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Beyond the Industrial Enclave: Analysing the Spatial and Socio-Economic Impact of Pithampur Automobile Cluster, India

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ABSTRACT

Industries are considered engines of growth for an economy. Developing countries like India have attempted to boost economic growth by initiating industrialization in areas unsuitable for industrial growth. Most studies on industries/industrial clusters focus on their financial performance, backward and forward linkages, and managing the supply and demand chains, rather than the socioeconomic and spatial influence on their locations and surrounding regions. Such studies are critical in determining which industry contributes to regional growth and what their spatial influences are. This paper contributes to this domain of research. In this study, the Pithampur Automobile Cluster (PAC) is examined. It was developed by the Government in 1984 with the intent to develop a backward area in the state of Madhya Pradesh in India. The study aims to discern PAC's influence on its surroundings, encompassing Pithampur town, adjacent villages, and towns within a 12–15-kilometer radius. Data from multiple census years (1981, 1991, 2001, 2011) and Land Use Land Cover (LULC) Analysis through GIS for the years 1981, 1991, 2001, 2011, and 2021 are employed. Contrary to expectations, the study reveals that the impact of industrial development is primarily confined to the boundaries of Pithampur, with surrounding villages showing relative detachment. The emergence of growth corridors is attributed to the appeal of neighbouring towns that offer better amenities and a more economically viable living environment.

1. INTRODUCTION

Industrial clusters drive economic growth by fostering synergies among interconnected businesses, exemplified by hubs like Biotechnology in Boston, Information Technology in Silicon Valley, Entertainment in Hollywood, Horse Trailer manufacturing in North Texas, Marine Technologies in Eastern North Carolina, Wine in Southern Washington etc. Firms in a cluster enjoy economies of scale and perform better than when they stand in isolation. This advantage is supported by Marshall (1890), Hoover Edgar M. (1948), Myrdal (1957), M. E. Porter (2003) and Krugman (2007) who are among the many economists who vociferously argued and analysed the functioning of clusters. Many theories discuss why

industries come together and where they should be located for optimum benefit. Numerous synonyms exist for the term "cluster", including 'agglomeration', 'industrial district', and 'industrial complex'. These terms are employed across various theories and explanations to denote similar concepts of concentrated economic activity.

Presently the term 'industrial cluster' is being widely used and it is much associated with the works of Michel E. Porter. Porter (1990) highlights their impact on competition through increased productivity, innovation, and the formation of new enterprises. This aligns with the emphasis of the ninth Sustainable Development Goal on inclusive industrial development and resilient innovation for sustainable economic progress. Governments have prioritized the promotion of these clusters, integrating them into economic growth strategies to leverage their inherent economic power. In the West, particularly in the United States, a market-driven policy with a focus on framework conditions is prevalent. The European Union (EU) countries display a strong cluster approach, with the EU actively supporting cluster development through various programs and initiatives (Ketels, 2017). Asian cluster policies are diverse, focusing on the global market rather than regional integration (Ketels, 2015). China follows a top-down approach, emphasizing export-oriented manufacturing through specialized towns like Socks City and Footwear Capital. Japan nurtures natural industrial clusters, like the textile cluster in Fukui and Ishikawa prefectures, following a top-down approach in cluster policy implementation (Yamawaki, 2002).

India's post-colonial industrialization history until 2007 was marked by sporadic state and institute-level initiatives aimed at fostering industrial clusters. However, it was only after the eleventh Five-Year Plan (2007-2011) that significant efforts were made to propel the creation of industrial clusters (Ministry of Commerce and Industry, 2011). Since then, numerous strategies and programs for developing industrial clusters have been launched at both the state and central government levels. According to the Foundation for MSME Clusters (FMC), there were 1300 industrial clusters, 2494 handicraft clusters, and 567 handloom clusters scattered across India, in addition to micro-enterprise clusters and services (The Foundation for MSME Clusters (FMC), 2023).

Many of these clusters were strategically planned in various regions as part of decentralization initiatives or backward area development drives, to leverage local and regional economies. In a developing country like India, grappling with unemployment, high rural-urban migration, housing shortages, and the burden of deteriorating urban infrastructure, planned industrial clusters situated in remote rural areas offer a potential solution to the source of these challenges. The Pithampur Automobile Cluster (PAC), the focus of this research, is one such planned industrial cluster in the state of Madhya Pradesh (MP). It was developed as part of the Growth Centre Approach adopted by the Madhya Pradesh government in the early '80s, under the auspices of the backward area development program (Madhavi et al., 2022). It is undeniable that industrial clusters possess the capability to propel an economy forward, however, while the existing body of literature offers numerous insights into the formation and financial performance of industrial clusters, there remains a noticeable dearth of studies exploring their socio-economic ramifications. Most studies on industrial clusters tend to focus on aspects such as financial performance, backwards and forward linkages, and supply chain management. These critical studies have largely overlooked these clusters' socio-economic and spatial influences on their immediate locations and surrounding regions. Understanding these dynamics is pivotal in determining which clusters contribute to regional growth and what specific spatial impacts they wield. Thus, this research explores this uncharted domain of industrial clusters by delving into their spatial and socio-economic ramifications. The Pithampur Automobile Cluster (PAC) offers an intriguing case study, as it did not emerge in proximity to existing urban centres or economies of scale, but rather in an agrarian setting in Madhya Pradesh, marked by highly unfavourable conditions for industrial growth.

2. LITERATURE REVIEW

Industrial clusters play a pivotal role in the economic development of regions, extending their influence beyond mere job creation, income growth, and infrastructure development to encompass a broader impact on local economies. According to Khalid and Barrientos (2004) these clusters are central to addressing poverty, exerting both direct and indirect impacts on economic well-being. On a direct level, they contribute significantly to job creation, income growth, and the improvement of living conditions for the working poor. Indirectly, industrial clusters wield a more widespread influence on local economies, typically finding their place in rural areas and the informal economies of metropolitan regions. McCormick (1999) examines the dynamics of industrial clusters in Africa, concluding that while they primarily generate low-wage jobs, these employment opportunities play a crucial role in helping people overcome poverty. Examining Peru's garment industry, Visser (1999) notes that firms within clusters tend to offer higher wages compared to those outside the industry cluster. Similarly, Notteboom et al. (2022) found that industrial clusters within harbour areas are significant employment generators employing a diverse labour force involved in cargo handling, ship operations and services, land transport, logistics operations, cargo services, industrial production, and government agencies. Ó hUallacháin (1992) identifies industrial clusters as credible indicators of metropolitan

employment and per capita income growth, noting variations in their impact on urban growth across different industries. Waldhorn et al. (1998) also found similar results. They studied 'new economy' industries and a group of 'traditional' industries in each metropolitan region in the U.S. Results revealed a positive association of concentration of new economy clusters in a metro region with the regional prosperity measures, namely, regional employment growth, growth in average wages, growth in real wage for the period 1975-1996. In contrast, traditional clusters negatively influence prosperity. Porter (2003) advocates for a focus on traded clusters in regional economic development policies, as they not only contribute to higher salaries but also drive local employment and wages. Larreina and Aguado (2008) illustrate the positive relationship between the performance of the wine cluster in Rioja, Spain, and regional economic development, showcasing its significant contribution to the local GDP. Wheaton and Lewis (2002) explore the effects of industrial and occupational specialization on manufacturing wage levels, finding positive correlations. Gibbs and Bernat (1997) investigate the impact of industry clustering on wages, identifying positive and significant cluster wage premiums for multiple manufacturing industries nationally. Feser et al. (2008), present evidence linking industry clustering to new business formation in the Appalachian region, emphasizing that clusters might contribute to economic development objectives but do not guarantee significant job growth. A comprehensive study on India indicates that significant disparities in regional economic performance across India are linked to considerable variations in the presence and strengths of industrial clusters. States with high GDP, as well as districts in the Top 70 and middle groups, typically host a variety of robust clusters, evidenced by a high number of three-star clusters and substantial overall cluster strength. Key economic metrics of these regions, such as Gross Domestic Product, innovation, and export levels, show a positive correlation with cluster strength, supporting theoretical expectations (Ketels et al., 2023).

Some works have highlighted the limitations of industrial clusters. For example, Morgan (2004) acknowledges their potential as an economic development strategy for metropolitan regions but emphasizes the complexity of their impact, noting that not all ventures are equally competitive within cluster strategies. Henderson (2002) emphasizes the importance of optimal city size for maximizing economic benefits, cautioning against excessive growth beyond a certain point. Fowler and Kleit (2014) found that industrial clusters are linked to lower poverty rates, especially in regions where employment spans multiple industries within the clusters, compared to those focused on a single industry. As one can see, the trend of scholastic research gravitating toward cluster-related studies is relatively new, having begun only three decades ago. It would not be wrong to say that there has been a surge of studies exploring various cluster dimensions since Porter (1990) acquainted the world with his insights on industrial clusters. Only recently, studies have begun to link industrial clusters to regional economies. This study contributes to this less-explored research domain.

3. METHODOLOGY

Various ramifications of the automobile cluster in Pithampur are analysed under the following sub-heads: a) Document the intercensal demographics in and around the Pithampur automobile cluster (Office of the Registrar General & Census Commissioner, 2011), b) Map the changes in terms of agriculture, built-up, water bodies, etc. (Satellite imagery).

To assess the influence of the Pithampur Automobile Cluster (PAC) on the broader region, our study encompasses Pithampur town, the surrounding villages, and other towns located within a radius of 12-15 kilometres from the centre of Pithampur. This study includes a total of 165 villages and incorporates data from three censuses for the towns: Mhow, Mhow Gaon, and Betma as illustrated in (Figure 1). Two methods have been used for the analysis: (i) Intercensal Analysis and (ii) LULC Change Analysis.

3.1. Intercensal analysis

Intercensal analysis plays a pivotal role in regional planning as it offers invaluable insights into the transformation of a region over time. This analysis is achieved by comparing and contrasting data collected during four consecutive censuses, providing a comprehensive view of shifts in a range of key factors, including population dynamics, economic activities, infrastructure, and more.

3.2. Study indicators

In our research, we focus on three primary indicators to assess the impact of the Pithampur Automobile Cluster (PAC) on the region.

3.2.1. Change in percentage of other workers

Definition: Other workers encompass individuals engaged in economic activities within the past year, excluding cultivators, agricultural labourers, or workers in household industries.

Significance: This indicator sheds light on alterations in the composition of the workforce, offering insights into the diversification of economic activities within the region. In this research, an increase in other workers means people moving towards the manufacturing and service sectors.

3.2.2. Change in sex ratio

Definition: Sex ratio is a crucial demographic measure indicating the number of females per 1,000 males within a specific population or age group.

Significance: The sex ratio serves as a key indicator for tracking gender imbalances and societal changes over time.

3.2.3. Change in percentage of irrigated land

Definition: This refers to land artificially supplied with water for agriculture, ensuring consistent water availability for crops.

Significance: Examining alterations in the extent of irrigated land provides a deeper understanding of the region's agricultural practices and resource management.

3.3. Study focus

The research primarily focuses on assessing the impact of the Pithampur Automobile Cluster (PAC) on the demographic landscape of Pithampur, the surrounding villages, and nearby towns (Fig. 1).

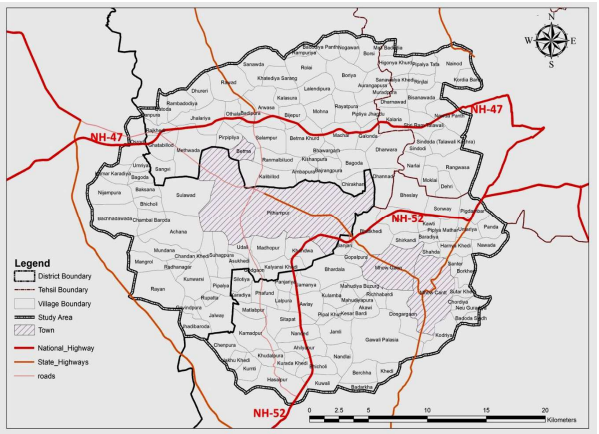

Fig. 1. The region under consideration for the study *(source: developed by the authors using data from Census of India, 2011).*

This assessment is conducted by tracking changes in demographic figures from 1981 through to 2011, spanning multiple census periods.

3.4. Limitations

A limitation of this study is that it relies on census data available up to the year 2011. The census data for 2021 could not be released to date by the government due to various reasons, including the occurrence of the COVID-19 pandemic and delays in freezing administrative boundaries. While the 2011 data provides valuable insights, it is essential to recognize that it may not capture more recent developments or changes that have occurred in the years following 2011. Nevertheless, the available data offers a comprehensive foundation for our analysis of the effects of PAC on the region. The shortcomings of this have been compensated by the LULC change analysis study as it provides very recent data substantiating the results of intercensal analysis.

3.5. LULC change analysis

One of the methodologies employed to extract information from satellite imagery is the Land Use and Land Cover (LULC) classification. In our study, we identified a total of five distinct LULC classes, adhering to the NRSC Level I classification scheme. These classes encompass Agricultural Land, Water Bodies, Built-up Areas, Fallow Land, and Barren Land. To ensure the accuracy of our LULC classification, field validation was conducted through post-classification field visits. This step was crucial in confirming the identified LULC classes. Subsequently, we estimated LULC changes by generating multi-temporal raster layers for the years 1981, 1991, 2001, 2011, and 2021. The comparison of corresponding statistics within these layers allowed us to assess changes over time. Specifically, Landsat 3 (MSS) data was used for 1981, Landsat 5 (TM) data for 1991 and 2011, Landsat 7 (ETM) data for 2001, and Landsat 8 (OLI/TIRS) data for 2021. The data was obtained from the United States Geological Survey (USGS) Earth Explorer for LULC mapping and change analysis. The spatial resolution of the Landsat TM data was 30 meters, and for OLI/TIRS data, it was 15 meters, following the incorporation of the panchromatic band. Further details regarding the satellite data used in this study can be found in Table 1.

Table 1. Details of the satellite data used.

No.	Satellite	Sensor	Spectral Band	Month/Year of Acquisition	Path/Row	Average Cloud Cover
1	LANDSAT 3	MSS	7	Apr 6, 1981	157/044	0.00
2	LANDSAT 5	TM	7	Jan 25, 1991	146/044	0.00
3	LANDSAT 7	ETM	7	Dec 14, 2001	146/044	0.00
4	LANDSAT 5	TM	7	Jan 16, 2011	146/044	0.00
5	LANDSAT 8	OLI_TIRS	11	Feb 28, 2021	146/044	0.00

The map of the study area was extracted from the Survey of India Toposheet at a scale of 1:50,000. Landsat data, used for the study has a 30m resolution, meaning each pixel stands for a 30m x 30m area on the ground. It is considered a medium-resolution image, which implies that the level of detail is not fine enough to distinguish individual objects like houses or cars. The satellite images downloaded for the study are from

different seasons of the year and so we see sudden rise and fall in the area of agricultural and fallow land. In the present study, both these land covers are taken together and considered as land available for cultivation.

4. RESULTS

The subsequent sections intricately explore the specific details and implications revealed by each methodological approach. These sections highlight the complex interrelationships between industrial development and the dynamics of the broader region, offering a deeper understanding of the many-sided impacts and consequences associated with the Pithampur Automobile Cluster.

4.1. Intercensal changes

While Pithampur town has undergone a remarkable shift in occupational dynamics, with the percentage of "Other Workers" surging from 7.6% in 1981 to a substantial 84% by 2011, the surrounding villages present a different picture. In the neighbouring villages, the shift towards "Other Workers" is more modest, increasing from 9.5% in 1981 to 18% in 2011. This significant difference underscores the distinctive employment patterns and transformations within Pithampur town compared to its surrounding rural areas (Table 2). An intriguing observation is that the corridors connecting Pithampur with neighbouring towns like Mhow, Betma, and Indore via Rau have experienced substantial shifts in occupation towards "Other Workers" compared to the remaining surrounding villages. Mhow, for instance, had already established itself as a town encompassing a cantonment, boasting a significant non-agricultural workforce. Additionally, the growth of industries in Pithampur prompted many migrants to settle in Mhow and the corridor linking Mhow with Pithampur (Mhow-Neemuch Road). This migration was primarily driven by the superior social and physical services offered by Mhow town.

Similarly, Betma, located to the north of Pithampur, has been significantly influenced by the industrial expansion in Pithampur. The very emergence of Betma as a town can be attributed to the growth of Pithampur. Positioned near Sector 3 and Kheda of the Pithampur Industrial Area, Betma has become home to a substantial number of workers directly or indirectly associated with Pithampur's industries. It is worth noting that the distance between Pithampur and Indore is greater in comparison to the distance between Pithampur and Betma or Mhow. Consequently, the corridor connecting Pithampur with Indore via Rau is experiencing change at a notably slower pace when compared to the other corridors.

Table 2. Percentage of other workers.

No.	Location	1981	1991	2001	2011
1	Pithampur	7.6	39.2	87	84
2	Mhow Cant	46	97	96.1	95.7
3	Mhow Gaon	63	81	86.8	88.5
4	Betma	46	55	71.9	76.1
5	Surrounding villages excluding Betma, Mhow Cant and Mhow	8.5	13.2	16.4	17
6	Villages along Pithampur- Mhow Corridor	22.2	52	64.2	64.2
7	Villages along Betma Corridor	46	55	71.9	76.1
8	Villages along Pithampur-Rau-Indore Corridor	12.8	15.4	18.9	24.4

Source: Census of India (1981, 1991, 2001, 2011).

Table 3. Change in sex ratio.

No.	Location	1981	1991	2001	2011
1	Pithampur	850	789	714	796
2	Mhow Cant	842	874	841	862
3	Mhow Gaon	919	855	867	900
4	Betma	936	905	951	949
5	Surrounding villages excluding Betma, Mhow Cant and Mhow Gaon	934	912	934	942
6	Villages along Pithampur- Mhow Corridor	904	873	852	908
7	Villages along Betma Corridor	936	905	951	949
8	Villages along Pithampur-Rau-Indore Corridor	919	841	863	836

Source: Census of India (1981, 1991, 2001, 2011).

In contrast to the changing sex ratio observed in Pithampur town (as depicted in Table 3), the sex ratio in the surrounding villages has remained relatively stable. This could be because not many male migrants who work in Pithampur prefer to live in nearby towns when allowed to reside close by industries in cheap locations saving on commuting. Additionally, the stable sex ratio in these villages might be a result of the absence of significant outmigration, possibly due to favorable returns from agriculture during this period.

In Madhya Pradesh, irrigation has been crucial to the growth and development of agriculture. Gross irrigated area has increased from 4.3 million ha in 2000–01 to 10.3 million ha in 2014–15 (Gulati et al., 2021). As has been the overall case of Madhya Pradesh where agriculture has improved over the years, the same scenario can be seen in villages around Pithampur. Over time, the land under irrigation has increased in the surrounding villages (Table 4). According to the census of India, the land under irrigation in 1981 for the surrounding villages of Pithampur was 11.4 % which rose to 45.2 % in the year 2011.

Table 4. Percentage of irrigated land.

No.	Location	1981	1991	2001	2011
1	Pithampur	7.7	14.3	N.A	N.A
2	Mhow Cant	N.A	N.A	N.A	N.A
3	Mhow Gaon	N.A	N.A	N.A	N.A
4	Betma	12.8	N.A	N.A	N.A
5	Surrounding villages excluding Betma, Mhow Cant and Mhow Gaon	11.4	26	42.4	45.2

Note: N. A (Not Applicable) – As they come under the urban area. *Source: Census of India (1981, 1991, 2001, 2011).*

4.2. Land Use/Land Cover analysis (LULC)

In this study, LULC change analysis provides a comprehensive picture of development in Pithampur, nearby villages and towns, and specific growth corridors connecting Pithampur to other towns. The changes in surface cover that have occurred, notably the growth in the built-up area, which is indicative of an increase in population in and around Pithampur, indicates the specific regions of development.

Table 5. LULC changes in Pithampur, nearby towns, and the surrounding villages.

Location	Land cover in percentage	1981	1991	2001	2011	2021
Pithampur	Built-up	2.13	6.3	11.2	22.8	35.3
	Agriculture	47.7	14.5	15.3	36.5	17.6
	Fallow	22.92	33.6	24.5	15.6	24.1
	Water body	0.005	1.5	0.8	1.3	2.0
	Barren land	27.14	44.2	48.2	23.8	21.0
Mhow Cant	Built-up	3.6	15.9	21.3	30.8	27.5
	Agriculture	22.4	11.9	7.8	8.5	24.6
	Fallow	9.6	38.3	18	31.1	18.8
	Water body	0.0	0.0	0.1	0.0	2.0
	Barren land	64.4	33.9	52.8	29.5	27.2
Mhow Gaon	Built-up	0.0	3.3	5.4	11.3	19.2
	Agriculture	23.1	15.4	10.9	14.3	15.6
	Fallow	7.9	23.6	13.4	22.8	18.3
	Water body	0.7	0.6	0.3	0.9	1.5
	Barren land	68.3	57.2	70.1	50.7	45.4
Betma	Built-up	0.0	2.0	2.5	1.6	8.3
	Agriculture	62.71	15.2	27.2	76.7	12.8
	Fallow	31.47	65.7	45.9	18.7	65.1
	Water body	0.00	0.0	0.0	0.0	0.2
	Barren land	5.82	17.1	24.3	3.0	13.6
Surrounding villages excluding Betma, Mhow Cant and Mhow Gaon	Built-up	0.8	2.6	4.4	7.3	12.6
	Agriculture	50.8	20.7	16.6	42.8	25.2
	Fallow	23.5	43.7	38.4	29	38.8
	Water body	0.4	0.6	0.2	0.5	1.1
	Barren land	24.5	32.4	40.5	20.3	22.3
Overall	Built-up	0.97	3.3	5.5	9.21	14.89
	Agriculture	49.35	19.7	16.1	41.27	24.26
	Fallow	22.87	42.3	36.1	27.74	37.23
	Water body	0.36	0.8	0.4	0.6	22.45
	Barren land	26.45	33.9	41.9	21.18	22.45

Source: developed by the authors using satellite imagery.

4.2.1. LULC changes in Pithampur

Pithampur has seen a substantial expansion in the built-up area, as shown in Table 5 and Figure 2. In 1991, the total built-up area was only 6.3%, but by 2021, it had risen to 35.3%. This increase can be attributed to the built-up area that contributes to industrial development as well as the one that accommodates

population growth. According to the survey, a significant land parcel of barren land has been exploited for industrial development and the development of the National Automotive Test Track (NATRAX) in Pithampur (Madhavi et al., 2022). This is one of the probable reasons for the decrease in barren land. Agriculture continues in Pithampur. The LULC changes do not show much reduction in the land available for cultivation (land under agriculture and fallow). As it was found in the survey, the residents of Pithampur still practice agriculture within the municipal boundaries.

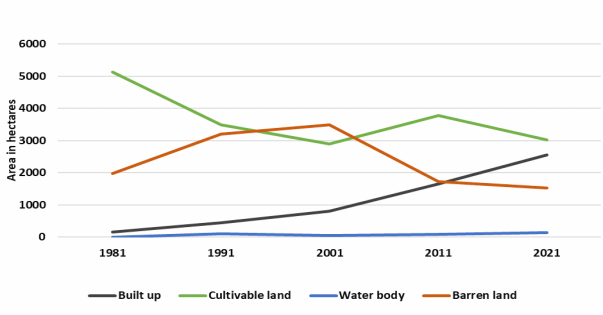

Fig. 2. LULC changes in Pithampur *(source: developed by the authors using satellite imagery).*

4.2.2. LULC changes in the nearby towns

The Land Use and Land Cover (LULC) changes in the nearby towns, specifically Mhow, Mhow Gaon, and Betma, illustrate a notable evolution in their physical environments. The expansion of built-up areas in both Mhow and Mhow Gaon indicates a significant shift toward urbanization, with historical factors like the establishment of Mhow Cant in 1818 and the ongoing influence of Pithampur's industrial growth playing pivotal roles. This transformation extends to Betma, where substantial growth is evident, particularly in response to the demand for housing arising from direct and indirect employment opportunities generated by Pithampur industries. The surge in real estate development further underscores the changing land use patterns in these towns. Importantly, the commuting patterns of workers during morning and evening shifts emphasize the interconnected nature of these towns with Pithampur, forming a cohesive regional landscape shaped by industrial and economic dynamics. This intricate interplay between historical, industrial, and residential factors contributes to the observed LULC changes in the nearby towns, reflecting a comprehensive transformation in their land use and cover over time.

4.2.3. LULC changes in the surrounding villages

The surrounding villages of Pithampur have been less affected by industrial development in Pithampur. There has been a very gradual increase in the built-up area (Fig. 3). Only 2.6% of land in villages was underbuilt in 1981, increasing to 12.6% in 2021. The surrounding villages are more into agricultural activity. The survey conducted with the villagers found no incidences where an industrial worker resided in these villages. An in-depth analysis of Land Use and Land Cover (LULC) changes in the adjacent villages does not indicate a significant reduction in land available for cultivation. Moreover, the positive trajectory of agricultural activities is supported by the overall increase in irrigated land across the state of Madhya Pradesh as has been discussed in section 4.1. Some reduction in the barren land can also be attributed to the development of National Automotive Test Tracks (NATRAX) in which case, along with agricultural land, barren land has also been acquired for the development of test tracks. The land has been acquired from three villages, namely Madhopur, Asukhedi, and Udali.

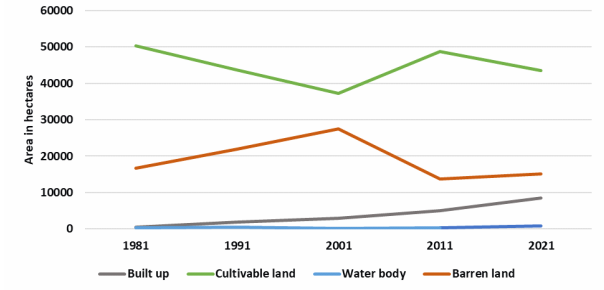

Fig. 3. LULC changes in the surrounding villages *(source: developed by the authors using satellite imagery).*

The LULC maps for the years 1991, 2001, 2011 and 2021 are presented in Figure 4.

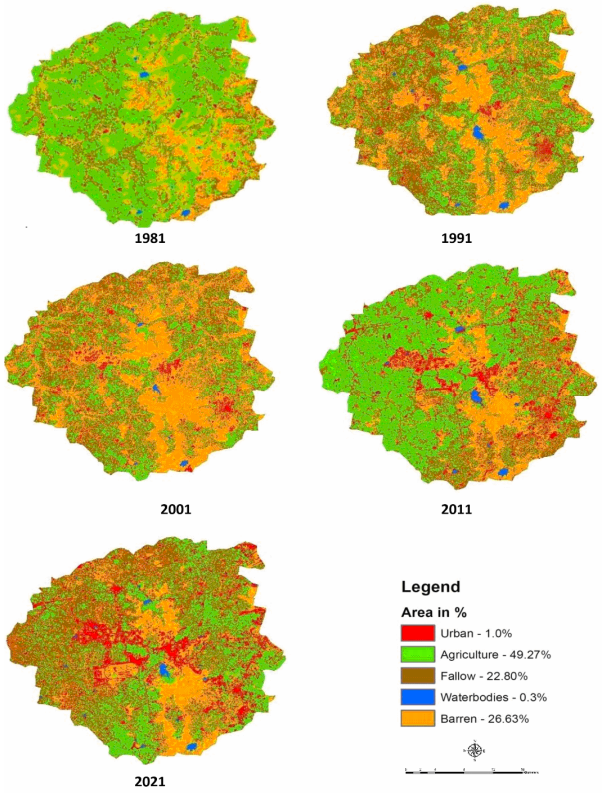

Fig. 4. LULC map of Pithampur, nearby towns and surrounding villages *(source: developed by the authors using Satellite Imagery).*

4.2.4. LULC changes in the corridors

Due to the proximity of Mhow, Betma, and Indore to Pithampur, three corridors have developed. The villages and towns falling in the Pithampur -Mhow corridor along the Mhow-Neemuch road have witnessed more development than the other villages surrounding Pithampur. Since the industrial development was initiated in Pithampur, the dependence of Pithampur on Mhow was inevitable as it offered better services and amenities. Pithampur's reliance grew over time as the town struggled to establish social infrastructure and attract high-wage workers. Because the distance between Pithampur and Mhow is only 8 kilometers, many people prefer to live in Mhow or near Mhow, ultimately opting for the Pithampur-Mhow corridor. According to the survey, private builders have developed townships along this route and intend to develop more in the future. Betma shares an administrative boundary with Pithampur in the north and is connected to Pithampur through Sagore Kuti road. Betma is close to Sector 3 and Kheda, major industrial sectors within Pithampur Industrial Area. It was a village till 1991, but evolved into a town later due to population increase and people inclining more to non-agricultural activities. A lot of workers commute to Pithampur from Betma. Also, similar to the Pithampur-Mhow corridor, this corridor witnesses township development by private builders. The Pithampur-Indore corridor along Rau-Pithampur road is developing at a slower pace than the other two corridors.

The shift towards other workers (Table 2) as well as an increase in the built-up area (Table 8) backs this claim. The probable reason behind this is the role of distance. The distance from Pithampur to Mhow and Betma is 8 km and 14 km (from the core city), respectively, while Indore is 22 km away from Pithampur.

Table 6. LULC changes along Pithampur-Mhow Corridor.

Location	Land cover in percentage	1991	2001	2011	2021
Villages falling under Pithampur - Mhow corridor	Built-up	6.7	9.6	15.9	18.9
	Agriculture	12.1	6.5	11.6	17.1
	Fallow	28.1	14.8	24.4	18.9
	Water body	1.0	0.1	0.9	1.7
	Barren land	52.1	69.0	47.2	43.3

Source: developed by the authors using satellite imagery.

Table 7. LULC changes along Pithampur-Betma corridor.

Location	Land cover in percentage	1991	2001	2011	2021
Villages falling under Pithampur - Betma corridor	Built-up	4.5	5.6	10.1	17.6
	Agriculture	18.8	17.7	57.8	18.1
	Fallow	47.7	40.6	15.9	42.5
	Water body	0	0	0	0.4
	Barren land	29	36	16.3	21.4

Source: developed by the authors using satellite imagery.

Table 8. LULC changes along Pithampur-Rau- Indore corridor.

Location	Land cover in percentage	1991	2001	2011	2021
Villages falling under Pithampur-Rau-Indore Corridor	Built-up	2.37	3.89	9.91	14.61
	Agriculture	33	24	31	37.8
	Fallow	43.64	39.14	40.44	35.6
	Water body	0.09	0.08	0.01	1.17
	Barren land	21	33.2	18.87	10.76

Source: developed by the authors using satellite imagery.

5. DISCUSSION

Our exploration into the developmental trajectory of Pithampur under the Growth Centre Approach provides significant insights into the dynamics of industrialization within the region. As we study the concentrated development in the town and connecting corridors, there arises a need to establish connections between our findings and the broader literature on industrial clusters and their socio-economic impacts. In our literature review, we highlighted the global trend of recognizing industrial clusters as pivotal drivers of economic growth (McCormick, 1999; Visser, 1999; Notteboom et al., 2022, Ó hUallacháin, 1992; Porter, 2003 etc.). Our results seamlessly align with this trend, illustrating how Pithampur's development mirrors the significance of strategic initiatives aimed at fostering industrial growth in underdeveloped regions – a recurrent pattern observed in the United States, Europe, and Asia. The identified partial success, revealed through the intercensal and Land Use Land Cover (LULC) Change

analyses, suggests that, aside from the corridors, the surrounding villages of Pithampur exhibit limited changes in occupation, sex ratio, and land use. This indicates that the growth of industries has not yet significantly impacted these surrounding villages. Similar to the overall case in Madhya Pradesh, where agriculture has witnessed improvement over the years, the villages around Pithampur present a comparable scenario. The identified partial success aligns with the intricate and detailed policies observed in various regions, such as the European Union (EU) countries, which exhibit a robust cluster approach with active support for development initiatives. Pithampur's concentrated growth appears to resonate with the focused efforts seen in these regions, emphasizing the imperative need for localized strategies to achieve holistic development within the region. The failure of the Pithampur cluster to sufficiently integrate nearby villages raises questions about the effectiveness of top-down development approaches, a theme echoed in the works of Morgan (2004), Henderson (2002) and Fowler and Kleit (2014). These scholars caution against the blind pursuit of industrial growth without considering the broader socio-economic impacts and the needs of local communities. The literature review also highlights the broader impact of industrial clusters on regional development, extending beyond job creation and income growth. The emergence of growth corridors, influenced by the gravitational pull of nearby towns, aligns with the literature's acknowledgement of clusters exerting influence beyond their immediate locations. This interplay between localized growth and the broader regional impact underscores the intricate dynamics at play in the context of industrialization within Pithampur.

6. CONCLUSIONS

The development of Pithampur under the Growth Centre Approach in Madhya Pradesh represents a significant effort to catalyse industrial growth in an agriculturally dominant region. However, while there have been notable advancements, the outcomes suggest a multifaceted portrayal of success, with industrial development predominantly concentrated within the town and its connecting corridors. A critical analysis of this growth trajectory is imperative to discern whether the limitations stem from inherent challenges within the chosen industry cluster or they are influenced by external factors shaping the region's economic landscape. Importantly, despite Pithampur's industrial progress, the transformative effects have largely been contained within its geographical boundaries, with surrounding villages exhibiting a degree of detachment from this developmental wave.

The emergence of growth corridors, a direct consequence of Pithampur's industrial advancement, underscores the intricate interplay of economic forces in regional development. These corridors, driven by the gravitational pull of nearby towns offering better amenities and economic opportunities, highlight the manifold dynamics shaping the growth patterns of the region. While our analysis benefits from the inclusion of Land Use and Land Cover (LULC) data, providing a more detailed understanding of recent developments, it is essential to acknowledge the temporal constraints. This reinforces the need for ongoing research to capture evolving socio-economic dynamics accurately.

In light of these insights, there is a clear imperative for a holistic understanding of the complex interplay between industrial initiatives and socio-economic dynamics. This awareness is crucial for informing future strategies and policies aimed at fostering inclusive and sustainable growth across the region. The research emphasizes the need for a comprehensive understanding of the interplay between industrial initiatives, and the socio-economic dynamics shaping regional development.

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