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SPATIAL-TEMPORAL VARIATION OF BURGLARY: A MATHEMATICAL MODEL

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ABSTRACT

S*patial and temporal analysis is an essential component of burglary related events. Such analysis plays a vital role in lots of security- related applications. This helps to provide information to lead the activities aimed at stopping, detecting and responding to security problems. Burglary prone area is identified based on the spatial location. But some burglary occurs in the urban residential area based on the temporal factors also. This study carried out to evaluate the spatio-temporal variation of burglary in six specific area of Bihar State of India.*

Keywords*: Spatial-temporal, Burglary, Variation, hotspot.*

INTRODUCTION

Burglary is the most common property crime. Furthermore, burglars are quite similar to thieves in a number of respects, so that these two classes provide leaves of the ordinary penal institution. Researchers found that burglars as a class were somewhat more intelligent than thieves but were less competent than embezzlers, forgers and robbers.

Burglary occurs everywhere. In recent decades it is a major issue in every big city. Some good neighbourhoods in a city approximately free from burglary events. However there are some bad neighbourhood where dense agglomerated of burglary or other crimes commit.

There is a spatio-temporal correlation between burglary and victims or their close neighbours. Some neighbours repeatedly victimized within short interval of time. Thus burglary often is clustered densely which tends to be spatial localized into a regions. These spatio-temporal clusters of burglary events occurrence are often referred to as burglary "hotspots".

Analysis of Spatio-temporal hotspot provide information to combat crime and to increase the effectiveness of the resources. When able to predict the location and time of hotspots can help police department for better prepared to either reduce the intensity of hotspots or be able to more quickly mobilize officers to handle the increased crime rate (Boba, 2005).

The main aim of this study is to discuss some models of criminal activity showing that burglaries are spatial and temporal act. For this study of spatio-temporal variation of burglaries data are collected from six specific district of Bihar state of India.

RELATED WORKS

Burglary or property crime is a dynamic event over space and time. Spatio-temporal analysis of this type of crime is an important part of crime analysis since place and time are two critical aspects of most crime related events.

Burglary hotspots are observed to vary depending upon the particular geographic, economic or environmental conditions present. Moreover, hotspots are seen to emerge or diffuse depending on specific category of crime. The emergence of hotspots is connected to repeat victimization. A successful burglar have tendency to commit repeat burglary in the same house or nearby house.

Some specific theory has been proposed to develop crime model to understand why hotspots increase in some locations rather than others. These theories and hypothesis like Routine activity theory, Crime pattern theory, rational choice theory, repeat and near repeat victimization theory and broken window theory are referred.

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Routine activity theory [1] supposes that crime is a function of target and presence of guardians. In other words, in order for crime to happen, there must be a suitable target and absence of guardian. The target must be one that makes the offender motivated enough to commit crimes and the time and location must be such that there are no police or other guardians available to prevent the crime. We interpret this to mean the criminal prefers specific types of targets.

Crime pattern theory [2] supposes that crime is not random. The location of a crime is likely near a criminal's normal activity space. The normal activity space is the collection of areas where the individual most frequently comes into contact with others.

Rational choice theory [3], [4] is about the criminal's decision making. It says that criminals make choices that benefit themselves that is they are rational.

Repeat victimization theory [5], [6], [7] states that a burglar may return to previously victimized home having already learnt the details of the home and the location and having past acquired experience and how to commit successful burglary than those as yet to victimize.

Near-repeat victimization theory [8] states that a burglar may return to the immediate neighbourhood of previously victimized home having already learnt detail of the area for successful rewards, if the first burgle house have no chance.

Broken windows theory [9], [10] asserts that signs of disorder attract more disorder and diminishing those signs will diminish the attraction of disorder.

Based on the above theories and hypothesis many literature has been developed on mathematical model of burglary. M.B Short [11] presented a mathematical model of burglary where he derived two differential equation – one is the movement of burglar and another is the attractiveness of each house to burglary.

A. B. Pitcher [12] proposed a modified model of burglary adding a deterrence factor by the presence of uniformed officers to the model. He introduced "burglar fatigue" into the short model because he assumed that if burglars are sufficiently deterred, then they will eventually get tired and stop to burgle.

Spatio-temporal techniques allows of establishing a topology of spatial-temporal characteristics of hotspots, as the spatial features of crime patterns within the hotspot can be established [17].

SPATIAL CATEGORIES OF BURGLARY EVENTS

1. Burglaries generally occur in isolated type apartments. In such cases persons of one apartment are totally unknown to the inhabitants of adjacent apartments or nearby other apartments.
2. Most residential burglaries occur on the first or ground floor of an apartment in the busy city.
3. Burglary occurs in a by-lane of a busy city or town area when the owner goes outside.
4. It occurs at proximate residential areas at afternoon and at late night when the owners are sound asleep.
5. It occurs at the extreme corner of a village area.

TEMPORAL CATEGORIES OF BURGLARY EVENTS

1. Most burglaries occur during day time when homes are empty.
2. Generally, most usual hour for a burglary to occur is in between 6 P.M. and 7 P.M. when the owners go outside for marketing or other works in a greater city.
3. Burglary occurs at the time of a great festival in a remote village area.
4. Burglary also occurs at late night when the owners of a town or a city remain in sound sleep.

SPATIO-TEMPRAL ANALYSIS OF BURGLARY

Spatio-tempral pattern analysis for burglary is to ascertain where and when burglaries are most likely to happen and to determine the correlation of spatial and temporal category of burglary. We discuss to produce spatial and temporal frequency plots of burglary.

For this analysis secondary data are collected from the website www.biharpolice.bih.nic.in. All the reported burglary data are taken in Bihar state for the year 2013 and 2014 up to the month November as in the Table 2.7.

Table-2.7: Month wise number of Burglaries for the year 2013 and 2014

Months	Burglary During 2013	Burglary During 2014	Months	Burglary During 2013	Burglary During 2014
Jan	286	390	July	391	463
Feb	332	340	August	389	416
March	301	352	sept	376	413
April	299	336	Octo.	362	424
May	323	370	Nov.	402	391
June	379	425			

Source: biharpolice.bih.nic.in

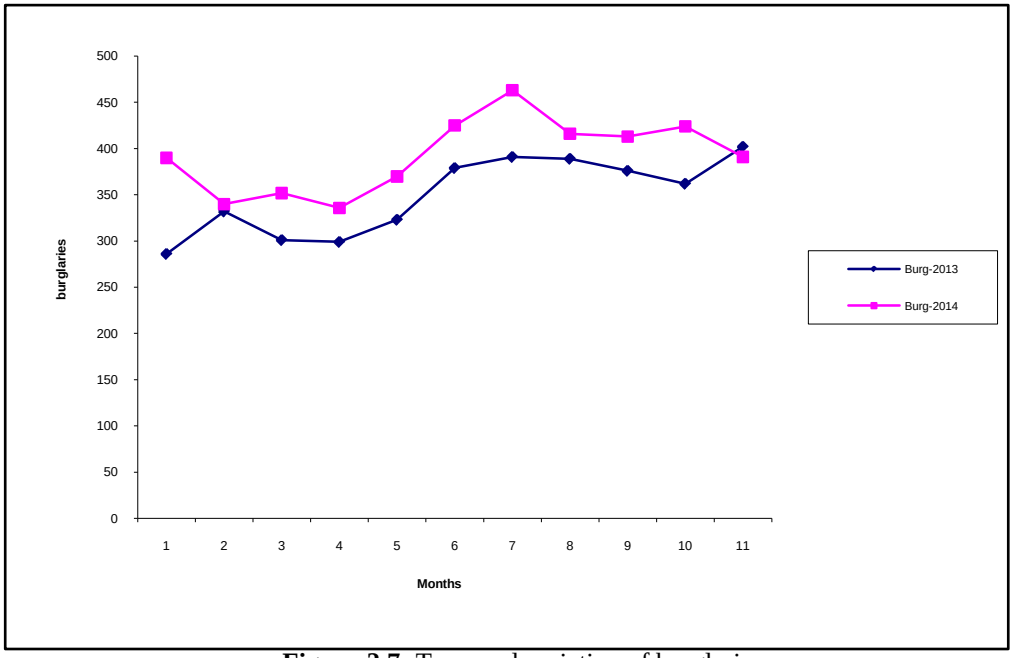

Figure-2.7: Temporal variation of burglaries (in general in Bihar State, India)

From the Fig. 2.7 we conclude as follows:-

Burglary peak in the month of June, July, august and September during both of the year, 2013 and 2014.But it dips in the other months. Hence temporal variation of burglary can be analyzed from the above data plotting.

For the spatial analysis, reported burglary data of six district of Bihar states are gathered for the whole year 2014 as in the Table 2.8

Burglaries for these six districts have been chosen for the following reasons:

1. These districts are the major urban agglomerated of population in Bihar.
2. Burglaries are highly reported crime in this area.
3. Literacy rate of the people are almost same except the district Purnea.

Approximate populations in lakhs are considered as per the census 2011 and only reported burglary data are collected from the police report of Bihar for the year 2014. According to the population census of 2011, the literacy rate of the people of these districts Patna, Gaya, Bhagalpur, Muzaffarpur, Darbanga and Purnea are respectively 84.05%, 85.45%, 80.76%, 85.07%, 80.74% and 74.04%.

Table-2.8: District wise number of burglaries for the year 2014

Sl. No.	Name of Districts	Total Population In lacs (Appr.)	Popu. in lacs(appr.) in urban clustered	Nos. of reported Burglaries	Burglaries Per 1 lakhs population
1	Patna	58.3	20.5	661	11.3
2	Gaya	44	4.7	209	4.8
3	Bhagalpur	30.8	4.1	225	7.3
4	Muzaffarpur	48	3.9	281	5.9
5	Darbanga	39.4	3.1	145	3.7
6	Purnea	32.6	3.1	80	2.5

Source:biharpolice.bih.nic.in

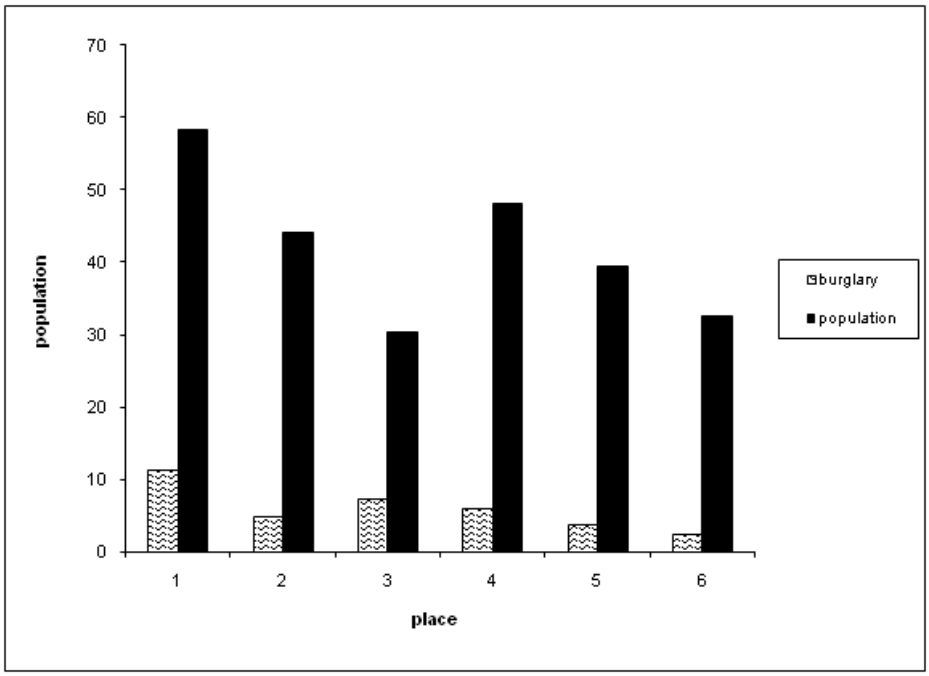

Figure-2.8: Spatial variation of burglary (in six district of Bihar state)

In Fig. 2.8, the sl. Nos. of the respective districts are shown in the horizontal axis and the total populations and the number of burglaries(per 1 lakh population) for the respective districts are shown in the vertical axis. It is clear that the place 1 *i.e.* Patna district shows the highest burglary occurrence followed by the place 3(Bhagalpur) and place 4 (Muzaffarpur). These spatial variations of burglary occur in these districts because of the differences of the urban clustered population pattern. However, the exception is found in case of second rank highly agglomeration of populated Gaya district of Bihar. Burglary rate is comperatively lower at Gaya district than the other districts like Patna, Bhagalpur and Muzaffarpur. This exception is taken place because that the literacy rate (85.45%) of population of Gaya district is the highest among the other districts.

Hence the spatial variations of burglary depends on the location whose populations are urban clustered and the literacy rate of people a location.

Spatio-temporal correlation can be analyzed with the following data. These data of reported burglaries for 10 years from the year 2005 to 2014 of Bhagalpur and Gaya urban area are gathered from biharpolice.bih.nic.in source.

Table-2.9: Reported burglaries of the cities Bhagalpur(BGP) and Gaya for the year 2005 to 2014.

Years	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
Burglary In BGP	119	157	114	130	130	127	127	140	134	225
Burglary In Gaya	146	128	120	147	163	138	161	147	212	209

Source: biharpolice.bih.nic.in

Table-2.10: Correlation Calculations

Sl.No.	**Burg. In BGP** x	**Assumed Mean** ($\bar{x}$ **=130)** X_i	x_i^2	**Burgl. In Gaya** y	**Assumed Mean** ($\bar{y}$ **=163)** y_i	y_i^2	$x_i y_i$
1	119	-11	121	146	-17	289	187
2	157	27	729	128	-35	1225	-945
3	114	-16	256	120	-43	1849	688
4	130	0	0	147	-16	256	0
5	130	0	0	163	0	0	0
6	127	3	9	138	-25	625	-75
7	127	3	9	161	-2	4	-6
8	140	10	100	147	-16	256	-160
9	134	4	16	212	49	2401	196
10	225	95	9025	209	46	2116	4370
		$\sum x_i = 115$	$\sum x_i^2 = 10265$		$\sum y_i = -59$	$\sum y_i^2 = 9021$	$\sum x_i y_i = 4255$

Now applying the Pearson product-moment correlation coefficient which is defined as

$$r_{xy} = \frac{N\sum_{i=1}^{N} x_i y_i - \sum_{i=1}^{N} x_i \sum_{i=1}^{N} y_i}{\sqrt{N\sum_{i=1}^{N} x_i^2 - (\sum_{i=1}^{N} x_i)^2}\sqrt{N\sum_{i=1}^{N} y_i^2 - (\sum_{i=1}^{N} y_i)^2}}$$

$$= \frac{10\times 4255 - 115\times(-59)}{\sqrt{10\times 10265 - (115)^2}\sqrt{10\times 9021 - (-59)^2}}$$

$$= \frac{49335}{88067.28}$$

$$= 0.56$$

where, N is the length of time series x and y and X_i and y_i are the respective values of x and y at time *i*. In this case N =10, so from the above data, we can calculate correlation coefficient, as r_{xy} =0.56.

CONCLUSION

Spatial variation of burglary depends on the urban clustered population pattern and literacy rate of population in a location. Temporal variation of burglary depends on the climate of a location. Burglary peaks for a particular period in every year. Spatial and temporal variations of burglary are correlated.

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REFERENCES

1. Cohen, L.E. and Felson, M. (1979): "Social Change and Crime Rate Trends- A Routine Activity Approach". American Sociological Review, Vol. 44, pp. 588-608.
2. Brantingham, P.L.and Brantingham, P.J (2008) Crime pattern theory. In wortley, R. and Mazerolle, L., editors, Environmental criminology and Crime Analysis. Routledge.
3. Clarke, R. V. & Felson, M. (editors) (1993) Routine activity and Rational choice. Advances in criminological theory, Vol. 5, Transaction Books, New Brunswick, NJ.
4. Cournish (et al, 1986) the Reasoning Criminal: Rational choice Perspectives on offending hague: Springer Verlag.
5. Pease, K. (1998) Repeat Victimization: Taking stock. Crime detection and protection series paper 90. The home office: Police Research Group.
6. Bowers, K. J & Johnson, S.D. (2005) Domestic burglary repeats and space-time clusters the dimension of risk. Eur. J. Criminol. 2,
7. Johnson, S. D., Bernasco, W., Bowers, K. J., Elffers, H., Ratcliffe, J., Rengert, G. & Townsley, M. (2007) Space-time patterns of risk: A cross national assessment of residential burglary victimization. J. Quantitative Criminology 23(3), 201-219.
8. Bernasco, W. (2008) Them again: Same offender involvement in repeat and near repeat burglaries. Eur. J. Criminol, 5, 411-413.
9. Keizer, K., Lindenberg, S. & Steg, L.(2008) The spreading of disorder. Science, 322(5908):1681-1685.
10. Wilson, J. Q. & Kelling, G. L. (1982) Broken windows and police and neighbourhood safety. Atlantic Monthly 249, pp. 29-32.
11. Short, M.B., D'orsogna, M. R., Brantingham, P.J., and Tita, Measuring and modeling repeat and near repeat burglary effects. J.Quant Criminol.25, 325-339(2009).
12. Pitcher, A.B., Adding Police to a mathematical model of burglary. Euro. Jnl. Of Applied mathematics (2010), vol.21.pp349-370.
13. Bernasco, W., Luykx,F.(2003) Effects of attractiveness, opportunity and accessibility to burglars on residential burglary rates of urban neighbourhoods. Criminol. 51, 981-1002.
14. Bernasco, W. and Nieuwbeerta, P. (2005) How do residential burglars select target areas? A new approach to the analysis of Criminal location choice. 45, 296-315.
15. Kumar, M.V, Chandrasekar, C., Spatio-Temporal Analysis of Residential Burglary Repeat Victimization: Case study of Chennai City Promoters Apartments, India. Int.J. Comp. Tech. Appl. Vol.2 (5). 1177-1191
16. Amin, R., (2019) Mathematical Model on spatio-temporal variation of criminal activities. IJMTT Vol.65 (7) page 69-72.
17. Ratcliffe.J. (2002) Scenario Planning: Strategic interviews and conversations. Foresight Vol. 4, No.1 pp. 19-30.
18. Boba R. (2005) Crime Analysis and Crime Mapping. SAGE, Social science 301 page.

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