

Spatial inequalities and industrial expansion : A critical appraisal of MIDC industrial development in Nagpur district

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Abstract

The study examines industrial growth dynamics in Nagpur district, Maharashtra, focusing on MIDC-created industrial estates. It emphasizes industrial development's role in regional economic changes by analyzing differences in project approvals, land allocation, employment, and capital investment from 2019 to 2024, using secondary data from socioeconomic surveys. Methods include paired t-test and Compound Annual Growth Rate (CAGR) analysis to evaluate industrial expansion's scope and significance, with

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GIS-based mapping revealing spatial disparities. Findings indicate significant variation in industrialization, with some tehsils experiencing rapid growth while others stagnate. Statistical results confirm temporal differences, showcasing Nagpur as an emerging industrial hub, underscored by locational advantages yet hindered by socio-economic and environmental challenges, guiding policymakers for balanced development.

Subject Classification: 62P25, 62H11, 91B84, 91B55, 62J05, 68U05.

Keywords: Industrial development, MIDC, Nagpur district, Spatial analysis, CAGR, Paired t-test, GIS.

Introduction

Industrial development is crucial for regional economic transformation, fostering job creation, productivity improvements, and altering socio-spatial structures [1], [2], [3]. Theories like growth pole theory and cumulative causation highlight the uneven and clustered nature of industrialization, leading to both spillover benefits and regional disparities [4], [5], [6]. The Maharashtra Industrial Development Corporation (MIDC) has played a significant role in fostering industrialisation by providing well-planned industrial estates in Maharashtra. Nagpur district, in central India, has become a significant industrial hub due to its strategic location, connectivity, and infrastructural base. The study reveals significant changes in employment between 2019 and 2024, while projects, area, and investment showed significant changes due to year-to-year volatility. However, all four indicators showed significant increasing trend over the time. This demonstrates the dynamic yet uneven trajectory of industrial development in Nagpur district, with moderate but steady growth in physical indicators and highly volatile but transformative investment growth. These patterns reflect industrial expansion and have implications for regional planning, resource allocation, and sustainable growth [7]. The study integrates quantitative analysis with geospatial visualisation to critically examine the spatial and temporal distribution of MIDC industrial development in Nagpur district, highlighting both opportunities and challenges associated with its industrial transition.

Review of Literature:

- Mankirat [8] examined industrial development in India post-reforms, using data from the Annual Survey of Industries. The study revealed

substantial inter-state disparities in fixed investment, output, and employment. While Maharashtra led in industrial growth initially, Gujarat and Tamil Nadu became significant industrial centers, with some states facing decline. It offers valuable insights into the structural transformation and shifts in industrial performance across states.

- Mishra [9] examines Nagpur City's economic conditions, focusing on employment patterns, working population, working density, and per capita income. An Oxford economic report predicts Nagpur will be the 5th fastest-growing city globally from 2019 to 2035, averaging an 8.41% growth rate. The paper aims to provide insights into Nagpur's economic landscape by analyzing various key indicators, including sectoral employment patterns, work-related population demographics, and individual income levels.
- Chobe [10] emphasizes the importance of infrastructure for industrial growth via the Maharashtra Industrial Development Corporation, asserting that well-planned industrial infrastructure is vital for economic prosperity and improved living standards. However, the study is primarily conceptual, lacking empirical analysis and detailed methodological explanations.
- Waghmare [11] examined the spatio-economic relationship of industries in the Greater Nagpur area using quantitative techniques like shift-share analysis and location quotient. The study employed spatial analysis tools to analyze industrial distribution patterns and regional structure, identifying leading and lagging industries, thus informing industrial location decisions.

Research Gap:

While prior research has described industrial distribution, few have statistically examined tehsil-wise spatial disparities using longitudinal data and GIS visualization. Additionally, there is a lack of studies that connect empirical findings to regional development theories like Growth Pole Theory and Cumulative Causation, indicating gaps in both methodology and theoretical understanding.

Study Area:

Nagpur district located in the centre of India, is a crucial part of socio-economic and industrial landscape of Maharashtra. Covering over 9892 sq.km., it features diverse physiographic features from fertile alluvial plains to Deccan Plateau [12]. Administratively divided into 14 tehsils, each with distinct developmental trajectories in land use, infrastructure, and industrial growth. The Maharashtra Industrial Development Corporation (MIDC), established in 1962 is the key player in the economic and spatial transformation of Nagpur district. It has developed a network of industrial estates including Butibori 5 Star Industrial Area, Hingana, Kalmeshwar, Umred, Narkhed, Katol, Sawner, and Bhiwapur, which cater to various industries, including textiles, chemicals, engineering, IT, food processing, and automobile manufacturing and logistic hubs. The Butibori Five-star industrial estate also known as industrial capital of Vidarbha, span over 2500 hectares and hosts leading firms in textiles, pharmaceuticals, and Power Generation. The Hingana Industrial Area, one of the oldest MIDC estates, supports SMEs and ancillary industries in Nagpur City. Newer industrial estates like Umred and Kuhi promote balanced regional development but raise concerns over environmental sustainability and agricultural land conversion [13]. The industrial growth of Nagpur is bolstered by its robust connectivity, including the golden Quadrilateral, Samrddhi Mahamarg Expressway, International Airport and Growing Container Rail terminals. This locational advantage makes Nagpur a favourable destination for both domestic and foreign investment [14].

Research Objectives:

- A Tehsil-wise Analysis of the Spatio-Temporal Dynamics of Industrial Development of MIDC projects in Nagpur district (2019 to 2024).

Research Methodology

Research Design: This study employs a mixed analytical approach combining statistical and spatial techniques.

Data collection: A secondary quantitative data (Table 1) gathered from a socio-economic survey of Nagpur district from the period of 2019 to 2024, prepared by the district statistical office, Nagpur, planning department, Maharashtra government, ensuring consistency through standardized annual reporting formats. Key indicators include number of

Table 1
Status of MIDC Industrial Projects in Nagpur District

Number Of Projects						Area Per Hecter								Employment (Lakh)								Investment (₹ Crore)									
Tahsils	2019	2020	2021	2022	2023	2024	2019	2020	2021	2022	2023	2024	2019	2020	2021	2022	2023	2024	2019	2020	2021	2022	2023	2024	2019	2020	2021	2022	2023	2024	
Bhivapur	7	7	7	10	10	10	2.24	2.24	2.24	9.07	9.07	9.07	20	20	82	25	75	75	75	1.5	1.5	1.6	39.1	44.1	44.1						
Hingna	1306	1306	1306	1316	1388	1417	312.45	312.5	312.5	535.44	535.44	540.44	24887	24887	25802	27500	27630	27830	61.3	61.3	173.7	6560.3	6595.92	6630.32							
Kalmeshwar	12	13	19	13	14	15	5.69	5.69	8.31	10.76	10.76	10.84	105	105	118	75	75	80	21.1	21.1	21.1	38.4	38.4	38.6							
Kamptee	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
Katol	125	125	139	114	110	118	83.28	83.28	83.28	96.31	96.31	98.76	2640	2640	2655	1100	1100	1150	45.8	45.8	45.8	356.92	356.92	366.92							
Kuhi	38	38	52	36	38	43	77.39	77.39	120.56	92.5	92.5	92.97	78	78	89	355	355	38	16	16	11	89.4	89.4	90.4							
Mauda	1	1	1	1	2	2	710.34	710.3	710.3	710.34	830.64	830.64	750	750	750	650	650	650	0.3	0.3	0.3	5500	12100	12100							
Nagpur Urban	1241	1241	1241	1343	1433	1454	923.17	923.2	923.2	1449.5	1462	1466	22634	22634	23431	23895	24991	25116	42.9	42.9	192.7	17314	17890.6	17925.6							
Nagpur Rural	1	1	1	35	33	33	6.64	6.64	6.64	5.33	5.33	5.33	1960	1960	1960	675	675	675	0.3	0.3	0.3	126.84	126.84	126.84							
Narkhed	5	5	5	4	7	8	0.63	0.63	0.63	6.2	6.2	6.7	15	15	183	65	65	70	4.3	4.3	11.24	25.94	25.94	28.8							
Parseoni	18	18	21	10	16	16	5.05	5.05	6.36	8.19	8.19	8.19	110	110	125	45	45	45	2.1	2.1	2.1	28.15	28.15	28.15							
Rantek	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
Saoner	38	38	43	34	43	45	52.35	52.35	52.35	61.39	61.39	61.55	560	560	575	275	275	290	18.8	18.8	0.8	74.74	74.74	75.98							
Umred	67	67	77	60	73	187	81.25	81.25	81.82	195.84	195.84	210.84	412	412	753	740	1707	2357	40.4	40.4	115.6	1876.81	2621.99	2678.99							
Total	2859	2860	2912	2976	3167	3348	2260.5	2260.5	2308.2	3180.9	3313.7	3341.4	54171	54171	56523	55400	57643	58376	254.8	254.8	576.1	32030.6	39993	40134.7							

Sources: (2019 to 2024 Socio-Economic Review and District Statistical Abstract of Nagpur District, n.d.) [15], [16], [17], [18], [19], [20]

projects, area developed (hector), employment (Lakhs), and investment (₹ crore). To strengthen reliability, data were cross-verified with MIDC annual reports.

Analytical Framework: The analysis is guided by a conceptual framework linking: Industrial drivers (policy, infrastructure) → spatial distribution (tehsil-level variation) → developmental outcomes (employment, investment, inequality).

Hypotheses:

Null Hypothesis: (H ₀)	There is a no significant relationship between number of projects, area developed, employment, and investment.
Alternative Hypothesis (H₁):	There is a significant relationship between number of projects, area developed, employment, and investment.

Research techniques:

- Spatial analysis technique of choropleth mapping using R software for displaying tehsil-wise Spatio-temporal variations.
- Spatio-Temporal Change detection in industrial indicators.
- Correlation and paired t-test to check the significance.
- Compound Annual Growth Rate (CAGR) = $\left[\left(\frac{\text{Final Value}}{\text{Initial Value}} \right)^{\frac{1}{\text{Years}}} - 1 \right] \times 100$

Results:

Spatial Analysis:

MIDC Industrial Area: The spatial expansion of the MIDC industrial zone in Nagpur district (Figure 1) from 2019 to 2024 exhibits a notable rise of almost 48%, increasing from 2260.48 hectares to 3341.35 hectares. Although this development strengthens the district's industrial importance in Vidarbha, it is not evenly spread. The main industrial centers, Nagpur Urban and Hingna, lead the growth, with Hingna expanding from 312.45 hectares to 540.44 hectares owing to its infrastructure benefits. Other peripheral tehsils such as Mauda are emerging as secondary industrial hubs, whereas Bhiwapur, Narkhed, and Parseoni show moderate growth, indicating the initial phases of industrial expansion. In contrast, Kamptee and Ramtek are mostly inactive, highlighting differences in regional

industrial progress. This distribution illustrates the dynamics of industrial concentration and the resulting spillover effects, with initial growth in central areas leading to wider diffusion into adjacent regions.

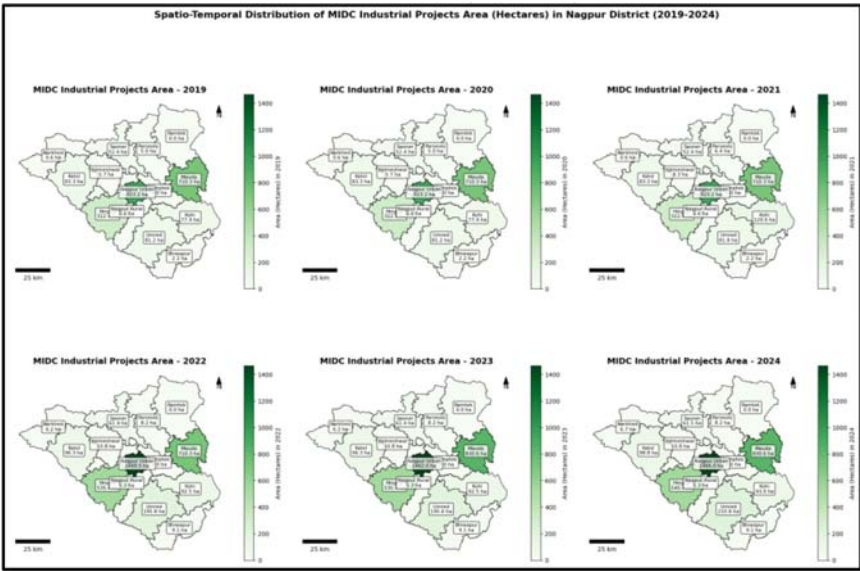


Figure 1

Spatio-Temporal Distribution of MIDC Industrial Projects Area (Hectares) in Nagpur district (2019-2024)

Source: Author-Self (Jupyter Notebook)

MIDC Industrial Projects: The count of industrial projects in Nagpur district (Figure 2) rose from 2859 in 2019 to 3348 in 2024, indicating an increase of about 17%. Nonetheless, the allocation of these initiatives is imbalanced, significantly prioritizing urban-industrial hubs such as Hingna and Nagpur Urban, which prevail in the industrial arena. This concentration highlights a core-periphery framework of industrial activities in regions with strong infrastructure and favorable policies. Conversely, Umred has developed into a key area for growth, with project figures increasing from 67 to 187, suggesting a potential shift in investment distribution. Other tehsils, including Katol, Kuhi, Saoner, and Parseoni, show variable industrial patterns, indicating difficulties in maintaining growth. The total lack of industrial initiatives in Kamptee and Ramtek emphasizes ongoing regional inequalities and restricted industrial growth in these regions.

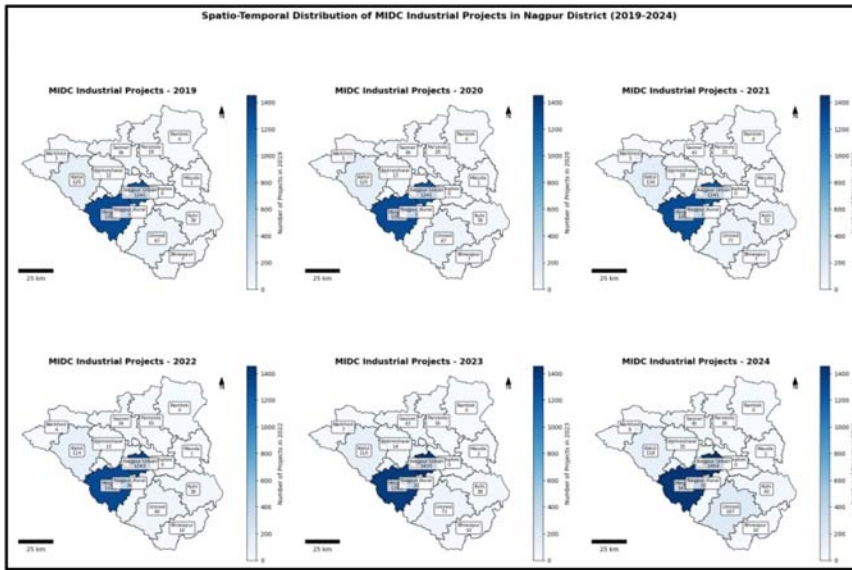


Figure 2

Spatio-Temporal Distribution of MIDC Industrial Projects in Nagpur district (2019-2024)

Source: Author-Self (Jupyter Notebook)

MIDC Industrial Investment: Industrial investment in the Nagpur district (Figure 3) has skyrocketed from ₹254.8 crore in 2019 to ₹40,134.73 crore in 2024, showing a substantial rise after 2021 due to the launch of large-scale, capital-intensive initiatives. Investment concentration is noticeable in particular tehsils like Nagpur Urban, Hingna, and Mauda, creating a high-investment corridor. Nagpur Urban constitutes a significant share of this investment, whereas Hingna serves as the industrial foundation of the district. Mauda's significant expansion is connected to new industrial growth hubs, possibly tied to major infrastructure or energy initiatives, and Umred also showcases heightened investor interest in areas that were previously less developed. Nonetheless, various other tehsils exhibit little to no investment, emphasizing the pronounced spatial disparity in capital allocation, where industrial development is biased towards a geographically confined and sectorally concentrated trend centered on capital-intensive industries.

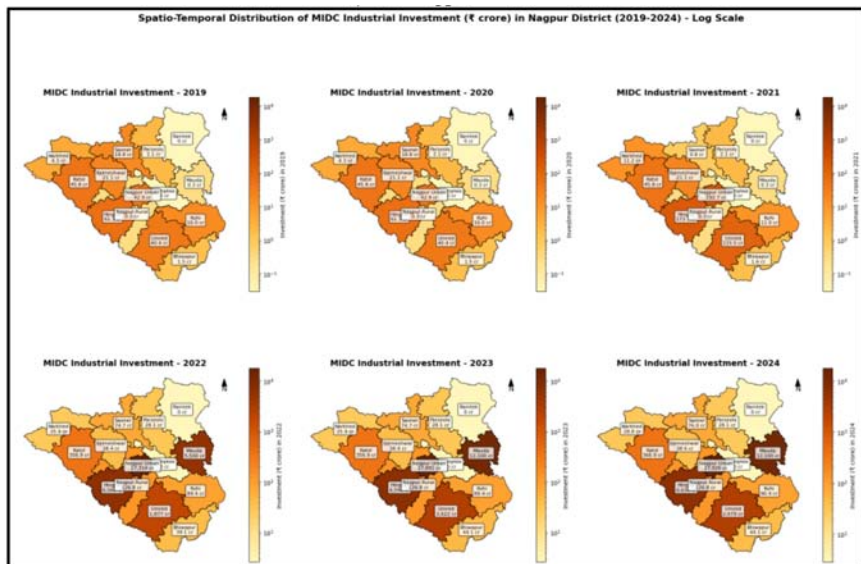


Figure 3

Spatio-Temporal Distribution of MIDC Industrial Investment (₹ Crore) in Nagpur district

Source: Author-Self (Jupyter Notebook)

MIDC Industrial Employment: Employment in MIDC industries (Figure 4) increased from 54,171 in 2019 to 58,376 in 2024, indicating a rise of around 7.8%. Employment concentration is significantly high in Nagpur Urban and Hingna, indicating that job opportunities are centralized in established industrial areas, with few advantages reaching surrounding regions. Umred distinguishes itself with considerable job growth, signifying its evolution as an emerging industrial zone. Conversely, various tehsils like Bhiwapur, Katol, Saoner, and Parseoni show varying or decreasing employment numbers, suggesting instability in their industrial sectors. A significant drop in Nagpur Rural employment after 2021 indicates shifts in industrial operations. Moreover, the absence of new jobs in Kamptee and Ramtek highlights their marginalization from industrial progress. In general, although employment has risen due to industrial expansion, its distribution is uneven and concentrated spatially, which impedes inclusive regional progress.

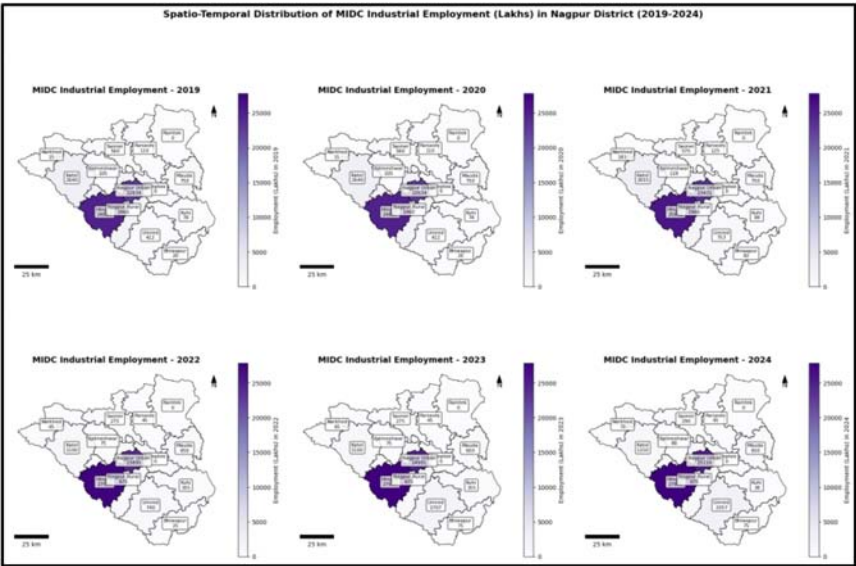


Figure 4
Spatio-Temporal Distribution of MIDC Industrial Employment in Nagpur district (2019-2024)

Source: Author-Self (Jupyter Notebook)

Discussion:

Change detection:

Table 2
Percentage Change in MIDC Industrial Indicators in Nagpur district (2019-2024)

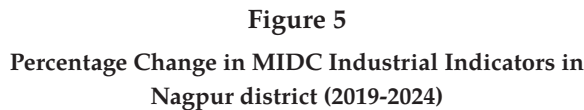
% Change (2019 to 2024)				
Tehsil	Projects	Area	Employment	Investment
Bhiwapur	42.86	304.91	275.00	2840.00
Hingna	8.50	72.97	11.83	10716.18
Kalmeshwar	25.00	90.51	-23.81	82.94
Kamptee	0.00	0.00	0.00	0.00
Katol	-5.60	18.59	-56.44	701.14
Kuhi	13.16	20.13	-51.28	465.00
Mauda	100.00	16.94	-13.33	4033233.33

Contd...

Nagpur Urban	17.16	58.80	10.97	41684.69
Nagpur Rural	3200.00	-19.73	-65.56	42180.00
Narkhed	60.00	963.49	366.67	569.77
Parseoni	-11.11	62.18	-59.09	1240.48
Ramtek	0.00	0.00	0.00	0.00
Saoner	18.42	17.57	-48.21	304.15
Umred	179.10	159.50	472.09	6531.16

Source: Author-Self (Microsoft Excel)

The analysis of percentage change (2019–2024) reveals notable spatial disparities in industrial growth in Nagpur district (Table 2 and Figure 5), illustrating a polarized development trend. Prominent industrial hubs like Nagpur Urban and Hingna flourish because of improved infrastructure and favorable policies, acting as growth magnets aligned with François Perroux’s Growth Pole Theory. In contrast, regions such as Kamptee and Ramtek display stagnation, indicating a deficiency in investment spread and a propensity for regional inequalities as described by Gunnar Myrdal’s Cumulative Causation Theory. Tehsils such as Umred and Narkhed exhibit slight progress, although growth is still confined to specific areas. A significant problem stems from the disparity between increased investment and the generation of jobs, especially in Mauda, Hingna, and Nagpur Urban, suggesting a shift towards capital-heavy industries with few job prospects. Furthermore, tehsils like Katol, Kuhi, Parseoni, and Saoner are experiencing falling employment rates despite moderate industrial development, which raises worries about the sustainability of industries and the retention of labor. The results indicate that national programs like Make in India could inadvertently enhance spatial concentration instead of fostering equitable development. The core–periphery model demonstrated in the district’s growth shows that developed centers gain advantages unevenly, and the impacts of industrialization are not adequately reaching surrounding regions. Consequently, there exists an urgent requirement for policies focused on equitable industrial growth, emphasizing infrastructure improvements, decentralized planning, and the promotion of labor-intensive industries to alleviate these spatial disparities.



Correlation Matrix: The analysis employing Karl Pearson's correlation (Figure 6) reveals robust positive correlations among essential industrial indicators, demonstrating a structurally cohesive growth trend. A nearly flawless correlation ($r = 0.998$) between industrial zones and investments indicates that land development stimulates capital influx, showcasing the strategic industrial growth supported by MIDC. Moreover, the associations among projects indicate strong links with employment ($r = 0.90$) and investment ($r = 0.86$), suggesting that industrial growth depends on both capital and labor resources. Nonetheless, the decreased correlation ($r = 0.75$) between employment and investment indicates a partial separation of these elements, implying a move towards capital-intensive industrial growth. This brings up worries about the restricted employment responsiveness in existing industrial growth trends.

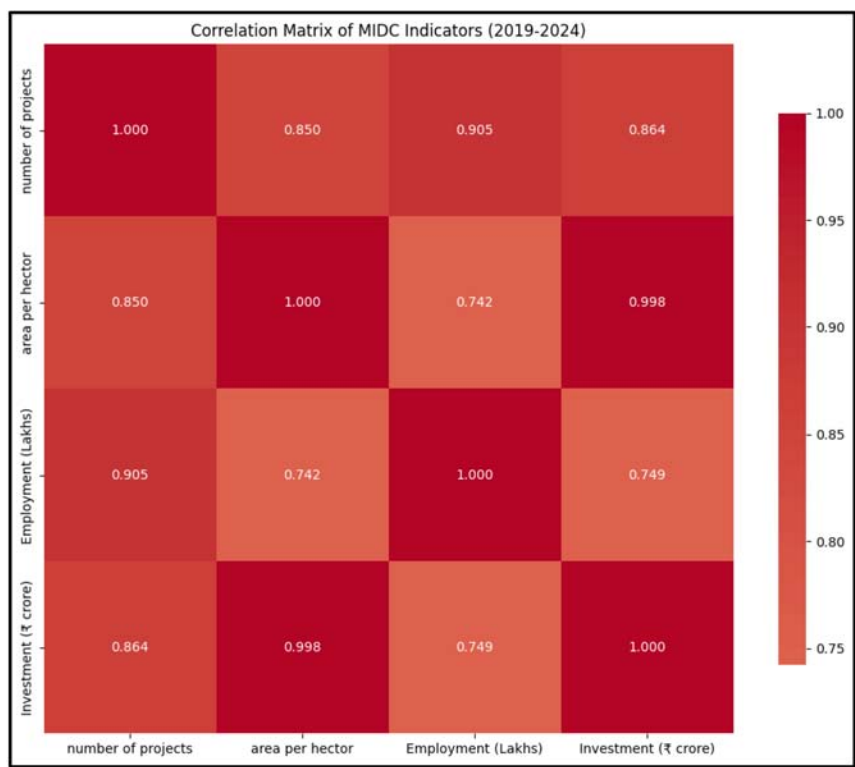


Figure 6
Correlation Matrix of MIDC Indicators (2019-2024)

Source: Author-Self (Jupyter Notebook)

- **Paired t-test:** The paired t-test (Table 3) assessing 2019 to 2024 figures shows statistically significant increasing trends in all industrial indicators ($p < 0.05$). The most significant increase happens in Investment (₹ 10,001.97 crore annually), followed by Employment (866.23 Lakhs annually), Area (269.62 ha annually), and Projects (98 annually). These findings indicate consistent industrial growth instead of arbitrary variations. Correlation analysis ($r > 0.74$) indicates a strong positive relationship among indicators, confirming the rejection of Null Hypothesis (H_0) and the acceptance of Alternative Hypothesis (H_1). The results underscore growth driven by cumulative policies and stress the importance of long-

term monitoring rather than merely relying on basic point-to-point comparisons.

Table 3
Linear Regression Trend Analysis

Indicator	Slope (per year)	R ² Value	P-value	Trend Significance
Number of Projects	98	0.8649	0.0072	Significant↑
Area per Hectare	269.62	0.8353	0.0108	Significant↑
Employment (Lakhs)	866.23	0.8388	0.0103	Significant↑
Investment (Crore)	10001.97	0.8339	0.011	Significant↑

Source: Author-Self (Microsoft Excel)

- **Compound annual growth rate (CAGR):** CAGR analysis (Figure 7) uncovers variations in industrial growth patterns. Projects exhibit a modest CAGR of 3.21%, reflecting stable industrial approvals, whereas industrial area growth surpasses this at 8.13%. Job growth lags notably at 1.51%, indicating a gap between industrial expansion and job opportunities, likely impacted by automation and advancements in efficiency. Despite exhibiting an impressive CAGR of 175.08%, the sustainability of investment seems questionable, probably due to irregular large investments instead of a continuous influx.

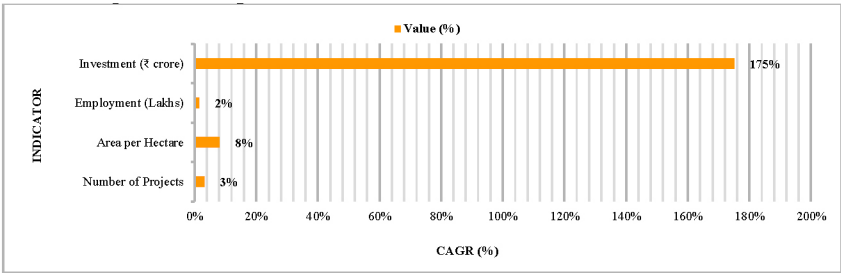


Figure 7
Compound Annual Growth Rate (CAGR 2019–2024)

Source: Author-Self (Microsoft Excel)

Conclusion:

- The spatio-temporal examination of industrial progress in the Nagpur district from 2019 to 2024 showcases a dual trend of swift expansion coupled with ongoing spatial disparities. Tehsils such as Nagpur Urban and Hingna, along with developing areas like Umred and Mauda, are witnessing significant industrial growth, whereas peripheral regions like Kamptee and Ramtek continue to be sidelined. This imbalance indicates a core-periphery development framework.
- The results align with François Perroux's Growth Pole Theory, suggesting that industrial development often clusters in particular areas, and Gunnar Myrdal's Cumulative Causation Theory, which clarifies how early benefits sustain regional disparities. The restricted spillover impacts of industrial advantages underscore major limitations on equitable regional growth, as research shows that disparities within districts reflect larger regional inequalities.
- Additionally, in spite of significant investments in the area, job growth remains rather slow, indicating a move towards capital-intensive industrialization that restricts labor absorption. Tackling skill shortages and boosting local workforce engagement is essential for promoting inclusive industrial advancement and guaranteeing fair access to opportunities, both of which are vital for attaining thorough regional progress.

Suggestions:

The results indicate a requirement for focused and decentralized industrial policy actions, such as:

- Enhancing infrastructure in underdeveloped tehsils.
- Supporting industries that require a lot of labor in addition to those that demand significant capital.
- Offering motivations for industrial distribution outside of traditional centres
- Synchronizing regional planning with programs like Make in India and the industrial policy framework of Maharashtra.

These strategies can improve equitable industrial distribution and diminish spatial clustering [21], [22].

Future scope of research:

The research relies on a brief dataset; consequently, future studies should:

- Broaden the time range (e.g., 2010–2024) to identify long-term patterns.
- Utilize spatial econometric methods like Moran's I or Gini coefficients to assess industrial concentration.
- Utilize primary surveys to investigate company-specific behavior and workforce patterns.
- Carry out a comparative analysis with different MIDC areas to enhance generalizability.

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