



## Predicting the Path of Progress: A Trend and Forecast Analysis of PMC Expenditure

Seema Nitin Dokrimare, Deepali Sunil Akolkar, Akshata Vijay Lembhe, Rupali Laxman Kamthe

Department of Statistics, Dr. D. Y. Patil, Arts, Commerce & Science College, Pimpri, Pune, Maharashtra, India

ARTICLE INFO	ABSTRACT
<p><b>Published Online:</b> 17 March 2026</p> <p><b>Corresponding Author:</b> Seema Nitin Dokrimare</p>	<p>This study presents a statistical examination of the capital expenditure pattern of the Pune Municipal Corporation (PMC) over the period 2016-2025. Using secondary data, the study evaluates annual expenditure summary statistics, trends, pre and post-COVID variations, and long-term behavior through graphical and numerical methods. A linear regression model is employed to assess the significance of the upward trend in municipal capital spending, while an ARIMA time-series model is used to forecast expenditure for the subsequent three years (2026-2028). The result reveals a stable expenditure pattern in the pre-COVID years, followed by a substantial rise after 2022, indicating renewed infrastructure investment. Forecasting results suggest that expenditure is expected to stabilize around the 2025 level, widening uncertainty in future years. Overall, the study provides insights into PMC's expenditure trajectory and offers evidence-based support for future budget planning and decision making</p>
<p><b>KEYWORDS:</b> Pune Municipal Corporation, PMC expenditure, linear regression, capital expenditure, Time series analysis, ARIMA model, pre and Post COVID</p>	

### INTRODUCTION

Capital expenditure represents long term investment in public infrastructure and civic development, and it plays a crucial role in strengthening the functional capacity of municipal bodies. For a rapidly expanding metropolitan region like Pune, systematic and planned capital expenditure is essential to support urban growth and improve the quality of civic services. The Pune Municipal Corporation (PMC) undertakes major developmental works such roads, water supply systems, drainage and sewer networks, solid waste management, environmental projects, and public amenities. Analyzing PMC's capital expenditure trends helps in understanding financial priorities and assessing the progress of infrastructural development.

Previous studies highlight the importance of evaluating municipal expenditure patterns to identify resource allocation efficiency, detect financial shifts, and support urban planning. Trend analysis, regression modelling and forecasting techniques are frequently used in public finance research to interpret long-term behavior and predict future expenditure. Such analytical methods become particularly relevant during periods of major disruption, such as the

COVID-19 pandemic, which has significantly influenced municipal spending throughout India.

In recent years, PMC's capital expenditure has shown both stability and sudden increases, reflecting changes in policy orientation, administrative reforms, and post-pandemic recovery measures. Examining these variations helps understand how municipal financial behavior adapts to evolving urban needs.

The study involves the following objectives:

1. To compute the summary statistics including total, average, minimum, maximum and standard deviation of capital expenditure.
2. To prepare combined bar charts showing total and average expenditure across years.
3. To analyze the trend of total capital expenditure of PMC from 2016-2025.
4. To apply a linear regression trend model to examine the long-term growth.
5. To compare expenditure patterns during the pre-COVID (2016-2020) and post-COVID (2021-2025) periods

6. To perform time series forecasting for 2026-2028 using an ARIMA model.

These objectives are addressed using descriptive statistics, graphical analysis, regression techniques, and forecasting models. The data analysis is carried out using Microsoft Excel and R statistical software enabling accurate computation and visualization.

## MATERIALS AND METHODS

This study was based on secondary data obtained from the PUNE Municipal Corporation (PMC) relating to annual capital expenditure for the financial years 2016-2025. The dataset consisted of year-wise expenditure values representing combined allocations under Budget A and Budget C. The data were compiled in Microsoft Excel prior to analysis.

All numerical values were checked for completeness, consistency and formatting errors. Missing entries if observed, were corrected using either interpolation or excluded when insufficient information was available. Descriptive statistics, including total, average, minimum, maximum and standard deviation, were calculated to provide an overview of annual expenditure behavior. Combined bar charts of total and average expenditure were prepared using Excel to illustrate yearly variation.

The cleaned dataset was imported into R statistical software for model fitting and forecasting. A line graph was used to present the overall trend.

To examine long term expenditure behavior, a linear regression model of the form

Capital Expenditure =  $\beta_0 + \beta_1(\text{Year})$  was fitted using `lm()` function in R. Model outputs such as the residual standard error, coefficient of determination ( $R^2$ ), adjusted  $R^2$  and F-statistic with corresponding p-value were used to evaluate the statistical significance of the trend. The results were interpreted using a significance level of  $p < 0.05$ .

For forecasting, the annual expenditure values were converted into a time-series object in R, and the ARIMA model was applied using `auto.arima()` function. Forecast plots were produced to visualize expected future expenditure levels and uncertainty ranges. All statistical analyses were performed using Microsoft Excel and R software.

The methodological approach provided a clear framework for identifying historical patterns, assessing COVID related shifts, modelling long-term trends and predicting future municipal capital expenditure.

## RESULT

This section represents the year-wise PMC's capital expenditure including descriptive statistics, graphical presentation, trend analysis and forecasting.

The following table represents the summary statistics of the annual capital expenditure of Pune Municipal Corporation (PMC) from 2016-2025 revealed the notable variation.

Table-1

The descriptive statistics reveal significance variation in capital expenditure across PMC departments. The highest average expenditure is observed in departments like Roads, Water Supply and Drainage, indicating the priorities of the core urban infrastructure. Lower expenditure levels are seen in smaller administrative departments. The standard deviation values highlight that while some departments maintained stable yearly investment, other experience considerable fluctuations.

Figure-1

The combined column chart of total and average expenditure shows that the Road Department receives the highest financial allocation among all PMC departments, followed by Flyover and River Improvement, Drainage Projects, and Water Supply Projects. Several departments such as Slum Rehabilitation, Women and Child Development, Youth Welfare, and Backward Welfare Schemes receive very low funding throughout the period. The results indicated a clear concentration of spending in infrastructure-related departments, with comparatively lower allocations to social and welfare-oriented sectors.

Table-2

The above table shows the summary statistics linear regression output. The linear regression model fitted to PMC's capital expenditure showed a statistically significant positive trend over the period 2016–2025. The slope coefficient for year was 383.8, indicating that capital expenditure increased by approximately ₹384 crore per year on average. The model explained 58.22% of the variation in expenditure ( $R^2 = 0.5822$ ). The trend was statistically significant as shown by the F-statistic ( $F = 11.15$ ;  $df = 1,8$ ;  $p = 0.01025$ ). The residual standard error was 1044, with residuals ranging from -1329.69 to +1385.03 crores. The positive coefficient and significant p-value confirmed a consistent upward movement in PMC's capital expenditure across the study period.

Figure-2

The Figure-2 is the trend plot for PMC's capital expenditure from 2016–2025 showed a long period of stability followed by a steep rise in the later years. Expenditure remained between approximately ₹1500–₹1800 crore from 2016 to 2022, with only minor fluctuations. A noticeable increase occurred in 2023, and a sharp escalation was observed in 2024 and 2025, in which expenditure exceeded ₹5000 crore. The fitted linear trend line indicated an overall upward trajectory across the entire study period. Although the actual values remained close to the trend line during the early years, large positive deviations appeared in 2024 and 2025, reflecting a significant surge in spending.

The comparison of capital expenditure across the pre-COVID (2016–2020) and post-COVID (2021–2025) periods showed a clear difference in spending levels. During the pre-COVID years, expenditure remained relatively stable, ranging between approximately ₹1500 crore and ₹1800 crore, with minimal year-to-year fluctuation. The COVID period (2020–2021) did not show a major decline but exhibited stagnation in spending. In contrast, the post-COVID period recorded a marked rise in capital expenditure, beginning in 2023 and peaking in 2024–2025, where expenditure exceeded ₹5000 crore. The post-COVID values showed significantly higher deviation from the long-term trend line compared to the earlier years.

Table-3

The table-3 the ARIMA model forecasted the capital expenditure for the years 2026–2028 to remain stable at approximately ₹5524.8 crore, matching the expenditure level observed in 2025. The 80% confidence intervals widened gradually from 4290–6759 crore in 2026 to 3386–7663 crore in 2028. The 95% intervals showed even greater spread, indicating growing uncertainty over the forecast horizon, ranging from 3636–7413 crore in 2026 to 2254–8795 crore in 2028. The forecast plot demonstrated that future values are expected to hover around the recent peak level while displaying increasing variability.

Figure 3 shows the ARIMA-based forecast of capital expenditure for 2026–2028.

Figure-3

## DISCUSSION

1) The expenditure pattern indicates that PMC places primary emphasis on core infrastructure such as roads, water supply, and drainage, reflecting the needs of a rapidly expanding city. In contrast, social and welfare departments receive significantly lower investment, suggesting limited priority toward community-focused development. The descriptive statistics also show that some departments experience large fluctuations due to major project phases, while others maintain stable, routine spending. Overall, the results highlight an infrastructure-dominant capital allocation strategy and point to the need for more balanced investment across sectors in future planning.

2) The regression and trend results show that PMC’s capital expenditure has moved from a long period of stability to a phase of accelerated investment. The significant positive slope confirms steady annual growth, while the sharp rise after 2023 indicates a major shift in spending priorities linked to large infrastructure programmes and post-COVID development activities. The strong deviations from the trend line in 2024 and 2025 suggest exceptional, project-driven expenditure far above normal growth levels. Although time explains a substantial portion of this increase, the moderate  $R^2$  value and high residual error imply that specific policy decisions and major project approvals also influenced the pattern. Overall, the trend

analysis reflects a transition toward more expansion-oriented and high-value infrastructure investment within PMC’s capital planning.

3) The differences between the pre- and post-COVID periods highlight a shift in PMC’s capital investment priorities. The stable pre-COVID pattern suggests routine infrastructure spending with limited expansion, reflecting steady project implementation and predictable financial planning. The stagnation during the COVID years is consistent with the administrative and economic slowdown caused by pandemic-related restrictions. The sharp rise in expenditure after 2022 indicates renewed investment activity driven by the resumption of delayed projects, increased urban development needs, and a possible strategic emphasis on large-scale infrastructure improvement. The magnitude of the post-COVID increase, particularly in 2024–2025, suggests that PMC allocated substantial resources to mobility, water systems, drainage networks, and modernization projects. This shift demonstrates a transition from stable spending to accelerated capital investment aimed at strengthening civic infrastructure and supporting post-pandemic urban growth.

4) The forecasting results indicate that PMC’s capital expenditure is expected to stabilize around the elevated 2025 level, rather than continue increasing sharply. This reflects a typical pattern of ARIMA (0,1,0) models, which project future values based on the most recent observation. The widening prediction intervals suggest increasing uncertainty in expenditure planning beyond 2026, likely influenced by project timing, budget approvals, or changes in development priorities. The stabilized point forecast highlights that while PMC has entered a phase of high expenditure, future spending is unlikely to escalate at the same rate unless new large-scale infrastructure projects are undertaken. Overall, the forecast supports the expectation of continued high but steady capital investment, with uncertainty growing in the medium term. The forecast graph indicates that future expenditure stabilizes around recent levels.

## CONCLUSION

The analysis of PMC’s capital expenditure from 2016–2025 shows a clear shift from stable, routine investment to a phase of rapid growth in the later years. Pre-COVID expenditure remained steady, while post-COVID years, particularly 2023–2025, exhibited a sharp increase driven by major infrastructure projects. Trend modelling confirmed a significant long-term upward trajectory, and forecasting suggested that future expenditure is likely to stabilise around the heightened 2025 level. Overall, the results indicate a strong emphasis on infrastructure development, with a need for balanced investment across sectors to support sustainable urban growth.

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**TABLES**

**Table 1. Summary statistics of PMC capital expenditure (2016–2025)**

Department	Total	Avg.	Min	Max	Std. Dev.
Solid Waste Management	551.02	55.102	26.11	142.35	37.15
Road Department	5353.95	535.395	252.45	1126.3	304.84
Traffic Control	475.95	47.595	0.9	105.89	39.96
Electrical Department	609.08	60.908	9.57	83.79	26.85
Flyover and River Improvement	1503.79	150.379	20.41	422	168.67
Storm Water & Drainage Department	639.42	63.942	27.95	130.8	36.25
Garden and Zoo	490.08	49.008	26.53	93.75	24.21
Land Acquisition	375.07	37.507	5.15	90	30.81
Slum Rehabilitation	177.54	17.754	0.7	34.68	11.82
Backward Welfare Scheme	136.92	13.692	8.15	20.93	4.53
Women and Child Development Scheme	128.92	12.892	8.48	24.68	4.87
Youth Welfare Scheme	155.57	15.557	11.77	23.94	3.84
Handicap Welfare Scheme	164.3	16.43	5.73	31.82	9.96
Pune District Planning and Development Committee	88.05	8.805	6.13	11.24	1.95
Depreciation on Plant & Machinery	231.54	23.154	11.86	66.45	16.23
Tree Protection and Conservation Authority, Gunthewari Fees, Commitment etc.	99.63	9.963	7.5	12.9	1.97
JNNURM, AMRUT & Smart Cities Mission	862.96	86.296	13.76	291.5	80.68
Swachha Maharashtra Abhiyan	28.46	3.5575	0.31	20.75	7.06
Public Transport & Special Project	848.24	84.824	28.89	264	78.17
Pradhan Mantri Awas Yojana (PMAY)	427.97	53.49625	8.86	118.62	38.90
Ward Office Work	105.44	10.544	0.09	22.99	7.75
Water Supply	490.48	49.048	13.12	119.35	32.12
Drainage	1958.34	195.834	61.66	493.77	152.63
Water Supply Projects	2648.75	264.875	103.22	542	140.01
Drainage Projects	1449.82	144.982	2.87	553	199.54
Ward Office Work	49.145	4.9145	0.84	11.64	3.81

**Table 2. Linear Regression Summary for PMC Capital Expenditure (2016–2025)**

Parameter	Estimate / Value	Interpretation
Intercept ( $\beta_0$ )	-773006.1	Baseline constant of the model

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Slope ( $\beta_1$ : Year)	<b>383.8</b>	Avg. yearly increase in capital expenditure (₹ crore)
Std. Error ( $\beta_0$ )	232233.6	Variability in intercept estimate
Std. Error ( $\beta_1$ )	114.9	Variability in slope estimate
t-value ( $\beta_1$ )	3.339	Strength of yearly trend
p-value ( $\beta_1$ )	<b>0.0102</b>	Significant positive trend ( $p < 0.05$ )
Residual Standard Error	<b>1044</b>	Avg. deviation of actual from fitted values
Multiple R <sup>2</sup>	<b>0.5822</b>	58.22% of variation explained by year
Adjusted R <sup>2</sup>	0.53	Model accuracy adjusted for degrees of freedom
F-statistic	<b>11.15</b>	Overall significance of the trend
F-statistic p-value	<b>0.01025</b>	Model is statistically significant

**TABLE 3. ARIMA Forecast of Capital Expenditure (2026–2028)**

Year	Point Forecast (₹ Crore)	Lo 80	Hi 80	Lo 95	Hi 95
<b>2026</b>	5524.8	4290.142	6759.458	3636.553	7413.047
<b>2027</b>	5524.8	3778.729	7270.871	2854.415	8195.185
<b>2028</b>	5524.8	3386.309	7663.291	2254.260	8795.340

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CAPTIONS TO ILLUSTRATIONS:

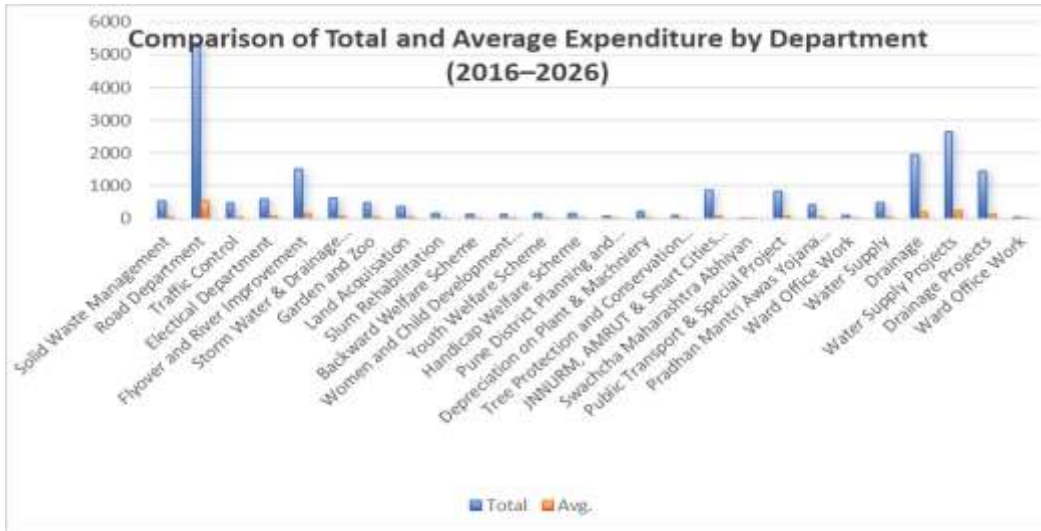


Figure 1. Combined bar chart showing total and average capital expenditure.

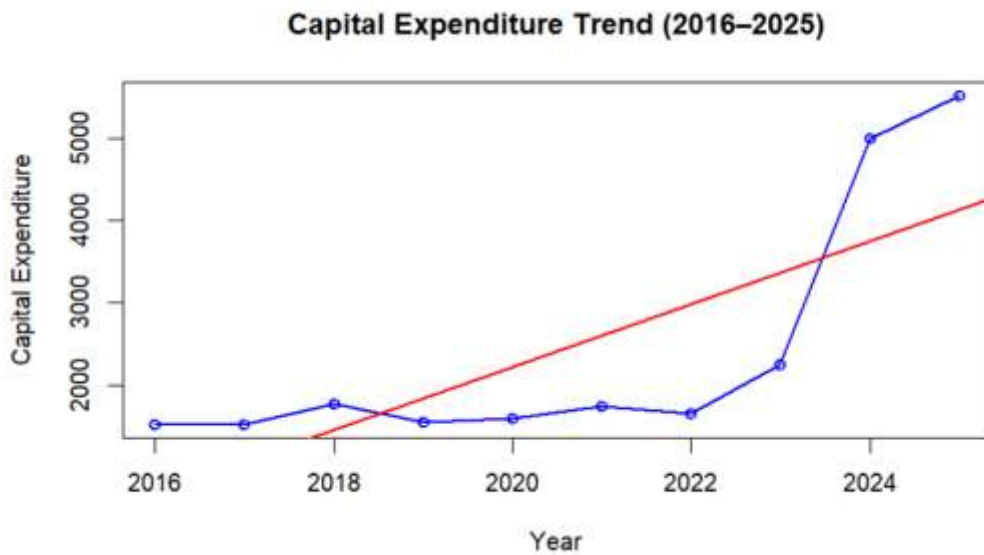
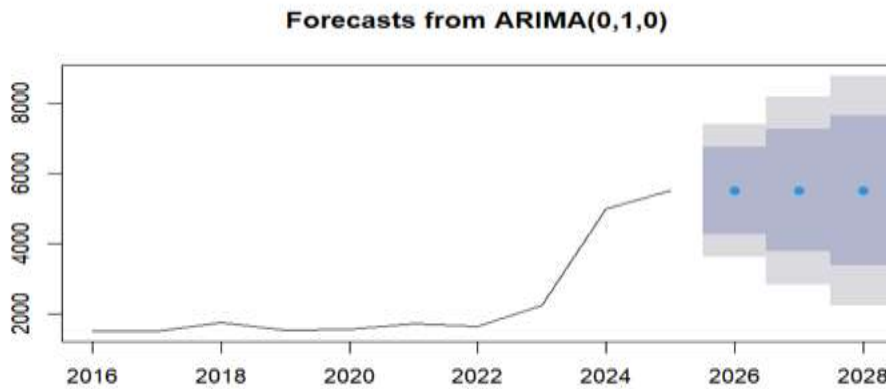


Figure 2. Year-wise capital expenditure trend from 2016–2025 and Linear regression trend line of capital expenditure.



**Figure 3.** ARIMA forecast of expenditure for 2026–2028.