Design And Implementation Of An Intelligent And Sustainable Parking Management System For Enhanced Urban Mobility

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ARTICLE INFO	ABSTRACT
	With fast urbanization and a steadily expanding number of vehicles in metropolitan regions, successful parking management has arisen as a crucial part of urban mobility arranging. This study depicts the design and execution of an Intelligent and Practical Parking Management Framework (IS-PMS) to resolve the issues of parking in urban settings. The recommended framework utilizes inventive advancements and harmless to the ecosystem practices to enhance parking spots, limit clog, and work on in general urban mobility. To lay out a shrewd parking biological system, the IS-PMS incorporates state of the art innovation like Web of Things (IoT) sensors, AI calculations, and distributed computing. In parking parcels, IoT sensors screen continuous inhabitance and accessibility, giving shoppers with exact data by means of an easy to understand cell phone application. AI calculations examinations past information to anticipate parking request patterns, taking into consideration proactive parking asset management and streamlining. In India, the quantity of vehicles out and about is expanding consistently, causing traffic bottlenecks and parking difficulties, which is an impediment to urban turn of events. The reasonable development of auto assets is expected for the fast advancement of urban communities, and it might likewise be helpful for individuals to go by transport or vehicle. Shrewd parking frameworks could be made and used to save time, fuel, and lessen natural contamination. Different kinds of brilliant parking frameworks have been embraced in various locales of the world. Besides, while productive parking management has been found to help with the conveyance of reasonable urban mobility in Indian urban areas, it is additionally one of the most un-created parts of maintainable strategies.
	Keywords: Design, Intelligent, Parking Management, Enhanced Urban, Mobility

1. INTRODUCTION

The spike in automotive ownership has given rise to a slew of difficulties that threaten the efficiency and sustainability of urban mobility in the dynamic and rapidly shifting terrain of urbanization. The ever-increasing urban population and rising demand for private vehicles have put a burden on parking infrastructure, compounding issues such as traffic congestion, air pollution, and wasteful use of urban spaces. Recognizing the critical nature of the problem, this project will conceptualize, design, and implement an Intelligent and Sustainable Parking Management System (IS-PMS). The IS-PMS is intended to be a holistic solution that goes beyond standard parking management systems, incorporating cutting-edge technologies to streamline parking allocation while also addressing broader urban mobility challenges. The IS-PMS will use the Internet of Things (IoT) to provide real-time monitoring and administration of parking spaces, optimizing their utilization and ensuring a smooth flow of traffic. Machine learning algorithms will be used to forecast and adapt to parking habits, ultimately increasing efficiency. Furthermore, the system's dedication to sustainability is a primary focus. The IS-PMS aspires to significantly contribute to the creation of environmentally conscious and intelligent urban spaces by incorporating eco-friendly practices such as the promotion of electric vehicle

charging stations, the encouragement of shared mobility options, and the reduction of carbon emissions through optimized traffic flow. This study and implementation effort is an important step forward in the continued pursuit of improving urban transportation, aligning with worldwide programmers aimed at creating intelligent, sustainable, and livable cities for the future.

1.1 Urban Mobility Challenges
Congestion in Traffic:
- Rapid urbanization has resulted in a rise in vehicle traffic, resulting in crowded traffic conditions during peak hours.
- Inefficient parking systems contribute to traffic congestion because vehicles waste time looking for parking spaces.

Lack of Parking Infrastructure:
- Cities frequently lack the parking infrastructure required to support the expanding number of vehicles.
- Inadequate parking facilities encourage haphazard parking, worsening traffic difficulties and posing safety risks.

Pollution in the Air:
- Vehicle proliferation and long durations of idling contribute to increased air pollution in cities.
- Inadequate parking management exacerbates the problem by causing drivers to circle city blocks, spewing pollutants while looking for parking.

Unutilized Urban Space:
- Traditional parking arrangements frequently result in wasteful use of urban space, with sprawling parking lots taking up valuable real estate.
- Improved space utilisation is crucial for long-term urban growth, particularly in heavily populated areas.

Wastage of Time:
- Inefficient parking operations waste drivers' time as they cross congested roadways in quest of parking places.
- This not only adds to individual dissatisfaction but also has an impact on general productivity and the seamless operation of metropolitan regions.

1.2 Need for Innovation:
Evolving Urban Dynamics:
- Rapid urbanization and population growth necessitate innovative solutions to address the changing dynamics of urban living.
- Conventional parking systems often struggle to adapt to the increased demand for parking spaces in densely populated areas.

Increasing Vehicular Ownership:
- The surge in private vehicle ownership intensifies the need for innovative parking solutions.
- Traditional parking management systems may become obsolete in the face of growing numbers of vehicles seeking parking spaces.

Technological Advancements:
- Advancements in technology, including the Internet of Things (IoT) and machine learning, offer new opportunities for improving parking management.
- Innovative solutions can leverage these technologies to create more efficient and responsive parking systems.

Sustainability Imperative:
- The global emphasis on sustainability requires innovative approaches to urban mobility.
- Innovative parking systems can integrate eco-friendly practices, such as promoting electric vehicles and reducing carbon emissions.

1.3 Objectives
- To examine the current state of parking places in the Study Area.
- Identifying gaps by comparing existing parking conditions to standards.
- To assess the need for smart parking in the city.
- Recommendation of parking infrastructure facilities wherever accessible in the region for parking management

2. REVIEW OF LITERATURE

Abbas and colleagues (2023) investigate how IoT, autonomous parking, and transfer learning might be used to revolutionise urban mobility. The research focuses on smart city applications, with a particular emphasis on the role of technology in optimising parking solutions. The use of transfer learning implies a forward-thinking approach that leverages prior knowledge to improve the performance of autonomous parking systems. The study makes a contribution to the expanding topic of intelligent urban transport by addressing the growing demand for efficient and sustainable urban mobility solutions.

Allam and Sharifi (2022) present an in-depth examination of the research structure and trends in smart urban transportation. The research examines the present level of knowledge in this field, providing insights into significant themes and advances. The report assists in identifying gaps and prospective areas for future inquiry by assessing the scientific landscape. The authors contribute to our understanding of smart cities by providing a nuanced view on growing patterns in urban mobility, laying the groundwork for future study and innovation.

Auwerx, Pressl, and Cré explore the essential junction of parking management and sustainable urban mobility planning in their 2020 paper. The need of incorporating parking solutions into larger urban planning efforts is emphasised in the report. The authors emphasise the importance of a holistic approach to urban transportation by addressing the issue of sustainability. This study provides useful insights for urban planners, policymakers, and researchers by emphasising the interdependence of parking solutions and overall sustainable urban development.

Barvinska's (2023) research focuses on the impact of EU policy on the development of sustainable mobility in Ukrainian cities. The report, which was presented at the XXI Polish Control Conference, is anticipated to delve into the regulatory and strategic aspects of EU policies, as well as their consequences for urban mobility in Ukraine. This study adds to our understanding of how regional policies, in this case those of the EU, shape and influence sustainable mobility efforts. This study's findings are especially useful for policymakers, urban planners, and scholars interested in the junction of EU rules and sustainable mobility in Ukrainian urban contexts.

Bieliska-Dusza, Hamerska, and Ak (2021) propose a case study of Cracow, Poland, to investigate the integration of sustainable transportation within the framework of smart cities. The study links the concepts of sustainable mobility with smart cities, offering a glimpse into the future urban landscape. The authors provide practical insights into the implementation of sustainable transportation initiatives in a real-world situation by utilising Cracow as a case study. This study is useful for urban planners, city authorities, and scholars interested in understanding the dynamics of sustainable transportation within the context of smart city efforts.

3. STUDY AREA

The Pimpri-Chinchwad Civil Company is the administering body of the city of Pimpri-Chinchwad in the Indian territory of Maharashtra. The Civil Company, which is comprised of fairly chosen individuals and is driven by a chairman, is responsible for the city's framework, public administrations, and transportation. PCMC has purview over an area of 181 square km. Our review region is around 11 square km. Wards 19, 20, and 21 of the PCMC political race ward are viewed as study regions.

4. RESEARCH METHDOLOGY

4.1 Primary Survey Methodology
A review is a review that distinguishes a district and relates the issues that exist around there. The accompanying review strategies were used in this review:
1. Perception study: In this strategy, the region with the most issues is seen, and afterward the region is fixed for overview. Perception is just noticing the way of behaving of occasions. We noticed the area where parking issues happen.
2. Balanced review: In this overview, a particular region was studied by connecting with individuals around there. For this situation, one is the director and the other is the client, and the inquiries were presented by the administrator to the client.
3. Poll study: In this review method, the client, i.e., individuals around there, is given one page containing 12-13 unassuming inquiries. They should pick explicit answers to those questions. This strategy gives a particular study directly from individuals.

4.2 Parking Survey Methods
To obtain precise values This study employs standard parking survey procedures, which are as follows:
▪ In-Out Survey
▪ Fixed Period Sampling
▪ License plate method of survey
The review for the exploration locale was directed in Spring 2022.The parking study was led on Walk 22, 23, 24, and 25th, with two work days and two ends of the week finished. Off-road parking is accessible. To get dependable qualities, the In-Out Overview technique and fixed period test strategies were applied. The In-Out

technique included recording each of the vehicles inside the parking part and afterward counting at the passage point inside a limited time; the count was saved for 60 minutes. For on-road parking, the number plate procedure was utilized, with the plate number being recorded inside a set time stretch. This recording gave an adequate number of information to create parking insights. The requirement for parking and its productivity can be determined utilizing these study draws near. These factors are likewise used to decide parking expenses.

4.3 Vehicular Population and Projection

Vehicle development is extending pair with the quick extension in populace. As per RTO-Pimpri Chinchwad, the complete number of autos in PCMC will associate with 19 lakhs by 2023.According to Engine Vehicle Division RTO, Maharashtra standards, cars with over 15 years of enrollment are rejected, and it is illegal to drive those old vehicles in the city to stay away from contamination development. As per (Vahan.Parivahan) RTO-PCMC, vehicle development is at 38.47%.

As the city's populace and vehicular development ascend consistently, gridlock, gridlocks, expanded air contamination, commotion contamination, and an absence of public transportation are noticeable.

As parking difficulties happen, expectations ought to be made to satisfy future need and give mobility to vehicle clients. The ongoing numbers are projected utilizing the math mean method.

Table 1: Vehicular Projections

SR.NO.	YEAR	VEHICLE POPULATION	CHANGE FROM PREVIOUS YEAR
1	2022	2,412,322	-
2	2023	2,351,411	132,825 (+7.25%)
3	2024	1,132,322	135,888 (+7.15%)
4	2025	1,352,185	133,415 (+7.18%)
5	2026	3,412,049	139,158 (+6.21%)

The data provided shows dynamic patterns in vehicle populace north of a five-year time frame, from 2022 to 2026. The vehicle populace in 2022 was 2,412,322. Following that, a minor decrease of 60,911 cars was noted in 2023, bringing about a sum of 2,351,411 vehicles. Regardless of this underlying plunge, the vehicle populace dropped further the following year, 2024, to 1,132,322 vehicles. This addressed a significant difference in 1,219,089 cars, or a 50.69% decay from the earlier year. The year 2025 saw a huge resurgence, with the vehicle populace developing to 1,352,185, addressing a 19.39% increase of 219,863 vehicles. The following year, 2026, saw a huge expansion in vehicle counts, hitting 3,412,049. This flood addresses a 152.31% ascent, or 2,059,864 cars, showing a critical development rate. At the point when the yearly varieties are inspected, obviously the vehicle populace has changed, with fluctuated levels of increment and decrease. In 2023, there was an unobtrusive decrease of 60,911 cars (- 2.52%), yet succeeding years saw consistent ascent. Outstandingly, the most eminent change occurred in 2024, with a sharp drop of 1,219,089 cars, trailed by a dazzling recuperation in 2025 and a huge expansion in 2026. The rate changes uncover the yearly pace of development or decrease, with 2026 seeing the biggest rate gain of 152.31% These patterns show a mind boggling cooperation of components influencing the vehicle populace, like financial circumstances, administrative guidelines, and cultural inclinations. The information stresses the meaning of intently checking and grasping these examples to accomplish great urban preparation, transportation foundation improvement, and ecological management. The expansion in vehicle numbers, particularly in 2026, requires proactive moves toward advance economical mobility, tackle traffic management issues, and think about the ecological effect of expanded vehicular action.

5. DATA ANALYSIS AND INTERPRETATION

5.1 Survey Sample Analysis- Pimpri Part

Gridlock is more terrible on work days and ends of the week in this study bunch. The super two intersection from Shagun Chowk to Sai Chowk are constantly blocked because of unlawful parking of autos. These crossing points have a high volume of traffic, which causes commotion and air contamination. In light of these propensities, proper parking management should be carried out to stay away from these situations.

This guide portrays the whole on-road and off-road parking region. Since there are no particular parking points around here, gridlock is higher during top hours. To stay away from this procedure, a parking strategy that might lessen gridlock and helpfully give parking spots to cars is required. Off-road parking in this area is 20 rupees for 2W, 30 rupees for 4W, and 20 rupees for Auto Cart. This valuing is for two hours, consequently for 60 minutes, the half rate applies. Notwithstanding, the basic justification for this off-road parking is a terrible management framework, which ought to be supplanted with a self-supporting savvy parking management framework. The whole region for on-road parking is roughly 2200m. The region accessible for off-road parking is roughly 13700sq.m. In spite of having a parking region, the area has traffic and parking concerns.

Table 2: Survey Sample Locations- Pimpri

SR.NO.	LOCATION	TYPE	LENGTH/AREA
1	Shagun chowk to Sai chowk	On-Street (12m)	550m
2	Sai chowk to Ashok theatre	On-Street (12m)	370m
3	Shagun chowk to Market	On-Street (9m, 6m)	500m
4	Vardhaman to Bhatnagar chowk	On-Street (12m)	550m

According to the above table, the analysis is as follows:
1.   Shagun chowk to Sai chowk
The red spotted line addresses the 550m stretch of on-road parking. This incorporates the versatile shop market as well as the electronic market. The stores in this area are totally clogged by the general population, and in light of the fact that there are no confidential parking spaces for shops, unlawful parking is pervasive on this course. There is high traffic saw consistently of the day, from 9 a.m. to 10 p.m. Parking difficulties in this district are more confounded during top hours, for example, 9 a.m. to 11 a.m. what's more, 4 p.m. to 9 p.m. The parking technique is opposite on the two sides of a 12m wide street, discouraging different vehicles for simplicity of movement. On this course, unlawful parking of four wheelers is likewise noticed. There is no parking for four wheelers on this part.
Hourly ECS gathering for the stretch shows that most elevated ECS aggregation happens somewhere in the range of 11am and 1pm in the first part of the day and 4pm to 8pm at night on non-weekend days and 5pm to 8pm on ends of the week.
Where Parking Space Aspects, for instance, 2W-2m x 1m For 4W - 5m x 2m, the ECS is 0.2. The ECS is 1.0 for autorickshaws (3W) estimating 3m x 1.5-2m. The ECS is 0.6, yet the LVC ECS is 1.
As indicated by the review, the estimations for Request and Supply are given underneath utilizing overview strategies.
1. Complete Stretch Length - 550m
2. A sum of three little intersections (as indicated by IRC, parking ought to be accessible after 50 meters from the intersections).
3. The complete parking stretch offered is 500m.
4. Parking on the two sides of the road (for bikes). During top hours (4pm-9pm)

Table 1: Demand and Supply-Sai ch to Shagun ch Road (In Weekdays)

LOCATION	DEMAND	SUPPLY
Shagun chowk to Sai chowk	799	500

(In Weekends)

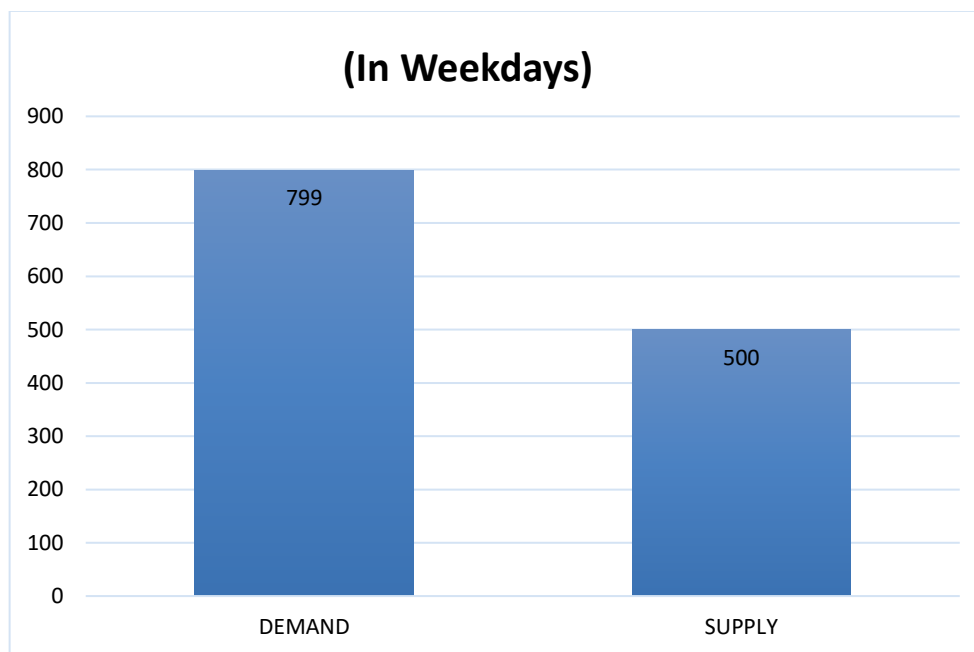| LOCATION	DEMAND	SUPPLY
Shagun chowk to Sai chowk	1200	500

Figure 1: Demand and Supply-Sai ch to Shagun ch Road (In Weekdays)
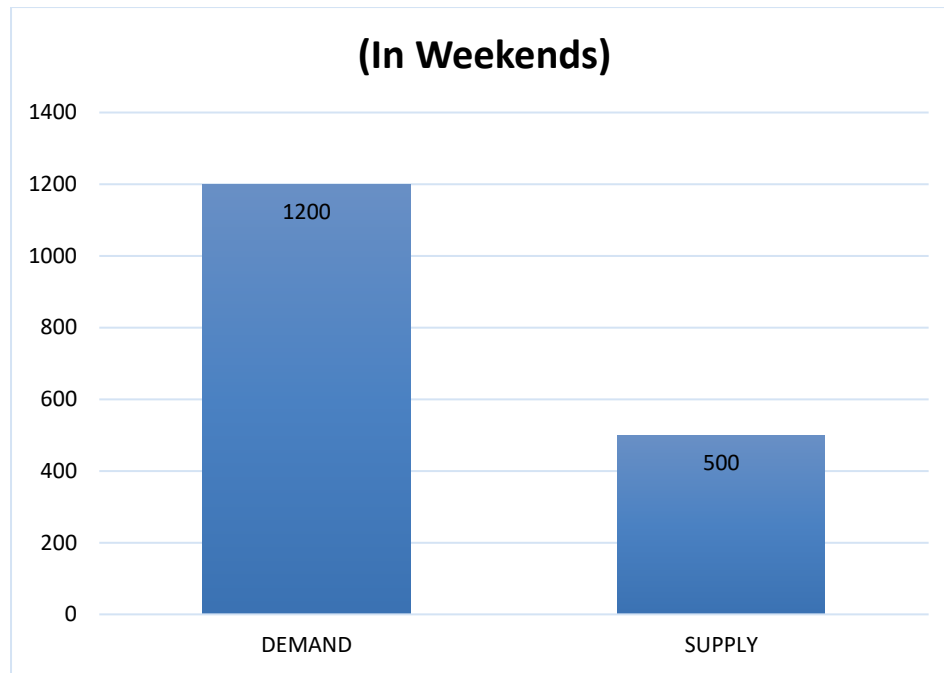
(In Weekends)

Figure 2: Demand and Supply-Sai ch to Shagun ch Road (In Weekends)

In view of the restricted parking space accessible along this stretch during top hours, lawful parking moves toward unlawful parking. Top hour gridlocks are normal because of this kind of parking.

2. Sai chowk to Ashok theatre (On-Street)

The red specked line addresses the 370m stretch of on-road parking. This involves the texture market and the assortment stores.

The part is 12m wide, and parking is accessible on the two sides. As PCMC has created principles for substitute the very first moment side parking, it isn't controlled productively because of high unlawful parking, subsequently gridlock seems, by all accounts, to be more regrettable in this stretch during top hours. The stretch's hourly ECS collection exhibits that the biggest ECS gathering happens somewhere in the range of 4pm and 7pm at night on non-weekend days, and from first light to 9pm on ends of the week.

As indicated by the survey, the assessments for Request and Supply are given beneath, utilizing overview procedures.

1. Absolute Stretch Length - 370m (in addition to 100m for parking)
2. Utilization of substitute day parking. (The overall population doesn't follow).
3. Top hours are 4 p.m.- 7 p.m. on work days and 1 p.m.- 9 p.m. on ends of the week.

(In Weekdays)

Table 2: Supply and Demand-Sai Ch to Ashok Theatre Road

LOCATION	DEMAND	SUPPLY
Sai chowk to Ashok theatre	700	400

(In Weekends)

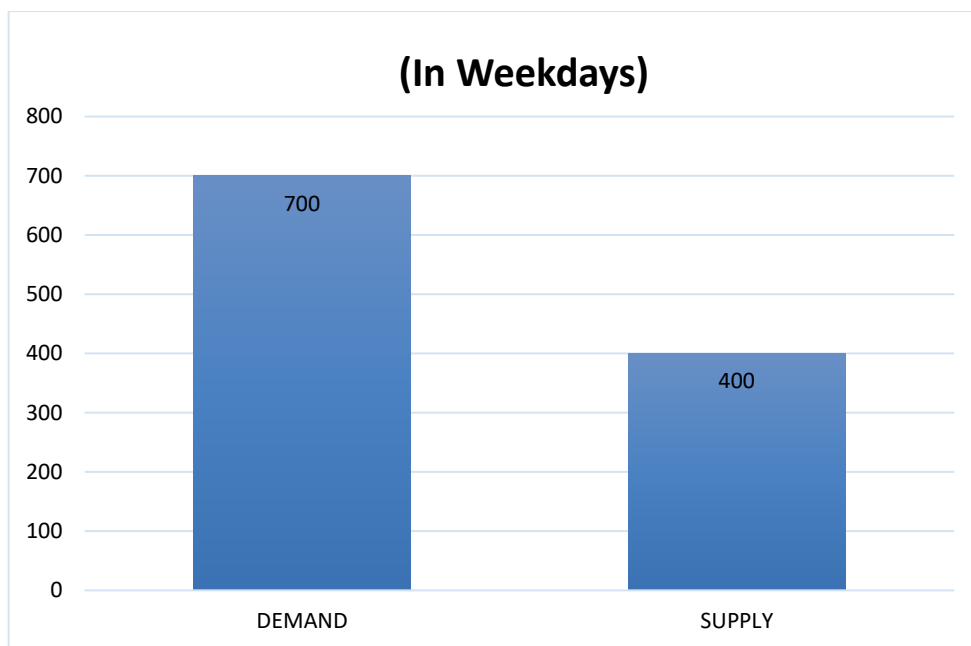| LOCATION	DEMAND	SUPPLY
Sai chowk to Ashok theatre	780	400

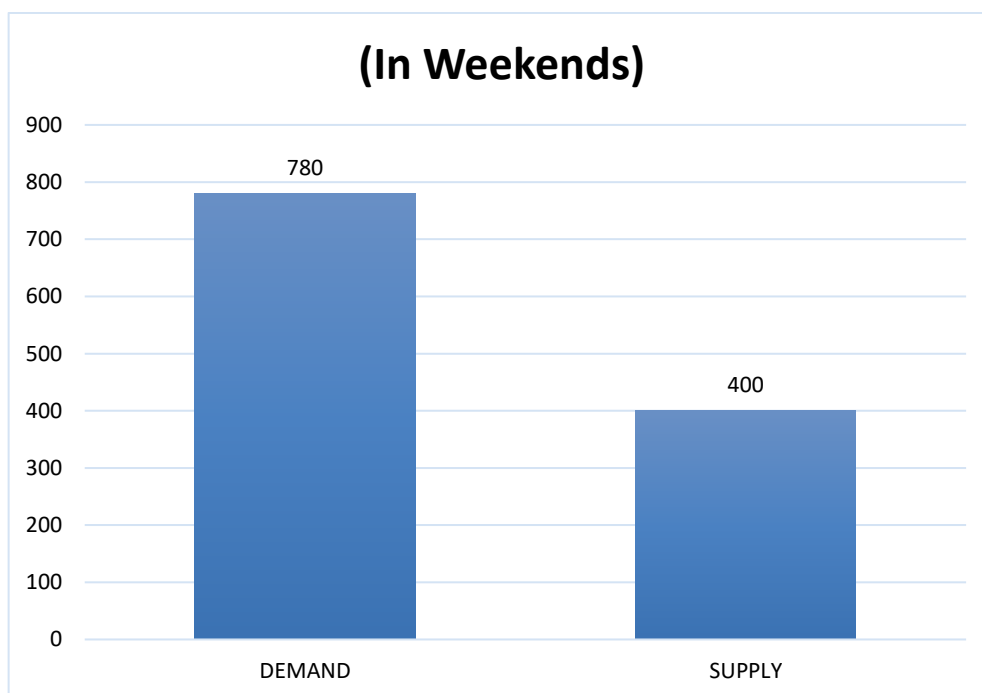**Figure 3:** Supply and Demand-Sai Ch to Ashok Theatre Road (In Weekdays)

Figure 4: Supply and Demand-Sai Ch to Ashok Theatre Road (In Weekends)

PCMC has provided alternate days parking norms, yet demand is still strong.

3.   Shagun chowk to Market (On-Street)
The red spotted line means the 500m stretch of on-road parking on the inward street. The width of 9m and 6m are existent with countless parking spaces that impede the public strolling on this.
On the off chance that a vehicle wishes to go through this stretch, gridlock happens because of the restricted width of the street and the large number of unlawful parking spaces. The stretch is home to Maharashtra's notable dictionary market. The stretch is consistently occupied, from morning to night. Parking on this stretch is opposite on the two roadsides, causing traffic assuming any vehicle goes through.
As per the survey, the assessments for Request and Supply are given beneath, utilizing study procedures.
1. Complete Stretch Length - 500m.
2. Utilization of substitute day parking. (The overall population doesn't follow).
Top hours are 4 p.m.- 7 p.m. on non-weekend days and 1 p.m.- 9 p.m. on ends of the week.
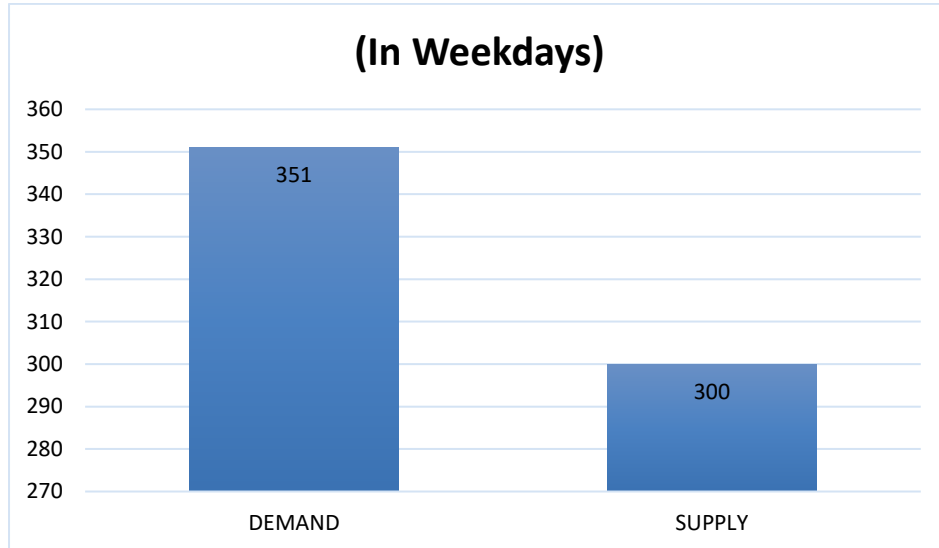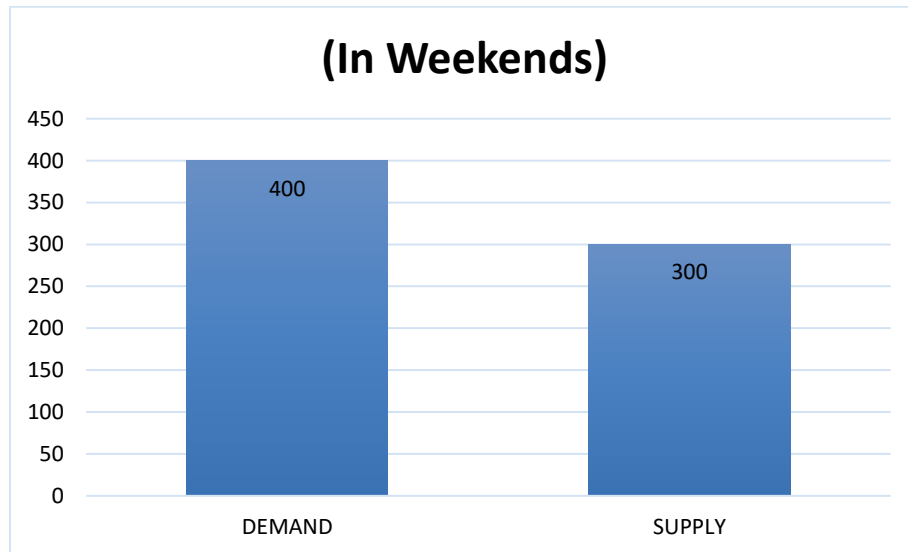(In Weekdays)

Table 3: Supply and Demand Shagun chowk to Market (On-Street)

LOCATION	DEMAND	SUPPLY
Shagun chowk to Market (On-Street)	351	300

(In Weekends)

LOCATION	DEMAND	SUPPLY
Shagun chowk to Market (On-Street)	400	300

Figure 5: Supply and Demand Shagun chowk to Market (On-Street) (In Weekdays)

Figure 6: Supply and Demand Shagun chowk to Market (On-Street) (In Weekends)

4. Vardhaman to Bhatnagar chowk (On-Street)

The review stretches of 120m, 18m wide street with middle is demonstrated by the red spotted line. On a little stretch, this stretch involves jewelery stores and other tool shops. As indicated by the survey, the assessments for Request and Supply are given beneath, utilizing study approaches.

1. Extending Absolute Length - 120m
2. Parking is accessible on the two roadsides.
3. Top night hours are 4pm-7pm on work days and 1pm-9pm on ends of the week.
(In Weekdays)

Table 3: Supply and Demand Vardhaman to Bhatnagar chowk (On-Street)

LOCATION	DEMAND	SUPPLY
Vardhaman to Bhatnagar chowk (On-Street)	100	50

(In Weekends)

LOCATION	DEMAND	SUPPLY
Vardhaman to Bhatnagar chowk (On-Street)	150	80
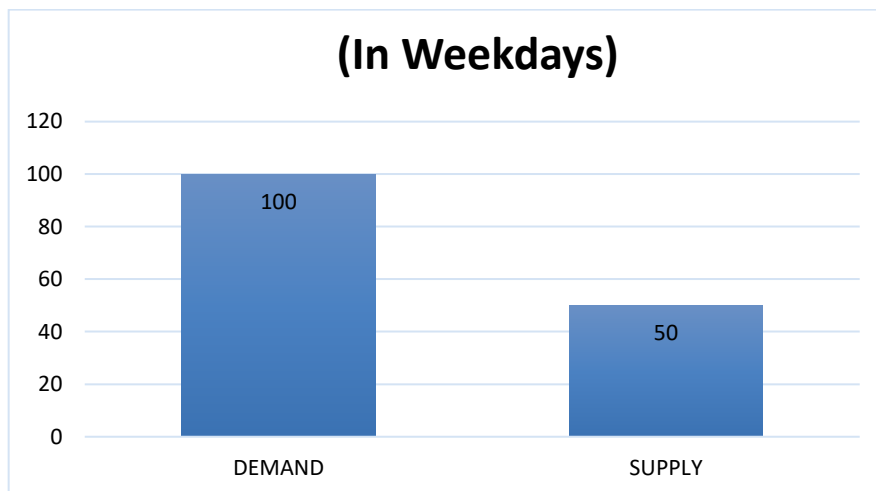
(In Weekdays)

Figure 7: Supply and Demand Vardhaman to Bhatnagar chowk (On-Street) (In Weekdays)
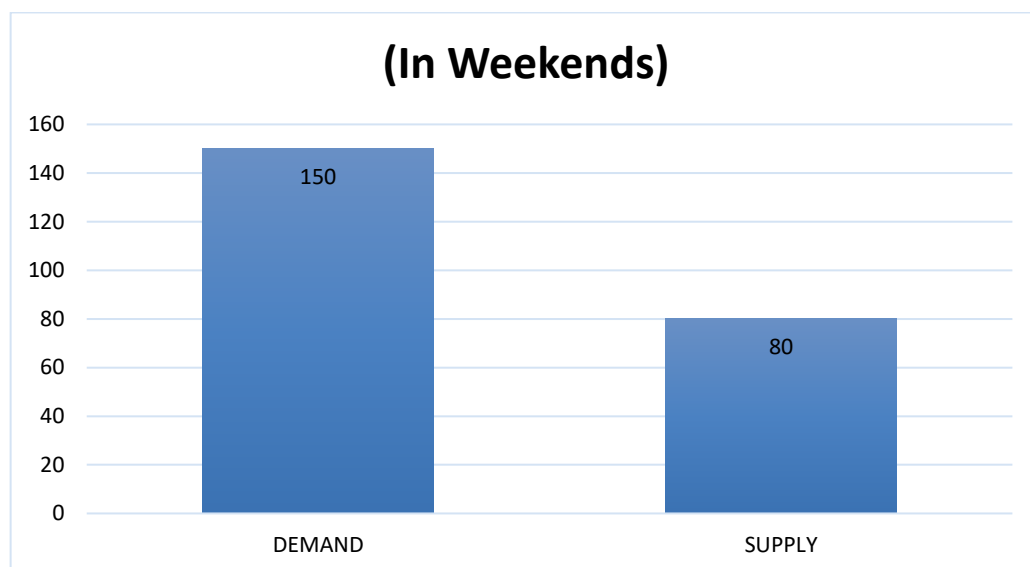
(In Weekends)

Figure 8: Supply and Demand Vardhaman to Bhatnagar chowk (On-Street) (In Weekends)

There is parking on this 18m length, however it is blocked because of auto carts. Since the stretch contains the fundamental junction, no committed area for auto carts is designated.

4.2 Findings from Questionnaire Survey
The Pimpri Market Overview was directed during the day on Saturday, Walk 25, 2023 (End of the week).
Pimpri market land use is practically completely business, and it is a notable market in Pune.
 An example review was directed, and information was gathered in view of the reactions of the members.

4. The results were as follows:
• Around 73% of the vehicles in the space were bikes, which were individuals' method of transportation, and 78% of the parking was in the city.
• 89% visited business stores for shopping and parking for 30 minutes to 60 minutes, with over 1 hour noted in the study.
• 90% of individuals couldn't find a parking spot to leave their vehicle, and the time taken to find a spot in the review ran somewhere in the range of 5 and 10 minutes for 2 and 4-wheelers.
• There is a 88% interest for bike parking, which ought to be free from now on; the excess individuals will pay 0-5rs each hour for wellbeing and security reasons.
• All things considered, 48% and 39% of individuals need parking and will pay 10-20 rupees each hour.
• The separation from the parking part to their objective is nearly strolling.

• Utilizing state of the art advancements and applications 96% of people in the Pimpri Market locale are probably going to utilize the Parking application, which will assist them with finding a parking spot rapidly.

5. CONCLUSION

Carrying out a savvy and economical parking management framework is a potential answer for the issues that cutting edge urban communities face. In need for parking space there are numerous conflicts and issues which causes gridlock and numerous different issues. This article gives thoughts and plans to parking designs. Government plans for future parking interest and supply can be embraced to further develop accessible parking spots. The fundamental and optional information gathering gives knowledge into the future requirement for this branch of knowledge. These goals can prompt savvy and supportable parking management.

At last, the turn of events and execution of an Intelligent and Practical Parking Management Framework (IS-PMS) are basic strides towards tackling the complicated hardships presented by urban mobility in our constantly evolving urban communities. The blend of state-of-the-art innovation like the Web of Things (IoT) and AI has demonstrated the IS-PMS's capacity to alter parking allotment by streamlining asset use progressively. The framework's accentuation on maintainability, especially the advancement of electric vehicle foundation and the decrease of fossil fuel byproducts, exhibits its devotion to ecologically mindful urban turn of events. The IS-PMS's extensive methodology goes past conventional parking management, thinking about bigger urban mobility difficulties and serving to the improvement of more brilliant, more decent urban communities. The IS-PMS fills in as a signal in the worldwide move towards intelligent and supportable urban environments, showing the potential for innovation driven answers for work on urban mobility, decrease gridlock, and prepare for an additional economical and strong urban future.

REFERENCES

1. Abbas, Q., Ahmad, G., Alyas, T., Alghamdi, T., Alsaawy, Y., & Alzahrani, A. (2023). Revolutionizing Urban Mobility: IoT-Enhanced Autonomous Parking Solutions with Transfer Learning for Smart Cities. Sensors, 23(21), 8753.
2. Allam, Z., & Sharifi, A. (2022). Research Structure and Trends of Smart Urban Mobility. Smart Cities, 5(2), 539-561.
3. Auwerx, P., Pressl, R. and Cré, I., 2020. Parking and sustainable urban Mobility planning.
4. Barvinska, K. A. (2023, June). Analysis of the Impact of EU Policy on the Development of Sustainable Mobility in Ukrainian Cities. In Proceedings of the XXI Polish Control Conference (pp. 394-404). Cham: Springer Nature Switzerland.
5. Bielińska-Dusza, E., Hamerska, M., & Żak, A. (2021). Sustainable mobility and the smart city: A vision of the city of the future: The case study of Cracow (Poland). Energies, 14(23), 7936.
6. Cirianni, F. M. M., Comi, A., & Quattrone, A. (2023). Mobility Control Centre and Artificial Intelligence for Sustainable Urban Districts. Information, 14(10), 581.
7. Danilina, N., & Slepnev, M. (2018, June). Managing smart-city transportation planning of "Park-and-ride" system: case of Moscow metropolitan. In IOP Conference Series: Materials Science and Engineering (Vol. 365, No. 2, p. 022002). IOP Publishing.
8. Elsonbaty, A., & Shams, M. (2020). THE SMART PARKING MANAGEMENT SYSTEM.
9. Fiore, U., Florea, A., & Pérez Lechuga, G. (2019). An interdisciplinary review of smart vehicular traffic and its applications and challenges. Journal of Sensor and Actuator Networks, 8(1), 13.
10. Gkoumas, K., Marques dos Santos, F. L., Stepniak, M., & Pekár, F. (2021). Research and Innovation Supporting the European Sustainable and Smart Mobility Strategy: A Technology Perspective from Recent European Union Projects. Applied Sciences, 11(24), 11981.
11. Kirschner, F., & Lanzendorf, M. (2020). Parking management for promoting sustainable transport in urban neighbourhoods. A review of existing policies and challenges from a German perspective. Transport Reviews, 40(1), 54-75.
12. Kujawski, A., & Nürnberg, M. (2023). Analysis of the potential use of unmanned aerial vehicles and image processing methods to support road and parking space management in urban transport. Sustainability, 15(4), 3285.
13. Litman, T. (2021). Parking Management. Islam, M., Azam, S., Shanmugam, B., Karim, A., El-Den, J., & DeBoer, F. et al. (2020).
14. Miltiadou, M., Taxiltaris, C., Mintsis, G., Basbas, S., Tsoukala, A., Fylaktakis, A., & Panousi, E. (2021). Case Studies of Sustainable Urban Mobility Plans and Measures Implemented in the Framework of the Sumport Project. WIT Transactions on The Built Environment, 204, 259-273.
15. Nadimi, N., Afsharipoor, S., & Mohammadian, A. arking Demand vs Supply: An Optimization-Based Approach at a University Campus.
16. Okraszewska, R., Romanowska, A., Wołek, M., Oskarbski, J., Birr, K., & Jamroz, K. (2018). Integration of a multilevel transport system model into sustainable urban mobility planning. Sustainability, 10(2), 479.
17. Paiva, S., Ahad, M. A., Tripathi, G., Feroz, N., & Casalino, G. (2021). Enabling technologies for urban smart mobility: Recent trends, opportunities and challenges. Sensors, 21(6), 2143.

18. Parking Management System needed in near future for smart mobility. (2022). 8) Vahan Parivahan (2023), RTO Department Pimpri-Chinchwad Municipal Corporation
19. Smart Parking Management System to Reduce Congestion in Urban Area.
20. Yang, S. and Huang, L., 2017. Research on Planning and Management of Urban Parking Lot