres. Cantonment had a total population of 68,755 in 1998, which increased to 70,741 in 2017. (GoP. 2017). Although the cantonment is located within Peshawar City District, it is an independent municipality under the control of the Military Lands and Cantonments Department of the Ministry of Defense. Figure 1 is showing the location of the study area.

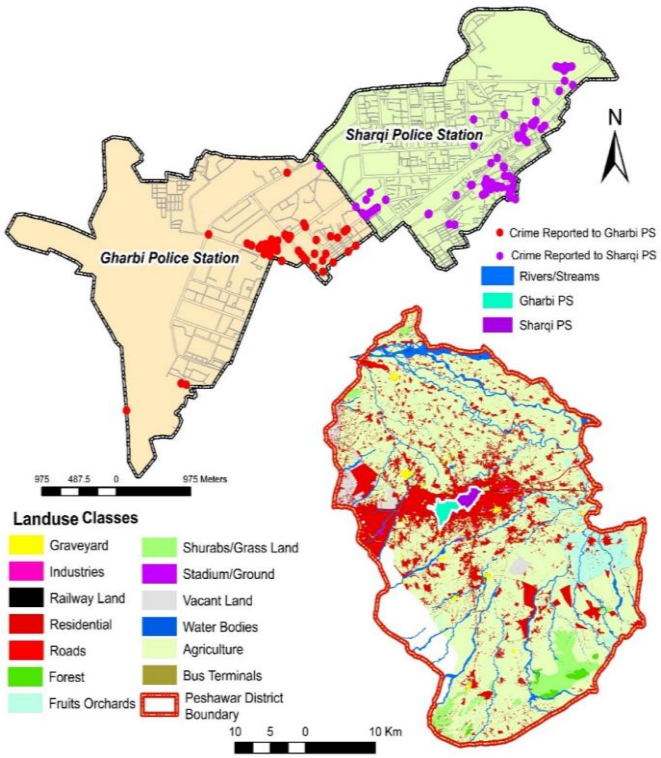

Figure 1: Police Station boundary and crime reported to *Sharki* and *Gharbi* Police Stations' inset map of Peshawar District showing location

Material and Methods

Study Area

The present study is entirely based on the data collected from both the *Sharki* and *Gharbi* police stations. The information gathered comprises the sort of crime, the location where it occurred, the day and time of occurrence, and so on. The map of the police station boundaries, on the other hand, was obtained from Police Line Peshawar, while the satellite imagery of Peshawar has obtained from SUPARCO regional office Peshawar. The image was classified, and a map of land usage/land cover was created.

The data were evaluated for a variety of reasons, including geographical, chronological, and seasonal distribution of crimes, as well as the identification of crime hot spots. The obtained police station boundary map was scanned and digitized in ArcMap 10.5.2 for this purpose. Following the creation of the geodatabase, a "crimes" point map was constructed, and the geographical distribution of various crimes was recorded with the help of a point on the map. Several properties of crime, such as location, time, date, kind, and so on, were recorded in the connected attribute table of point map "crimes." Finally, geographical, temporal, and hotspot maps were constructed, and data was tabulated and visually represented. The methodology adopted to achieve the study objectives is explained in figure, 2. The collected data was analyzed under the following parameters:

1. Spatial distribution of Crime
2. Temporal distribution of Crime
    a) Hourly Distribution
    b) Seasonal Distribution
3. Hotspot Analysis

Results and Discussion

Spatial Distribution of Crimes in Sharki Police Station

The obtained data is geographically examined to show how crimes are dispersed in space. The information gathered primarily consisted of car lifting, murder, attempted murder, stealing ordinance, and snatching. The geographical distribution of offenses reported to the *Sharki* police station is depicted in Figure 3. According to the findings, the majority of crimes occur in the civil quarters and *Shuba*Bazar. In the *Sharki* police station, a total of 90 offenses of various types were reported. Vehicle lifting is the most common crime, accounting for 48 percent of all offenses (out of a total of 90).

The majority of car lifting incidents were recorded in the *Shuba Khyber* Bazaar, and *Saddar* areas. These neighborhoods are not only densely populated during the day, but they also lack

dedicated parking places. Most of the time, the cars are left unattended along the roadways. *Shuba*Bazar is the largest concentration of spare parts shops not only in Peshawar but also in Khyber Pakhtunkhwa.

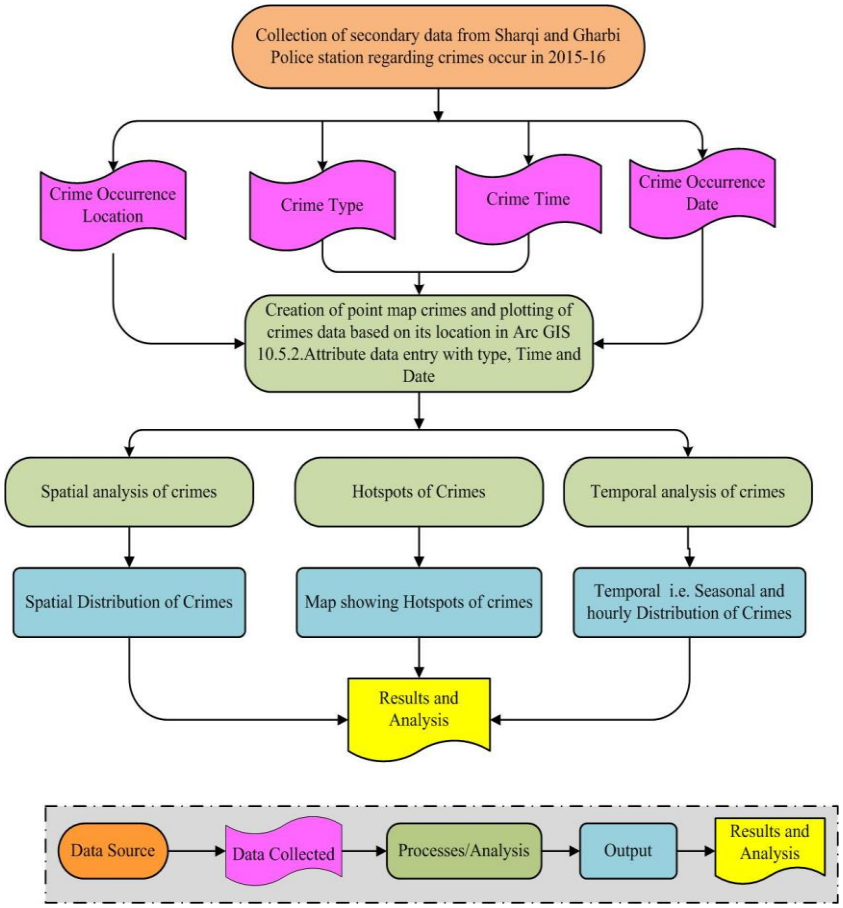

Figure 2: Flow chart showing Methodology adopted to achieve the study

Because of its proximity to the Khyber Agency and Afghanistan, it is one of the major marketplaces for stolen car components in the province of KP. The snatching of wallets/purses and mobile phones are the second most common crime reported to *Sharki* police station. A total of ten snatching crimes were recorded, all of which followed a similar pattern. According to the information gathered, murder has been recorded 9 times in the *Sharki* police station in Peshawar. Out of a total of 9 murder cases, 3 were reported from the *Balahisar* area, 2 from the *Saddar* area, 3 from the civil quarter's area.

Two of the seven attempted murder cases reported to *Sharki* PS were from civil quarters, while three were from the Peshawar district court area. The majority of attempted murders were recorded in district and session court jurisdictions. In the majority of cases, the victims were the persons who appeared in court for hearings. Table 1 and Figure 3 depict the spatial distribution of killings and attempted murders reported to *Sharki* Police Station in Peshawar during 2015-2016.

Table 1: Crimes Reported to Sharki Police station (2015-2016)
Source: Sharki Police station

S.no	Type of crime	Frequency	%age of total Crimes
1	Vehicle lifting	48	54
2	Snatching	10	11
3	Murder	9	10
4	Attempt murder	7	8
5	Threats	5	6
7	Hurts	4	5
8	Theft ordinance	4	5
9	Kidnapping	2	2
Total		89	100

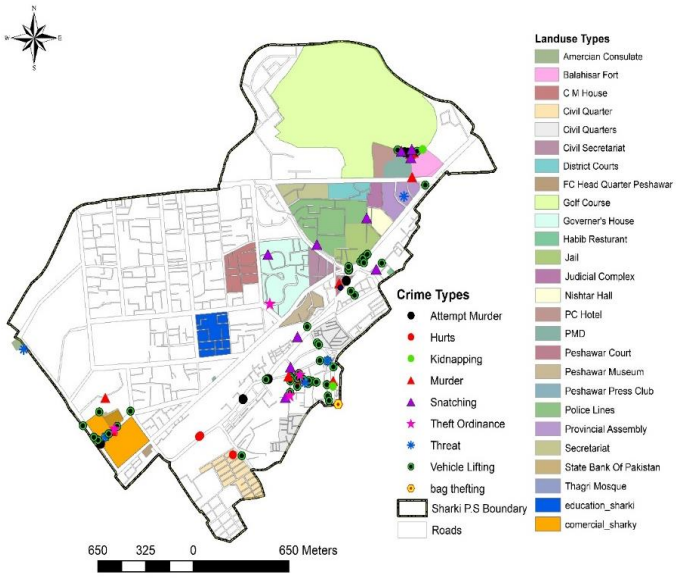

Figure 3: Sharki Police Station boundary and various crimes reported to Sharki Police Station, Peshawar.

Spatial distribution of crimes (2015-2016) Gharbi Police station

The majority of the area covered by the *Gharbi* police station border is commercial, with a high population density throughout the day. In 2015-16, a total of 55 crimes of various types were reported to *Gharbi* police station in Peshawar. Figure 4 depicts the spatial distribution of crimes reported to the *Gharbi* police station, while table 2 depicts the crime reported to the *Gharbi* police station.

According to the findings, the majority of the recorded incidents were narcotics-related. Out of a total of 55 occurrences, 22 were narcotics-related offenses, accounting for 35% of all crimes reported in 2015-16. Drug-related crimes are on the rise in Peshawar, particularly in the *Saddar* area, which is a commercial district with a high daytime population density. Aside from that, certain drug-related crimes have been recorded in the Peshawar club area. Theft, foreign act, and vehicle lifting were the crimes reported to *Gharbi* police station in Peshawar 13 times, 10 times, and 6 times, respectively. These incidents are primarily recorded in the Peshawar club area. The primary reason appears to be high daytime population density.

Table 2: *Spatial distribution of crimes (2015-2016), Gharbi Police station*
Source: Gharbi Police station

S.no	Type of crime	Frequency	%age
1	Narcotics	20	35
2	Theft ordinance	13	24
3	Foreign act	10	18
4	Vehicle lifting	6	11
5	Hurts	2	4
6	Snatching	2	4
7	Flirt	1	2
8	Murder	1	2
Total		55	100

Temporal distribution of crimes

The collected data were examined on an hourly basis, to establish the time of day when the majority of crimes occur. The 24-hour day was divided into six time periods for this reason (table 3), and the crime that happened in each period was plotted against the kind of crime (figure 5). According to the findings, the bulk of crimes occur/are reported between the hours of 12 p.m. and 4 p.m. At this time of day, 32 different types of offenses were recorded.

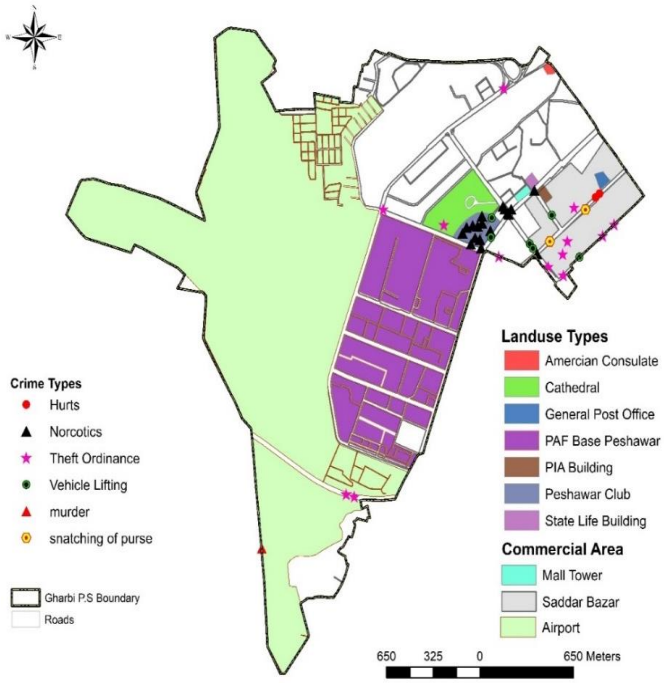

Figure 4: *Gharbi* Police Station boundary and various crimes reported to *Gharbi*Police Stations'

This is followed by 4 to 8 p.m. and 8 p.m. to 12 a.m., when 21 and 16 offenses, respectively, were recorded. The increase in crime is predictable given that this is the busiest period for shopping in the famed *Saddar* Bazaar, where the majority of the crime happened. Similarly, in the summer, the hours of 4 to 8 p.m. are perfect for shopping and socializing with family and friends. When the types of crimes committed during this period are examined, it is evident that 17 of the 32 offenses took place between 12 p.m. and 4p.m. were car theft. Similarly, 13 vehicle lifting instances were committed between 4 and 8 p.m., which decreased to 7 between 8 and 12 a.m.

According to the temporal study of crime distribution, the bulk of crimes were committed in the afternoon since individuals are more mobile at that time of day. Aside from the lack of parking facilities in the *Saddar* area, one of the biggest concentrations of retail malls and business activity appears to be a significant element driving this development. The majority of visitors leave their automobiles parked along the roadside unattended, creating an ideal setting for vehicle lifting. Table 4 and Figure 6 show the hourly distribution of crime in Peshawar's *Gharbi* police station

Table 3: Temporal distribution of crimes (2015-2016), Sharki police station

Type of crime	12 a.m.-4 a.m.	4 a.m.-8 a.m.	8 a.m.-12 p.m.	12 p.m.-4 p.m.	4 p.m.-8 p.m.	8 p.m.-12 a.m.
Attempt murder	0	0	0	4	2	1
Hurts	1	0	1	1	1	0
kidnapping	0	0	0	1	1	0
Murder	0	1	1	4	2	1
Threats	0	0	1	3	0	1
Vehicle lifting	0	2	9	17	13	7
Snatching	0	1	3	2	1	3
Theft ordinance	0	0	1	0	1	2
Total	1	4	16	32	21	15

Source: Sharki Police station

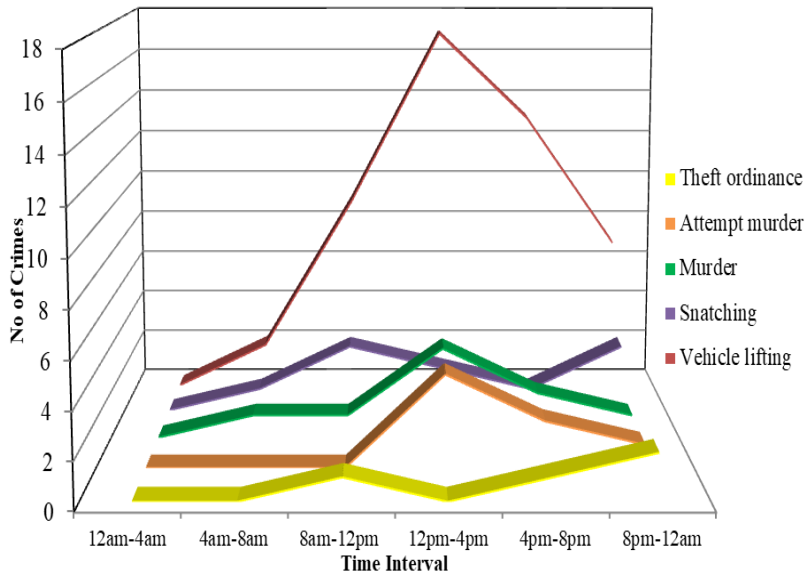

Figure 5: Showing the hourly distribution of crimes in *Sharki* Police Station, Peshawar

Gharbi police station. The largest number of crimes are perpetrated between 12 p.m. and 4 p.m. in the *Shuba*Bazar region and other congested areas. Another significant finding of the study is that

the largest number of narcotics-related crimes are recorded between the hours of 8 p.m. and 12 a.m. Various elements, such as time-varying criminal opportunities, target availability and appeal, and time-varying criminal conduct, can all contribute to a temporal pattern of crime. However, it is plausible that the temporal pattern of crime is largely determined by the changing attractiveness of targets over time. As a result, the temporal pattern in crimes is determined not only by the time constraints of perpetrators but also by those of prospective targets. Similarly, different offenses may have different time-varying opportunities (van-Sleeuwen et al., 2021). For example, most car lifters aim to avoid arrest by targeting abandoned automobiles; similarly, pickpocketing and snatching are likely to occur in public settings such as shopping malls, etc. The bulk of car lifting crimes happened between 12 p.m. and 4 p.m. when most individuals sought refuge from the blistering heat of summer and left their automobiles unattended on the street.

Table 4: Temporal distribution of crimes (2015-2016) Gharbi police station

Type of crime	12 a.m.-4 a.m.	4 a.m.-8 a.m.	8 a.m.-12 p.m.	12 p.m.-4 p.m.	4 p.m.-8 p.m.	8 p.m.-12 a.m.
Hurts	0	0	1	1	0	0
Murder	0	0	0	1	0	0
Vehicle lifting	1	1	0	2	0	2
Snatching	0	0	0	2	1	0
Theft ordinance	0	1	0	4	1	7
Foreign act	0	1	2	5	1	1
Narcotics	0	0	1	4	4	11
Total	1	3	4	19	7	21

Source: Gharbi Police station

Seasonal distribution of crimes:

The weather and crime, or the seasonal distribution of crimes, are the fourth and most essential parameter utilized to evaluate the collected data. According to the study, over half of the crimes recorded in 2015-16 were committed between May and September (summer season), followed by 30 percent between October and February (winter season), and the remaining 20 percent in spring (March-April). Some weather-related crime studies in France, the United Kingdom, and the United States have shown that assaults, notably domestic violence, murder, robbery, and suicide, were higher in the summer when other meteorological characteristics

were combined. According to Jerry McKean, Professor of Criminal Justice at Ball State University in Indiana, crime numbers climb in July and August, when the bulk of the country begins to bake. (From USA Today, 2000.)

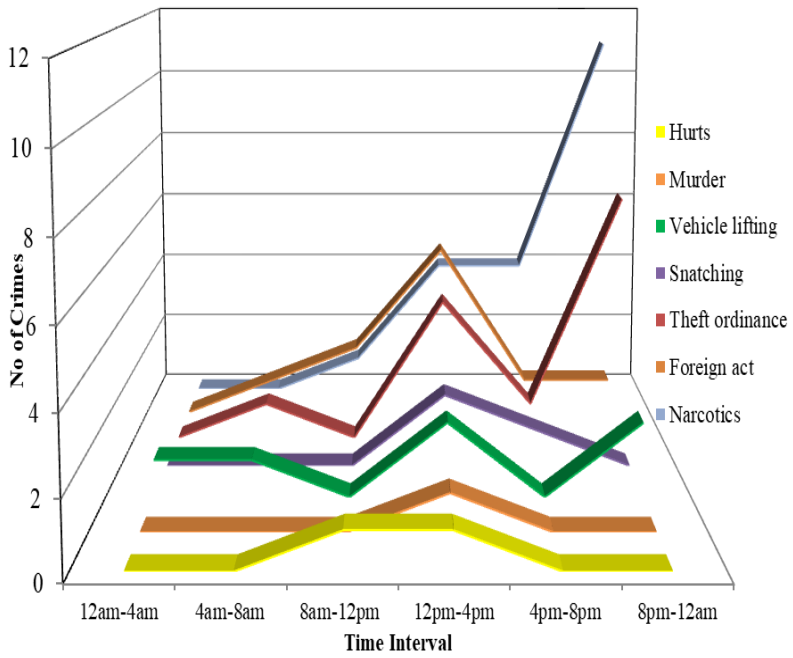

Figure 6: Showing the hourly distribution of crimes in *Gharbi* Police

Aggressive crimes, such as murder, assault, and extortion, are more prevalent during the warm seasons of the year (Ebadinejad et al., 2020). According to Henke and Hsu (2020), hot weather works as a stimulant for expressive aggression. According to research conducted by, Xu et al., (2020), interpersonal violence in the United States increases as the temperature rises. According to the study, every 5°C rises in daily average temperature is connected with a 9.5% increase in deliberate homicide in Chicago and New York. A study conducted by Stevens et al., (2020) titled "in cold weather, we bark, but in hot weather, we bite: pattern in social media anger, aggressive behavior, and temperature" finds that the number of assaults is higher in the summer than in the winter. According to Falk (1952), crimes against people are more prevalent in the summer than in the winter. Murders, robberies, kidnappings, and rapes are more common in the summer (April to July) than in the winter (November to February). According to the findings, these crimes are positively associated with temperature. According to the findings, the

temperature is a significant factor in the occurrence of crimes (Mandal, 2020).

This appears to be the case in the research area. The examination of tables 5 and 6, as well as figures 7 and 8, indicates that the bulk of crimes in both *Sharki* and *Gharbi* police stations were committed over the summer (May to September), 42 and 41, respectively, for a 47 percent and 93 percent of total crime respectively. Another highlight of the analysis is that majority of the aggressive assaults (Hurts), Murders, and attempted murders took place in the summer.

Table 5: Seasonal distribution of crimes (2015-2016), Sharki police station

S.No	Type of crime	March-April (spring)	May-September (summer)	October-February (winter)
1	Attempt murder	0	5	2
2	Hurts	0	3	1
3	kidnapping	0	1	1
4	Murder	2	5	2
5	Threats	0	3	2
6	Vehicle lifting	15	16	17
7	Flirt	0	0	1
8	Snatching	1	6	3
9	Theft ordinance	0	3	1
Total		18	42	30

Source: Sharki Police station

Table 6: Seasonal distribution of crimes (2015-2016), Gharbi police station

S.No	Type of crime	March-April (spring)	May-September (summer)	October-February (winter)
1	Hurts	0	2	0
2	Murder	0	0	1
3	Vehicle lifting	1	4	1
4	Flirt	0	0	1
5	Snatching	0	0	2
6	Theft ordinance	2	8	5
7	Foreign act	1	7	3
8	Narcotics	0	20	0
Total		4	41	10

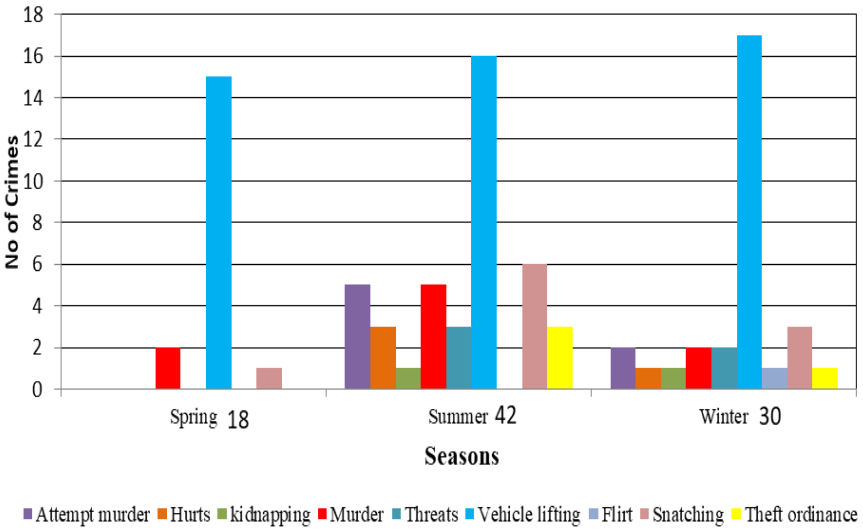

Figure 7: the seasonal distribution of crimes in *Sharki* Police Station

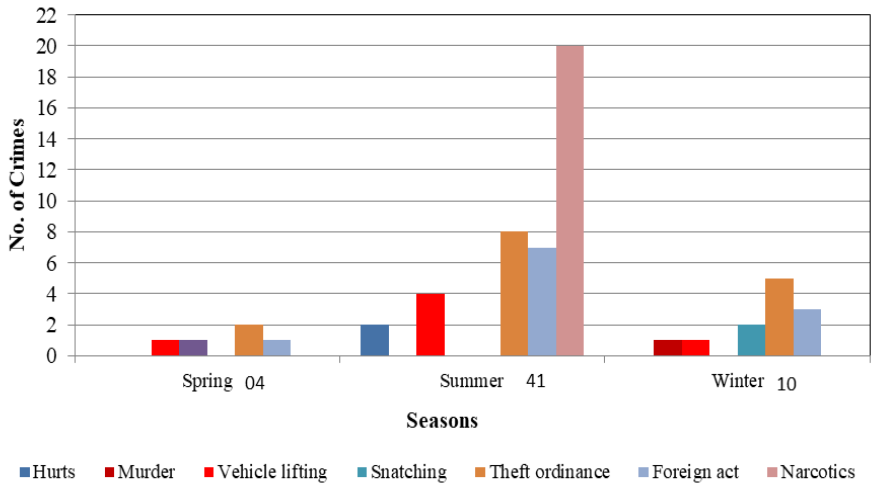

Figure 8: The seasonal distribution of crimes *Gharbi* Police station

Hot Spots distribution

Crime hotspots are locations of high crime intensity on a map. Creating maps with hotspots is becoming an important and powerful tool for policing; they aid in the development of information and awareness of distinct regions in a city and perhaps why crime happens there. GIS assists and analyses crimes in a variety of ways. The most important application of GIS is to depict crime in a geographical context. Police may use this geographical

visualization to determine hotspots and analyze the pattern of crime incidence. Figures 8 and 9 depict hotspots in the *Gharbi* and *Sharki* police stations, respectively. According to the findings, the hotspot at *Gharbi* Police Station is comprised of the Pakistan International Airline (PIA) building and the State Life building in the *Saddar* neighborhoods, where the vast majority of crimes were recorded. Similarly, the *Sharki* police station's hotspot includes the Civil Quarters, *Dabgari*, and Shuba neighborhoods. The spatial analysis of crimes suggests that in *Gharbi* police station most of the crimes were reported from the *Saddar* area specifically from Peshawar Club and PIA building area. As for as *Sharki* police station is concerned, majority of crimes were reported from the Civil quarter *Dabgri* area and *Shuba* Bazar area

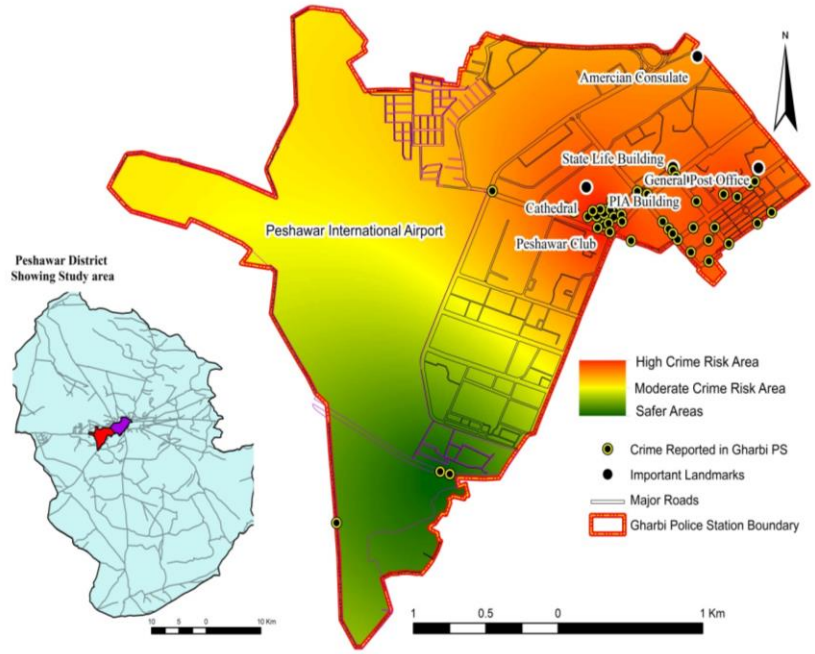

Figure 9: Showing Hot Spots in *Sharki* Police station

Conclusion

According to the study of crimes by category, a total of 55 incidents of various crimes were reported to the *Gharbi* police station. The bulk of the 55 offenses were drugs and drug-related. In addition, 13 incidents of theft and 10 cases of the foreign act were recorded. A total of 90 offenses of various types were reported to the *Sharki* police station. Out of 90 crimes perpetrated within the boundaries of *Sharki* police station, 48 (54 percent of total crimes)

were car theft, followed by snatching 10 (11 percent of total), and 9 murder instances.

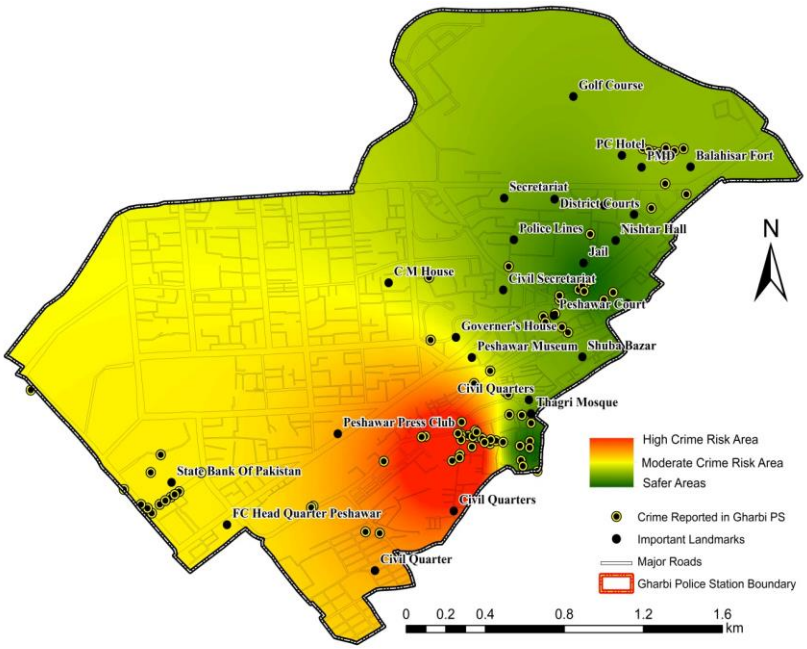

Figure 10: Hot Spots in *Gharbi* police station

According to hourly distribution, the bulk of crimes reported to *Sharki* police station occurred between 12 to 4p.m. (32 crimes out of 90 crimes), with 21 offences occurring between 04-08p.m. In terms of seasonal distribution of crime, the bulk of offences in both *Gharbi* and *Sharki* police stations, 42 and 41 respectively, were committed during the summer. Two hotspots are suggested via hotspot analysis. The detailed analysis indicates that the hotspot in *Gharbi* Police Station is comprised of the PIA building and the State Life building in the *Saddar* neighborhoods, where the vast majority of crimes were recorded. Similarly, the *Sharki* police station's hotspot includes the Civil Quarters, *Dabgari*, and *Shuba* neighborhoods.

It is therefore proposed that cities and nationwide crime mapping be carried out to identify the regions where crimes are expected to occur more frequently and to reinforce the police in such areas to control crimes. Police should be given modern sophisticated equipment, such as GPS, to acquire precise position data.

Limitation

The study's primary drawback is the approximate location of where crime is perpetrated. GIS spatial analysis and hotspot analysis require an actual location to discover genuine hotspots, which may then be used to combat crime.

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