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Mobility Patterns of Criminals in Chennai City, India: A Spatial Analysis

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Abstract: The pattern of journey by criminals varies from one part of the city to another. The analysis of the spatial movement pattern of offenders deserves closer attention. With the help of quality crime data, appropriate methodology, and the availability of GIS mapping techniques, this study aims to understand the travelling pattern of criminals in Chennai. The findings of this study demonstrate that the criminals' travel patterns when staging a crime are linked to the physical and functional aspects of various zones of Chennai. Criminals are more likely to travel longer distances to commit crimes in areas with limited environmental potential. On the other hand, because of increased environmental potential, the rate of occurrence of crimes is higher in commercial and high-income residential neighbourhoods, and criminals travel less in these regions. The maps created with GIS software identify the places where criminals travel at a high and low level. This type of identification could aid the police in making better law enforcement plans.

Keywords: location preference, commuting of offenders, origin and destination of offenders, environmental opportunity

Crime geography deals with the study of the spatial and temporal distribution of crime incidences. Desired targets, crime types, operational convenience, and individual decisions decide the spatial movement of criminals. The journey to crime starts at the criminal's residence and ends at the place of operation. Criminals living in different parts of the city have different travel patterns related to differences

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within broader communities. Criminals' travelling patterns in a city are a unique type of general mobility. Investigating criminal and victim movement patterns is an important aspect of the spatial analysis of crime since movement patterns are dynamic (Brantingham & Brantingham, 1984, p. 237). Using spatial and temporal patterns of crime, we can better understand how different neighbourhoods attract different types of criminals and how such interactions influence the destinations and origins of criminals. The movement of criminals and things unavoidably expands the region where control is required. (Sutherland & Cressey, 1985, P.25). By examining the spatial behaviour of criminals in Madras, Sivamurthy (1975) made a pioneering contribution to crime geography. In this study, he investigated the travelling patterns of criminals in Madras, newly urbanised and older inner-city areas. The scope of this research was limited to property offences. According to this study, many criminals travel 5 to 10 kilometres to commit crimes. Later, Sivamurthy (1979) investigated the spatial pattern of travelling criminals in Madras City using Census divisions as area units and discovered that commercial centres and transportation terminals attract more criminals from far-off regions.

To investigate the relationship between criminal residence and other geographical variables such as land use and the built environment. Most crime events were found in areas with high unemployment rates and low middle-class incomes (Canter et al., 2000). A crime requires both offenders and targets to be present simultaneously. A criminal's intersection with their target in time and space. It covers their motivations, destinations, routes, distances, directions, modes of transportation, and travel companions (Bernasco, W. (2014).

Neighbourhoods of different socioeconomic statuses attract criminals' travel patterns (Bunting et al.,2018). The features of the home community are more important than those of the target community, while the features at the individual level are most influential. Older burglars travel longer distances to commit their crimes than younger ones. Group burglars tend to travel further than solo burglars (Xiao et al.,2018)

The travelling criminal's journey to crime has received much attention in mobility triangle research. In contrast, the travelling victim's journey and the distance between the residence of the offender and the victim have received less attention. Travel patterns are affected by the demographic characteristics of criminals and victims. Criminal behaviour also impacts travel patterns. The chances of crime are closely related to the distance between the residences of the offender and the victim (Luo et al. et al., 2021)

Previous studies have provided noteworthy insights into the behavioural characteristics of criminals, with different conclusions being drawn. However, the importance of choosing certain geographic areas over others for committing crimes due to their abundant opportunities or proximity to the criminals' residences has not been highlighted. This study has highlighted their significance, based on which the criminal’s travelling pattern is mapped, to provide a bird's eye perspective of a

criminal's choice of places from most to least preferred and the rationale behind it. The concept of commuting and the Relative commuting index were briefly examined to assess crime patterns.

The ultimate goal of this research is to map out crime-prone areas based on the loot worthiness of a location, a criminal's place of residence, and his place of operation, or, to put it another way, to conduct a spatial movement analysis of criminals and determine the correlation and statistical significance between socioeconomic development and criminals' willingness to leave an area of interest.

Geospatial analyses can help law enforcement better target prevention programs. Geographically, it is important to investigate the spatial patterns of offenders' movements since local components are essential. It is observed that criminal journey patterns vary from place to place, even when the type of offence is the same. Using GIS mapping techniques and enhanced data quality and methodology, the study aims to understand the mobility of criminals in the City of Chennai. It is heavily urbanised, with the highest population density, and has the highest crime rate in Tamil Nadu. Despite the uniqueness and severity of the crime problem, Chennai city was chosen for study.

Data and Methodology

Chennai city had 7450 incidents of crimes in 2017, according to police station records (Figure 1). Data about the place of occurrence (Crime scene) and Location of the criminal's residence (Place of origin) along with the charged offence have been collected from the CRB (Crime Records Bureau) for 70 police stations in Chennai city.

A Chennai city map was compiled using EICHER maps, and georeferencing was performed using GIS tools software using Ground Control Points (GCP) of important locations in and around the city. With the georeferenced map, the Chennai City boundary could be accurately delineated, which assisted in demarcating the Police boundary. This study used a police boundary map for Tamil Nadu found in an article published by Sivamurthy (2005) (A study of spatial mobility of property offences, the Indian Police Journal) was used for the current study. To obtain the police boundary precisely, the map was traced and redrawn (Figure 2). We created a base map consisting of police station boundaries and police station locations.

GIS tools were used to plot the crime scene locations (Figure 1). After this, X and Y coordinates were generated for various crimes, such as theft, house burglary, pocket-picking, cycle theft, automobile theft, and chain snatching, and unique IDs were created for each crime. Next, the residences of the Criminals were plotted, and then the origins and destinations of their trips were identified.

Origin and destination reveal much about the spatial dynamics of movements and interactions. In order to analyse the attractiveness of the area in terms of the

movement of offenders, a Commuting index (CI) was calculated. The reason an individual commutes from one area to another is believed to be a lack of opportunity in his area

Figure 1

Spatial pattern of Property crime -2017

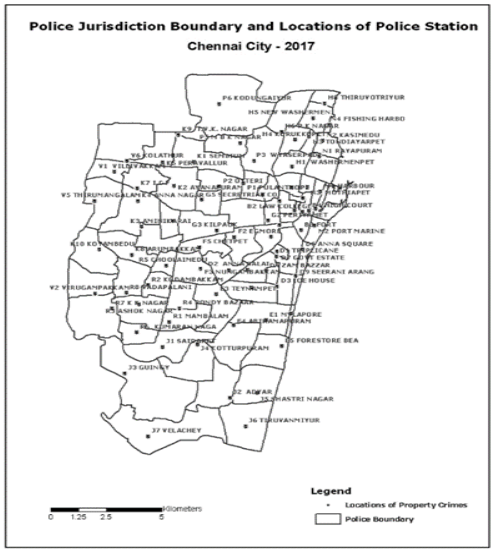
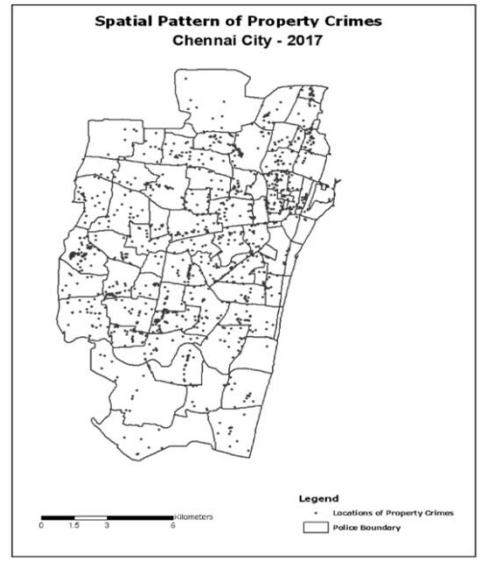


Figure 2

Police Stations Location with Jurisdiction- 2017



The commuting index has been calculated for each of the 70 police jurisdictions.

$$\text{Commuting Index: } \frac{\text{Total no.of Offenders living in the police station jurisdiction (B)}}{\text{Total no.of Offenders who live and commit a crime in the same police jurisdiction (C)}} \quad \text{(i)}$$

The higher value of the Commuting Index indicates that there are few opportunities in the area, so the offenders are required to travel out of their area. The commuting index has further been mapped (Figure 3).

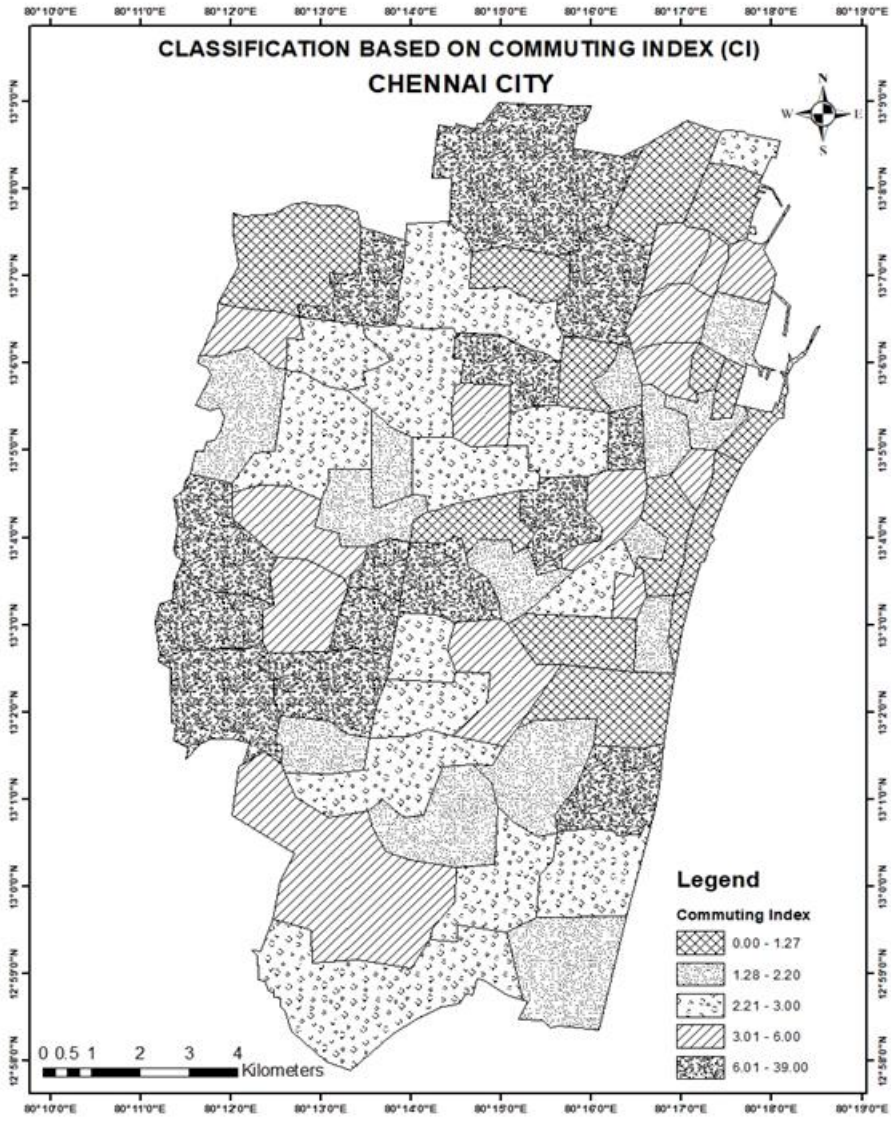
In areas such as P6 Kodungaiyur and P3 Vyasarpadi, the committing index is quite high, indicating a greater tendency to commit crime in new areas due to a lack of opportunities in their zone. Other zones, such as G7 Chetpet, E2 Royapettah, etc., are at the opposite end of the spectrum.

While tracking the mere outward movement of criminals alone would not provide a meaningful picture in terms of analysing usefulness, this has subsequently prompted the incorporation of an index known as the Relative Commuting Index (RCI) to help extract patterns. RCI is just an enhanced version of CI where the value obtained for a particular region is divided by the number of crimes committed there for which offenders are identified. The Commuting Index is based solely on the number of offenders who live and commit crimes in a given area. Commuting indexes only consider criminals who live and commit crimes in a particular area at a

given time. However, environmental factors that influence their choice of places to commit crimes can also be taken into account by looking at the number of Crime events within each jurisdiction. RCI faithfully incorporates this factor to map an offender's holistic commuting behaviour.

Figure 3

Commuting Index (CI)



In arriving at the RCI values for the different areas, the Police department was able to distinguish and link crime activities with alleged offenders. Therefore, a Relative Commuting Index is another commuting index variant expressed as a

proportion of total crimes committed in the area for which offenders are known. It is derived as below.

$$\text{Relative commuting Index: } \frac{\text{Commuting Index } (B/C)}{\text{Total crimes for which offenders are known } (A)} \quad \text{(ii)}$$

To explain the usefulness of RCI, a simple example is given here to help explain its importance in the current analysis.

For instance, we have two areas, A and B. The number of Criminals residing in A and B are 100, respectively. Of the total lot (100), only 50 operate inside A while 80 operate in B. From this, we arrive at the CI values of 2 and 1.25 for A and B, respectively. It is obvious from CI that criminals in Area B are reluctant to move out of their dwelling zone, while it is the other way around in Area A. Now that the CI is computed, RCI comes into play, which relies upon a Criminal's Modus Operandi. Since the number of native criminals who operate in A (50) tends to be much less than B (80), the number of crimes committed by them in A (say 25) would, by all means, be significantly lower when compared to B (say 50). By taking these values into account,

RCI for A = 2/25 = 0.08
RCI for B = 1.25/50 = 0.025

Having a lower RCI value for B further strengthens its chances of proving its environmental worthiness or scope for opportunity is far superior to A.

Mapping and Analysis

As previously stated, the Relative Commuting Index (RCI) is the degree of commuting expressed as a ratio of the Commuting Index to the total number of crimes committed in the area. Choropleth maps were created using GIS software to demonstrate the spatial pattern of criminals travelling by treating police station jurisdictions as areal units. The lower index indicates that the area relies very little on external travelling because it is rich in environmental opportunities. Meanwhile, the higher score indicates fewer opportunities in the area, forcing criminals to travel outside.

When the pattern of occurrence of crimes is compared to the pattern of travelling of offenders, it becomes clear that locations with a higher degree of offenders' travelling have a lower crime rate. To put it another way, locations with a higher crime rate are thought to have more environmental opportunities, and as a result, the degree of travelling of offenders is low.

Table 1 contains the Number of Crimes for which Offenders are known (A), the Number of Offenders residing in the Area (B) and out of those who commit crimes locally (C). To corroborate the rationality behind narrowing their choices down to select areas and test them statistically, the Socioeconomic Development

(SED) indicator is considered. SED values represent how socially and economically sound an area is in percentage terms. A spatial and statistical approach is needed to prove the strong connection between SED and RCI.

Table 1

Jurisdiction -wise Data

S.NO	AREA	A	B	C	CI	RCI	SED
1	H5 New Washermpet	22	24	10	2.40	10.91	25.99
2	N4 Fishing harbour	7	1	1	1.00	14.29	25.01
3	N2 Kasimedu	8	19	6	3.17	39.58	28.94
4	N3 Muthialpet	13	6	1	6.00	46.15	30.94
5	H3 Tondiarpet	29	36	9	4.00	13.80	30.05
6	P4 Basin Bridge	5	1	1	1.00	20.00	27.75
7	P6 Kodungaiyur	24	69	10	6.90	28.75	30.86
8	N1 Royapuram	25	22	11	2.00	8.00	29.97
9	P3 Vyasarpadi	15	102	10	10.20	68.00	27.06
10	H1 Washermanpet	9	55	11	5.00	55.56	29.97
11	K1 Sembium	47	33	12	2.75	5.85	30.90
12	V4 Rajamangalam	1	0	0	0.00	0.00	31.76
13	V5 Thirumangalam	75	69	35	1.97	2.63	34.81
14	K2 Ayanavaram	70	24	10	2.40	3.43	31.43
15	K4 Anna Nagar	28	9	4	2.25	8.04	32.66
16	K8 Arumbakkam	33	23	6	3.83	11.62	32.32
17	F5 Choolaimedu	11	14	1	14.00	127.27	34.72
18	G5 Secretariat Colony	27	5	1	5.00	18.52	34.14
19	C2 Elephant Gate	31	23	15	1.53	4.95	27.42
20	C3 Seven Wells	44	35	7	5.00	11.36	29.32
21	G7 Chetput	1	0	0	0.00	0.00	36.79
22	G1 Vepery	39	20	9	2.22	5.70	32.49
23	F2 Egmore	27	9	1	9.00	33.33	34.09
24	F4 Thousand lights	55	33	22	1.50	2.73	36.79
25	R2 Kodambakkam	18	15	3	5.00	27.78	34.46
26	R3 Ashok Nagar	60	9	1	9.00	15.00	34.59
27	R9 Valasarawakkam	2	1	1	1.00	50.00	32.24
28	F3 Nungambakkam	41	8	1	8.00	19.51	34.94
29	R4 Pondy Bazar	49	3	1	3.00	6.12	38.35
30	R1 Mambalam	95	39	16	2.44	2.57	34.72
31	E3 Teynampet	26	25	7	3.57	13.74	33.12
32	R6 Kumaran Nagar	16	6	3	2.00	12.50	32.48
33	J1 Saidapet	27	40	15	2.67	9.88	29.45
34	J4 Kotturpuram	26	8	4	2.00	7.69	29.45
35	E4 Abiramapuram	52	18	12	1.50	2.88	34.23
36	J7 Velacherry	48	71	31	2.29	4.77	33.83
37	J6 Thiruvanmiyur	56	52	26	2.00	3.57	35.27
38	J5 Sastri Nagar	16	3	1	3.00	18.75	36.33
39	E5 Pattinapakkam	4	39	1	39.00	975.00	32.89
40	D5 Marina	9	1	1	1.00	11.11	35.29
41	D3 Ice House	19	22	10	2.20	11.58	28.29
42	K10 Koyambedu	69	9	1	9.00	13.04	32.36

S.NO	AREA	A	B	C	CI	RCI	SED
43	R5 Virugambakkam	21	39	1	39.00	185.11	32.36
44	R7 KK Nagar	11	8	1	8.00	72.73	30.72
45	F1 Chindadiripet	33	61	16	3.81	11.55	30.88
46	D1 Triplicane	66	44	22	2.00	3.03	39.56
47	D7 Govt. Estate	5	1	1	1.00	20.00	39.56
48	D4 Zam Bazar	11	6	2	3.00	27.27	33.48
49	D5 Marina	9	1	1	1.00	11.11	28.39
50	B3 Fort	3	4	1	4.00	1.33	32.24
51	B5 Harbour	1	0	0	0.00	0.00	30.18
52	D6 Anna square	8	1	1	1.00	12.50	30.63
53	B5 Harbour	1	0	0	0.00	0.00	30.63
54	B1 North Beach	15	8	7	1.14	7.62	30.63
55	K6 T.P. Chatram	24	12	9	1.33	5.56	31.98
56	G2 Periamedu	24	8	1	8.00	33.33	28.07
57	C1 Flower Bazar	44	22	16	1.38	3.13	25.78
58	B2 Explanade	20	9	7	1.29	6.43	32.24
59	V1 Villiwakkam	46	75	24	3.13	6.79	32.40
60	K7 ICF	14	3	1	3.00	21.43	30.69
61	P1 Pullianthope	21	83	7	11.86	56.46	30.05
62	C5 Kothawal chavadi	24	1	1	1.00	4.17	29.18
63	E2 Royapettah	45	19	15	1.27	2.81	36.50
64	E1 Mylapore	37	37	12	3.08	8.33	31.73
65	J2 Adyar	43	29	11	2.64	6.13	36.69
66	P5 MKB Nagar	16	1	1	1.00	6.25	28.88
67	J3 Guindy	22	82	14	5.86	26.62	29.19
68	K3 Aminjikarai	132	47	36	1.31	0.99	34.18
69	K5 Peravalur	15	19	2	9.50	63.33	33.44
70	G3 Kilpauk	36	17	7	2.43	6.75	35.31

With some notable exceptions, Table 1 and Figure 3 show a positive and negative correlation between CI, RCI, SED, and RCI, respectively. RCI and CI tend to be directly proportional, with the key difference being a criminal's pure willingness to explore (CI) and the environmental opportunities that influence his decision (RCI). It can be seen from Figure 3 that regions with low levels of development have higher levels of commuting and vice versa. Noteworthy exceptions like E5 Pattinapakkam and F5 Choolaimedu are the causal effects of factors like frequent Police patrolling and the presence of VIP residences.

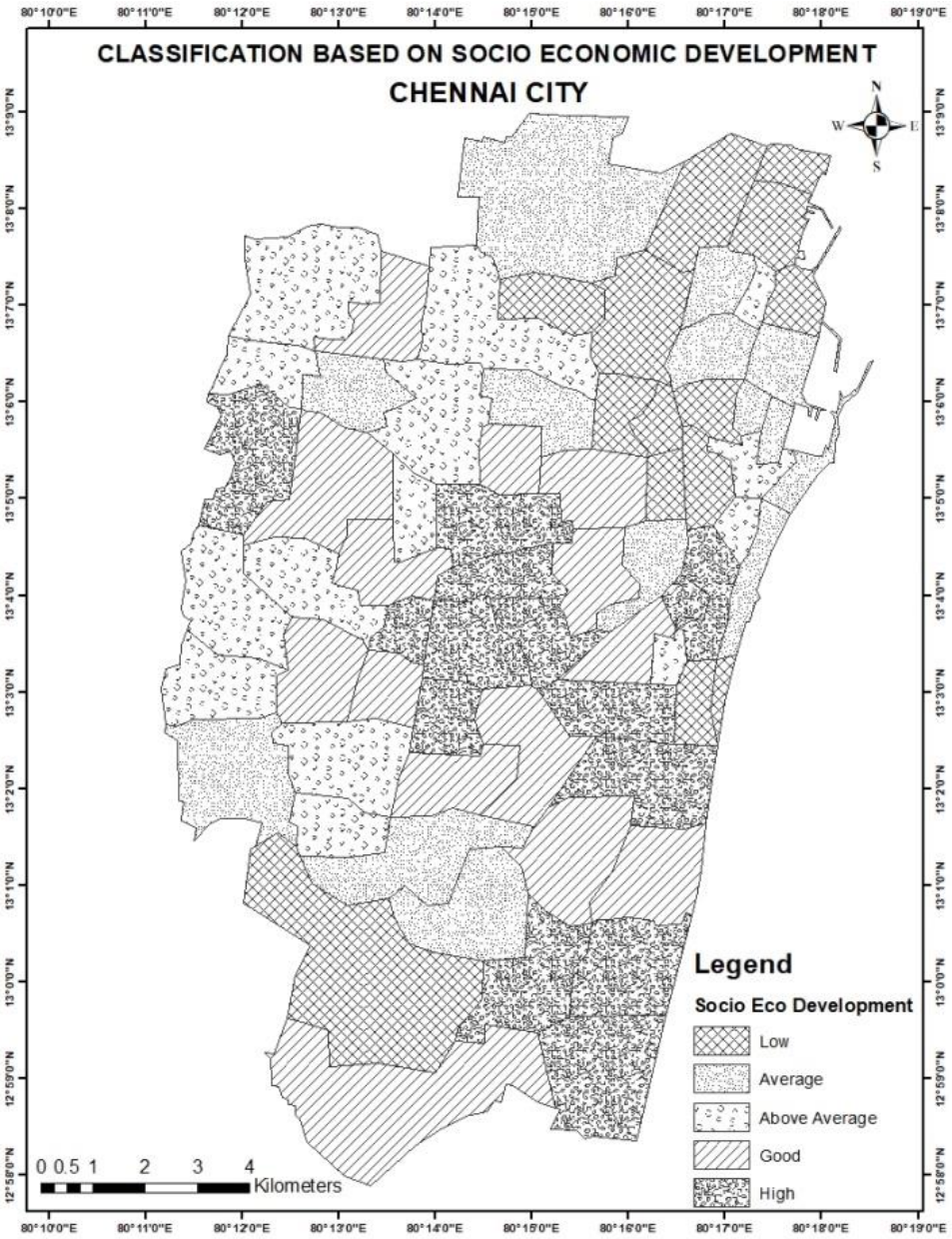
Figure 4 shows that in areas such as Aminjikarai (K3), Pondy Bazaar (R4), and Anna Salai (D2) in Central Chennai, Thirumangalam (V5) and Ayanavaram (K2) in the West, Triplicane (D1) in the East, Harbour (B5) and Flower Bazaar (C1) in the North, and Adyar (J2) in the South, criminals have a low preference for travelling. Because of the lower level of commuting of offenders in these locations, most criminals likely commit crimes in their neighbourhood.

It is observed that these areas, especially Pondy Bazaar and Anna Salai in Central Chennai and Flower Bazaar in North Chennai, are essentially characterised by commercial and service functions—the other areas, namely. Aminjikarai in

Central Chennai, Thirumangalam in the West and Adyar in the South are mainly the high-income residential areas. These areas also provide a great environmental opportunity for offenders. A relatively lower percentage of travelling is also found in the peripheral parts of Southern Chennai, characterised by industrial and high-income functions.

Figure 4

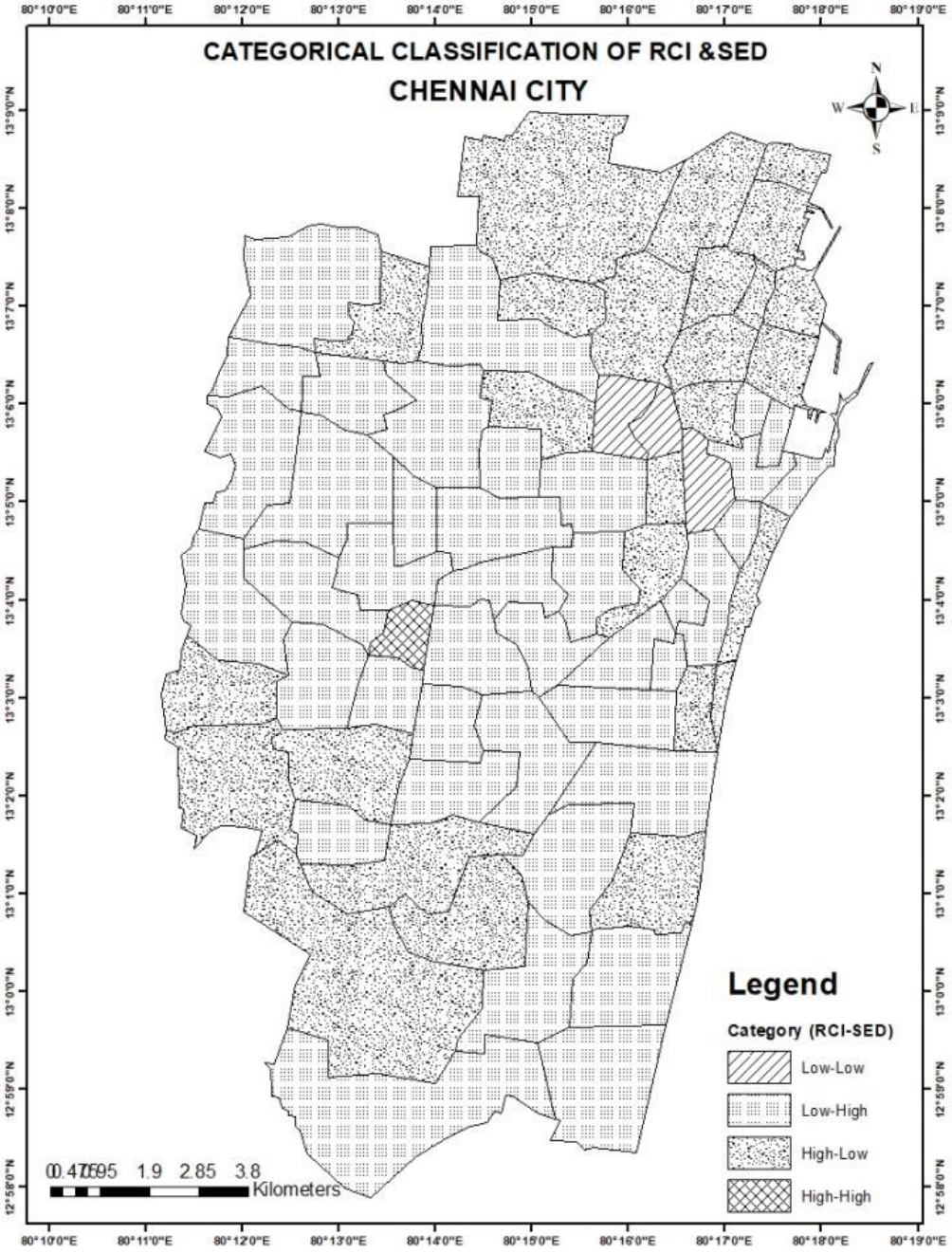
Comparing SED With Commuting Preference



The concentration of a high degree of travelling (Hotspot-like feature) is found distinctly in the North and North East Chennai.

Figure 5

Relative Commuting Index (RCI)



Furthermore, most offenders prefer their home (areas where they reside) to distant counterparts, as seen in Figure 4, with some noticeable exceptions in Chennai's northern parts. In contrast to the previous observation, the latter demonstrates a lack of opportunities due to low living conditions. Figure 5 indicates the relative commuting index.

Table 2

RCI-SED Pair Values and Police Divisions

RCI/SED	Police Divisions
Low-Low	C2 Elephant Gate, C1 Flower Bazar, C5 Kothawal chavadi
Low-High	K1 Sembium, V4 Rajamangalam, V5 Thirumangalam, K2 Ayanavaram, K4 Anna Nagar, K8 Arumbakkam, G5 Secretariat Colony, G7 Chetput, G1 Vepery, F2 Egmore, F4 Thousand lights, R2 Kodambakkam, R3 Ashok Nagar, F3 Nungambakkam, R4 Pondy Bazar, R1 Mambalam, E3 Teynampet, R6 Kumaran Nagar, E4 Abiramapuram, J7 Velachery, J6 Thiruvanmiyur, J5 Sastri Nagar, D5 Marina, K10 Koyambedu, D1 Triplicane, D7 Govt. Estate, D4 Zam Bazar, B3 Fort, B5 Harbour, B1 North Beach, K6 T.P. Chatram, B2 Esplanade, V1 Villivakkam, K7 ICF, E2 Royapettah, E1 Mylapore, J2 Adyar, K3 Aminjikarai, G3 Kilpauk
High-Low	H5 New Washermanpet, N4 Fishing harbour, N2 Kasimedu, N3 Muthialpet, H3 Tondiarpet, P4 Basin Bridge, P6 Kodungaiyur, N1 Royapuram, P3 Vyasarpadi, H1 Washermanpet, C3 Seven Wells, R9 Valasarawakkam, J1 Saidapet, J4 Kotturpuram, E5 Pattinapakkam, D3 Ice House, R5 Virugambakkam, R7 KK Nagar, F1 Chindadiripet, D2 Marina, D6 Anna square, G2 Periamedu, P1 Pullianthope, P5 MKB Nagar, J3 Guindy, K5 Peravalur
High-High	F5 Choolaimedu

Table 2 denotes the categorical classification of various Police Jurisdiction limits according to four combinations of RCI-SED Pair values. Since the very purpose of this paper is to cull out the negative correlation between RCI and SED parameters, this table is a testimony for the same, as 40 of the limits fall under the Low-High category, 26 under High-Low, three under Low-Low and one under High-High.

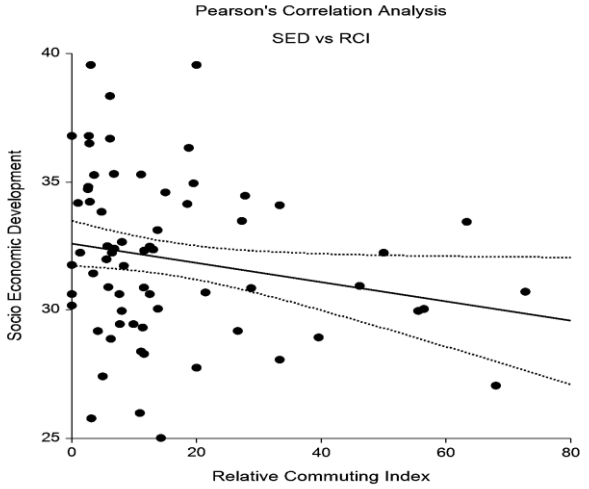
A Low-High combination indicates that the offenders in an area of interest are reticent to move out of their places to commit crimes. On the contrary, a High-Low Combination expresses their desire to move out due to the prevalence of low economic opportunities to commit crimes in their residing places.

Low- and High-High combinations refute our core hypothesis but can be considered outliers due to their minuscule number of 4.

Pearson's correlation coefficient analysis is performed between the Development indicator (SED) and the RCI using NCSS Statistical software, and its statistical significance is tested.

Figure 6

Correlation Between SED and RCI



According to the results (Figure 6), there is an obvious decline in the regression line, bounded by 10% Confidence Intervals on both sides, showing a clear negative correlation between the two. A few notable outliers (such as Pattinapakkam (E5)) were ignored to arrive at a factual conclusion.

Further, Null(H_o) and Alternative hypothesis (H_a) were formulated, and the data was tested for significance at Probability value(α=0.1) where H_o denotes no significant correlation, i.e. the variables are random, and H_a disapproves it.

Table 3

Pearson Correlation Test Section

Ho: $\rho = 0$

Alternative Hypothesis	Pearson Correlation	Count	df	T - Value	P-Value	Reject Ho at $\alpha = 0.1$?
$\rho \neq 0$	-0.2051	67	65	1.6897	0.0959	Yes

Source: NCSS Statistical Software

Since the obtained P- Value (0.0959) is less than the assumed probability value (α=0.1), H_o is rejected, and a significant correlation between SED and RCI is further reestablished (Table 3).

Locations with low environmental opportunities have a relatively high degree of travelling, which can be vital in monitoring the movements of recorded suspects in high-valued RCI areas while beefing up the security levels in high-valued RCI counterparts.

Conclusion

Criminals travelling are less common in commercial and high-income residential regions due to increased environmental opportunities. However, it is also vital to highlight that some exceptions are related to evident causative causes. In this way, the study helps us understand the relationship between offenders' travel patterns and the areas' characteristics. Moreover, from a Geographers perspective, apart from just a mere spatial portrayal of events, this study has employed Statistical techniques to ascertain the factors of influence as it is essential to cull out the root cause, say, for instance, analysing the push and pull factors that prompt these malicious occurrences. Push factors are the ones that force a person to commit crimes in the likes of poverty and unemployment, which can be noticeably recognised in areas of low socio-economic development, especially in northern parts of the city, and Pull factors express the magnetic pull some of the areas in central parts of the city have on gullible people to commit offences due to socio-economic disparities and increasing capitalistic environment. Therefore, mitigating crime requires tough laws and punishments, increased attention to Push and Pull factors, and allocating resources that address equity in regional development and living standards.

References

Sivamurthy, A., & Thilagaraj, R. (2011). The spatial pattern of commuting of property offenders in Chennai city. *International Journal of Geomatics and Geosciences*, 2(2), 502-518.

Sivamurthy, A. (1981). Urban ecological aspects of crimes in Madras City. *Indian Journal of Criminology*, 9(2), 91-98.

Brantingham, P. J., & Brantingham, P. L. (1981). Environmental criminology. Sage Publication Inc.

Canter, D., Coffey, T., Huntley, M., & Missen, C. (2000). Predicting serial killers' home base using a decision support system. *Journal of Quantitative Criminology*, *16*(4), 457–478. https://doi.org/10.1023/A:1007551316253

Sivamurthy (2005). A study of spatial mobility of property offences. *The Indian Police Journal, 52*(2), 62–72.

Bunting, R. J., Chang, O. Y., Cowen, C., Hankins, R., Langston, S., Warner, A., Yang X., Louderback, E.R., & Roy, S. S. (2018). Spatial patterns of larceny and aggravated assault in Miami–Dade County, 2007–2015. *The Professional Geographer*, *70*(1), 34–46. https://doi.org/10.1080/00330124.2017.1310622

Bernasco, W. (2014). Crime journeys: Patterns of offender mobility. http://www.wimbernasco. nl/Manuscripts/English/Crime% 20Journeys_WebManu script. Pdf [Zugriffsdatum: 14.05. 2016].

Xiao, L., Liu, L., Song, G., Ruiter, S., & Zhou, S. (2018). Journey-to-crime distances of residential burglars in China disentangled: origin and destination effects. *ISPRS International Journal of Geo-Information*, 7(8), 325.

Luo, F., Zhang, Y., & Hoover, L. T. (2021). The journey to crime and victimisation. *International Journal of Police Science & Management*, 14613557211008477.

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