

## Statistical Analysis of Crime Data

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### **ABSTRACT:**

The states considered like Andhra Pradesh, Assam, Bihar, Chhattisgarh, Delhi, Goa, Gujarat, Haryana, Himachal Pradesh, Jammu & Kashmir, Jharkhand, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Odisha, Punjab, Rajasthan, Tamil Nadu, Telangana, Uttar Pradesh, Uttarakhand & West Bengal with the 11 variables like Rate of Environment Offences in 2017-18(X1), Total Persons Arrested in 2017(X2), Total Persons Charge sheeted in 2017(X3), Rate of Crime Registered in GRP during 2017-18(X4), Total Number of Cases Reported(X5), Total number of extremist crime recorded in 2017-18(X6), Total number of Police Cases for Investigation(X7), Total number of police cases with final report during 2017-18 (X8), Total Cases Disposed Off by Police in 2017-18 (X9), Value of Property – Stolen during 2015-16(X10), 2016-17(X11) & 2017-18(X12) has been considered to rank the states based on crime. The states have also been grouped using cluster analysis.

**KEYWORDS:** ranking, clustering, rank sum, z-score, paired t-test

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### **I. INTRODUCTION**

The National Crime Records Bureau (NCRB) report itself clearly states that the numbers will vary with population and so crime rate (measured as crime per lakh population) might be a better indicator to assess the trend. However, the report also states that a lower crime rate need not imply that the police system is more effective or that a higher crime rate means the police system is ineffective since NCRB data is purely based on the cases registered by the police.

The comparison might help get a better understanding of the variance in crime rates among states and if there is any under-reporting in some states. Violent crimes such as murder, Dowry Deaths, attempt to murder, rioting, kidnapping are those which involve the use of force to harm or threaten the victim. Such serious crimes also have a greater probability of receiving the attention of the public & media and hence have a greater chance of being registered in police records. 8.1% of all crimes registered in India are violent crimes. There are 15 different types of crimes as per various sections of the Indian Penal Code that have been classified as violent crimes in the NCRB report. One in four of the registered violent crime in 2019 is a kidnapping. Around 1.05 lakh cases were booked as kidnapping and abduction in 2019, under IPC sections 363-369 and constitute over a quarter of the violent crimes. Crimes registered as 'Grievous hurt' contribute to more than one-fifth (89,115) of the violent crimes recorded in India in 2019. Over 51,254 cases were booked under attempt to commit murder and 46,209 cases registered as rioting. Further, a total of 32,033 cases of rape accounting for nearly 8% of the violent crimes were registered in 2019. Robbery and Murder contributed to about 7% of the violent crimes each. The states like Uttar Pradesh, Maharashtra, Bihar, and West Bengal were among the top contributors to violent crime in the country. Among the larger states, the number of violent crimes registered per lakh population is 83.4 for Assam, almost 2.7 times the national violent crime rate. A total of 12 States had a higher violent crime rate than the national rate. Delhi, Odisha, West Bengal, Haryana, Bihar, Kerala, Maharashtra, and Jharkhand which together accounted for close to 56% of the registered violent crimes, were also among the states which recorded a violent crime rate above the national rate. Meanwhile, larger states like Uttar Pradesh, Madhya Pradesh, and Rajasthan which are among the top ten states by number of violent crimes, and other southern states have reported a violent crime rate less than the national rate. The crime rate was the least in the states of Andhra Pradesh, Tamil Nadu, and Gujarat. Among the violent crimes, murders and dowry deaths are the most probable ones to get reported and hence there could be near 100% reporting of these crimes. Even in the case of kidnapping and abduction, the percentage of crimes being reported must be substantially higher. Such crimes which are difficult to hide may reflect the actual status of violent crimes in the states, unlike the overall violent crime numbers. The crime rate for murder across states reveals that Jharkhand had the highest murder rate of 4.3 per lakh population in 2019, almost twice the national rate. Assam, which recorded the highest violent crime rate had a murder rate of 3.6. States of Bihar, Delhi, and Madhya Pradesh have also

recorded a murder rate above national rate. Rajasthan, Karnataka, Maharashtra, Uttar Pradesh, and Gujarat are among the states with low murder rates. Kerala, in spite of having an overall crime rate higher than Uttar Pradesh, has a lower murder compared to Uttar Pradesh. In fact, in the case of dowry deaths, Kerala and Gujarat have reported almost a zero rate while Uttar Pradesh has recorded the highest rate of 2.2, twice the national rate. Bihar, Jharkhand, Madhya Pradesh, and Delhi are among the top ten states in terms of dowry death rate. At the same time, it is seen that in Delhi, Assam, Bihar, Maharashtra, and Madhya Pradesh, the rate of kidnapping is among the highest whereas in Gujarat, and Kerala, it is among the lowest. The national crime rate of Kidnapping in 2019 was 7.9 while Uttar Pradesh reported a rate of 7.3. Such low crime rate in the Kerala in the case of murder, dowry deaths & kidnapping could mean that the higher overall crime rate in Kerala is because of better reporting. And this could be the opposite in the case of states like Bihar & Uttar Pradesh. Uttar Pradesh and Rajasthan have recorded the highest number of rapes in the country and together constitute more than 28% of the rape cases in India in 2019. However, the crime rate of rapes in Uttar Pradesh is exceptionally low, half the national rate. Concomitantly, Kerala and Delhi have recorded crime rates of 11.1 and 13.5 in the case of rape, among the top three states in the country. In Bihar, the number as well as rate are low.

Under cases registered under 'Assault on women with intent to outrage her modesty', Delhi and Kerala are among the top five states with high rates of crime under this section whereas Bihar has recorded the least and Uttar Pradesh falls below the national rate. A similar trend is observed in the case of crimes registered under 'insult to the modesty of women'. Uttar Pradesh and Bihar have a crime rate of close to zero under this section. It has to be noted that the most populous states of Uttar Pradesh, Bihar, and Maharashtra have a lower overall crime rate. However, the crime rate in the case of murders, dowry deaths, and kidnappings in Uttar Pradesh is higher. Gujarat and Kerala have lower numbers of such crimes and lower rates. For instance, in the case of dowry deaths, UP reported 300 times more dowry deaths in 2019 compared to Kerala. According to National Family Health Survey (NFHS-4), India's biggest survey of social indicators, conducted in 2015-16, about 5.2% of the 61,906 married women surveyed had experienced sexual violence in the last 12 months. An additional 22.6% had suffered physical violence and 23.7% responded to have experienced both. The spouse was the perpetrator in majority of the cases. The Mint based on the data of NFHS-4 estimated that over 99.1% of the sexual violence cases went unreported. A study conducted by TISS (Tata Institute of Social Sciences) and sponsored by Bureau of Police Research and Development (BPRD), an organization under the Ministry of Home, titled 'A Study on Non-Registration of Crimes: Problems & Solutions' conducted across six states identified the following to be the reasons behind under-reporting.

- Police are burdened with heavy workload and long working hours which prompted them to avoid more work by registering less cases.
- Behaviour of police towards the complainants, mainly women and marginalized sections of society discouraged people from reporting a crime.
- Budget allocation for the police is low which has resulted in shortage of manpower, infrastructure and transport.
- Management of crime statistics by police functionaries has linkages with performance appraisals of police.
- Classification of cognizable and non-cognizable nature of crimes of which a normal citizen is unaware is exploited by police to twist the complaint
- Police may get loaded with false complaints to investigate.
- Interface of political/NGO/Media and other influential person in the process of registration of crime
- Corruption

All of this indicates that a higher or a lower crime rate is not at all an indicator of the functioning of the police and also does not reflect the status of the law & order in a particular state. Reporting & registration of a crime are essential for an efficient criminal justice system and steps must be taken to ensure these. Data mining is useful in analysis and prediction of crime cases. In this communication, attempt has been made to analyse crime cases of different types over the states. Ranking of the states has been made. Grouping among the states has been tried using Cluster Analysis.

## **II. DATA**

The main data source is National Crime Bureau Reports published. The 23 states considered are Andhra Pradesh, Assam, Bihar, Chhattisgarh, Delhi, Goa, Gujarat, Haryana, Himachal Pradesh, Jammu & Kashmir, Jharkhand, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Odisha, Punjab, Rajasthan, Tamil Nadu, Telangana, Uttar Pradesh, Uttarakhand & West Bengal. The 11 variables considered are Rate of Environment Offences in 2017-18(X1), Total Persons Arrested in 2017(X2), Total Persons Charge sheeted in 2017(X3), Rate of Crime Registered in GRP during 2017-18(X4), Total Number of Cases Reported(X5), Total number of extremist crime recorded in 2017-18(X6), Total number of Police Cases for Investigation(X7), Total number of

police cases with final report during 2017-18 (X8), Total Cases Disposed Off by Police in 2017-18 (X9), Value of Property – Stolen during 2015-16(X10), 2016-17(X11) & 2017-18(X12). These are last available reports in NCB reports.

### III. RESULTS

The states may be compared. The basic objective is to compare the states. In first approach, states are being ranked based on each variables. The sum of the ranks of the states may be obtained and states can be ranked. Better is the state with lower sum of rank.

**Table -1** showing ranks for the states on each of 12 variables

State	RX1	RX2	RX3	RX4	RX5	RX6	RX7	RX8	RX9	RX10	RX11	RX12
Andhra Pradesh	14	14	14	14	17	11	13	10	12	13	12	12
Assam	13	13	13	4	18	2	14	17	15	7	8	10
Bihar	8	8	7	16	16	3	17	16	6	12	9	15
Chhattisgarh	9	9	8	12	11	14	5	6	17	6	6	6
Delhi	3	3	3	22	15	16	22	23	4	22	22	22
Goa	4	4	5	9	9	5	1	1	23	1	1	1
Gujarat	11	11	11	20	3	10	10	12	11	19	16	19
Haryana	6	6	4	18	7	4	8	18	14	15	19	17
Himachal Pradesh	16	16	17	1	4	9	2	2	21	3	3	3
Jammu & Kashmir	2	2	2	2	1	23	4	4	20	4	4	4
Jharkhand	15	15	15	6	23	6	7	9	18	5	5	5
Karnataka	19	19	18	8	8	18	15	15	9	18	20	21
Kerala	21	21	21	21	12	22	18	5	5	8	7	7
Madhya Pradesh	7	7	10	19	14	19	20	19	2	20	17	16
Maharashtra	18	18	19	23	19	21	23	21	3	23	23	23
Odisha	1	1	1	7	13	13	9	7	16	11	11	13
Punjab	5	5	6	15	2	7	6	8	19	10	10	8
Rajasthan	22	22	22	10	20	12	12	20	8	17	18	18
Tamil Nadu	23	23	23	11	5	20	19	14	7	14	14	14
Telangana	17	17	16	13	21	8	11	11	13	9	13	11
Uttar Pradesh	20	20	20	17	10	17	21	22	1	21	21	20
Uttarakhand	10	10	12	3	6	1	3	3	22	2	2	2
West Bengal	12	12	9	5	22	15	16	13	10	16	15	9

Note : RX1 is the rank of X1, etc..

It is to note that with respect to X1-X2-X3, the better states (low rank) are Odisha, Jammu & Kashmir, Delhi, etc. and risk states (high rank) are Tamil Nadu, Rajasthan, Kerala, Uttar Pradesh, etc.; with respect to X4, the better states (low rank) are Himachal Pradesh, Jammu & Kashmir, Uttarakhand, Assam, etc. and risk states (high rank) are Maharashtra, Delhi, Kerala, etc.; with respect to X5, the better states (low rank) are Jammu & Kashmir, Punjab, Gujarat, etc. and risk states (high rank) are Jharkhand, West Bengal, Telangana, Rajasthan, etc.; with respect to X6, the better states (low rank) are Uttarakhand, Assam, Bihar, etc. and risk states (high rank) are Jammu & Kashmir, Kerala, Maharashtra, etc.; with respect to X7, the better states (low rank) are Goa, Himachal Pradesh, Uttarakhand, etc. and risk states (high rank) are Maharashtra, Delhi, Uttar Pradesh, Madhya Pradesh, etc.; with respect to X8, the better states (low rank) are Goa, Himachal Pradesh, Uttarakhand, etc. and risk states (high rank) are Maharashtra, Delhi, Uttar Pradesh, etc.; with respect to X9, the better states (low rank) are Goa, Himachal Pradesh, Uttarakhand, etc. and risk states (high rank) are Maharashtra, Uttar Pradesh, Madhya Pradesh, etc.; with respect to X10-X11-X12, the better states (low rank) are Goa, Himachal Pradesh, Uttarakhand, etc. and risk states (high rank) are Maharashtra, Delhi, Uttar Pradesh, etc..

**Table – 2** showing the ranks of the states based of sum of the ranks

State	Rank	State	Rank
Andhra Pradesh	14	Kerala	16
Assam	10	Madhya Pradesh	17
Bihar	9	Maharashtra	23
Chhattisgarh	7	Odisha	6
Delhi	18	Punjab	5
Goa	1	Rajasthan	21
Gujarat	12	Tamil Nadu	19
Haryana	11	Telangana	15
Himachal Pradesh	4	Uttar Pradesh	22
Jammu & Kashmir	2	Uttarakhand	3
Jharkhand	8	West Bengal	13
Karnataka	20		

It is to note that with respect to sum of ranks, the better states are Goa, Jammu & Kashmir, Uttarakhand, Himachal Pradesh, Punjab, Odisha, etc. and risk states are Maharashtra, Uttar Pradesh, Rajasthan, etc..

**Table – 3** showing the average and sd of the variables

Variable	Average	SD
X1	1752.42	4737.65
X2	1692.42	4108.08
X3	1730.67	4238.40
X4	5.46	6.31
X5	117.96	131.74
X6	118.29	198.25
X7	176595.04	129303.01
X8	36671.75	45891.83
X9	125783.67	94095.42
X10	336.52	906.80
X11	402.51	910.08
X12	205.65	320.57

In second approach, z-score  $(=(\text{value}-\text{average value})/\text{sd})$  for each variable and each states are calculated. The sum of the z-scores of the states may be obtained and states can be ranked. Better is the state with lower rank. Better states are Tripura, Himachal Pradesh, Uttarakhand, etc. and risk states are Delhi, Tamil Nadu, Rajasthan, Uttar Pradesh, etc..

**Table – 4** showing the ranks of the states based of sum of z-scores

State	Rank	State	Rank
Andhra Pradesh	13	Kerala	19
Assam	12	Madhya Pradesh	18
Bihar	15	Maharashtra	24
Chhattisgarh	6	Odisha	7
Delhi	23	Punjab	5
Goa	4	Rajasthan	21
Gujarat	11	Tamil Nadu	22

Haryana	9	Telangana	14
Himachal Pradesh	2	Tripura	1
Jammu & Kashmir	10	Uttar Pradesh	20
Jharkhand	8	Uttarakhand	3
Karnataka	16	West Bengal	17

The variables may be tested among themselves pair wise. I have tried all combinations and the results are in Table- .

**Table –5** showing pair test results

Pair	SE	r	Sig. of r	t	Sig. of t	95% CI	
						Lower	Upper
X1-X2	160.33	0.996	0.00	0.39	0.70	-269.89	395.10
X1-X3	154.47	0.993	0.00	0.15	0.89	-297.66	343.06
X1-X4	1007.02	-0.065	0.77	1.81	0.08	-265.50	3911.36
X1-X5	1008.95	-0.059	0.79	1.69	0.11	-386.82	3798.04
X1-X6	1003.86	0.094	0.67	1.70	0.10	-374.78	3788.95
X1-X7	26238.11	0.222	0.31	-6.95	0.00	-236640.38	-127811.36
X1-X8	9677.91	0.023	0.92	-3.76	0.00	-56468.28	-16326.77
X1-X9	19065.24	0.237	0.28	-6.78	0.00	-168804.59	-89726.80
X1-X10	1036.37	-0.059	0.79	1.43	0.17	-669.01	3629.58
X1-X11	1012.22	-0.045	0.84	1.60	0.13	-485.01	3713.42
X2-X3	65.94	0.998	0.00	-0.61	0.55	-176.67	96.84
X2-X4	872.55	-0.059	0.79	2.02	0.06	-49.23	3569.87
X2-X5	873.97	-0.039	0.86	1.88	0.07	-169.50	3455.50
X2-X6	869.73	0.089	0.69	1.89	0.07	-159.23	3448.19
X2-X7	26239.70	0.249	0.25	-6.95	0.00	-236706.29	-127870.67
X2-X8	9640.07	0.055	0.80	-3.78	0.00	-56452.40	-16467.86
X2-X9	19059.92	0.272	0.21	-6.79	0.00	-168856.16	-89800.45
X2-X10	902.30	-0.047	0.83	1.57	0.13	-453.57	3288.93
X2-X11	908.41	-0.079	0.72	1.48	0.15	-537.83	3230.02
X2-X12	876.97	-0.028	0.90	1.77	0.09	-267.13	3370.32
X3-X4	900.27	-0.045	0.84	2.00	0.06	-66.80	3667.27
X3-X5	901.73	-0.04	0.86	1.87	0.08	-187.16	3552.99
X3-X6	896.95	0.101	0.65	1.88	0.07	-175.77	3544.55
X3-X7	26228.25	0.255	0.24	-6.95	0.00	-236642.62	-127854.51
X3-X8	9634.67	0.062	0.78	-3.78	0.00	-56401.30	-16439.14
X3-X9	19040.24	0.287	0.18	-6.79	0.00	-168775.44	-89801.34
X3-X10	928.02	-0.039	0.86	1.57	0.13	-467.00	3382.18
X3-X11	934.58	-0.074	0.74	1.48	0.15	-552.20	3324.22
X3-X12	904.26	-0.022	0.92	1.76	0.09	-283.81	3466.82
X4-X5	27.44	0.137	0.53	-4.28	0.00	-174.23	-60.42
X4-X6	42.01	0.108	0.62	-2.76	0.01	-202.97	-28.72
X4-X7	26442.69	0.699	0.00	-6.96	0.00	-238887.59	-129210.01
X4-X8	9647.71	0.626	0.00	-3.96	0.00	-58228.57	-18212.33
X4-X9	19278.31	0.625	0.00	-6.80	0.00	-171069.40	-91107.85

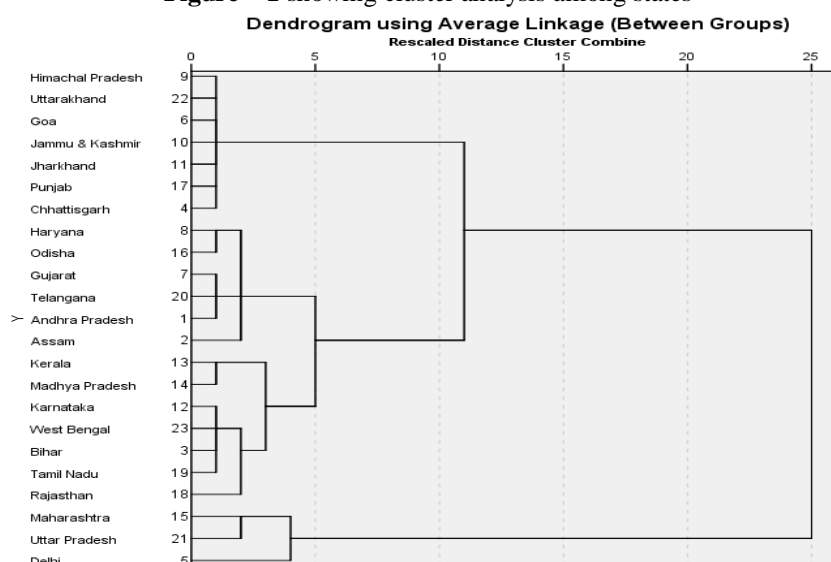
X4-X10	191.83	0.839	0.00	-1.79	0.09	-740.47	55.18
X4-X11	191.97	0.911	0.00	-2.16	0.04	-812.34	-16.11
X4-X12	66.52	0.917	0.00	-3.14	0.01	-346.67	-70.78
X5-X6	54.23	-0.174	0.43	0.03	0.98	-110.99	113.95
X5-X7	26436.39	0.263	0.23	-6.96	0.00	-238757.19	-129105.77
X5-X8	9644.84	0.135	0.54	-3.95	0.00	-58105.31	-18100.95
X5-X9	19274.87	0.156	0.48	-6.80	0.00	-170944.93	-90997.68
X5-X10	186.41	0.304	0.16	-1.21	0.24	-611.90	161.26
X5-X11	190.08	0.183	0.40	-1.56	0.13	-691.11	97.30
X5-X12	66.44	0.25	0.25	-1.38	0.18	-229.20	46.39
X6-X7	26441.29	0.056	0.80	-6.96	0.00	-238768.84	-129097.07
X6-X8	9650.25	-0.039	0.86	-3.95	0.00	-58118.01	-18091.21
X6-X9	19276.16	0.072	0.75	-6.80	0.00	-170949.10	-90996.47
X6-X10	189.67	0.186	0.40	-1.20	0.25	-620.15	166.55
X6-X11	192.61	0.122	0.58	-1.55	0.14	-697.83	101.07
X6-X12	75.02	0.129	0.56	-1.24	0.23	-248.45	62.69
X7-X8	20807.24	0.704	0.00	7.01	0.00	102676.77	188979.93
X7-X9	10592.74	0.94	0.00	5.00	0.00	30992.17	74928.18
X7-X10	26336.62	0.557	0.01	6.98	0.00	129087.35	238324.96
X7-X11	26314.27	0.672	0.00	6.98	0.00	129062.12	238207.03
X7-X12	26396.71	0.693	0.00	6.97	0.00	129096.64	238583.50
X8-X9	14860.87	0.656	0.00	-6.25	0.00	-123687.74	-62048.61
X8-X10	9582.21	0.353	0.10	3.95	0.00	18005.52	57750.09
X8-X11	9497.70	0.785	0.00	3.98	0.00	18109.20	57503.25
X8-X12	9606.70	0.62	0.00	3.96	0.00	18088.64	57934.81
X9-X10	19198.51	0.422	0.05	6.81	0.00	90930.72	170561.25
X9-X11	19176.39	0.536	0.01	6.81	0.00	90905.00	170443.80
X9-X12	19241.31	0.56	0.01	6.80	0.00	90975.87	170783.93
X10-X11	125.04	0.79	0.00	-0.57	0.57	-330.91	187.74
X10-X12	131.12	0.942	0.00	1.02	0.32	-138.00	405.83
X11-X12	133.10	0.924	0.00	1.54	0.14	-70.53	481.53

The following pairs are significant at 10% level –

X1 and X4, X6, X7, X8, X9; X2 and X4, X5, X6, X7, X8, X9, X12; X3 and X4, X5, X6, X7, X8, X9, X12; X4 and X5, X6, X7, X8, X9, X10, X11, X12; X5 and X7, X8, X9; X6 and X7, X8, X9; X7 and X8, X9, X10, X11, X12; X8 and X9, X10, X11, X12; X9 and X10, X11, X12.

To study the similarity among states, cluster analysis has been used. It is observed that Maharashtra, Uttar Pradesh and Delhi is one group and has formed a 2 link cluster with rest of the states.

Figure – 1 showing cluster analysis among states



**REMARKS**

The attempt has been made to analyse crime data those of NCRB with 12 variables over 23 states has been made. Maharastra, Uttar Pradesh & Delhi may be very risky state in terms of crime as of 2017-18. On the other hand, every state tried to signify the number of disposed off cases from police. It may be the value of property or cruelty of crime or most socially impacted crime. More specific data may be published and freely available for more accurate policy decision framing.

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