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Comprehensive Analysis Of Urban Vehicle Parking Challenges: A Comprehensive Survey Of Delhi

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1. Abstract

In recent times, the urban population, particularly in India, has been experiencing a significant upward trend. This demographic surge brings forth a pressing concern, notably the escalating challenges associated with urban living. Among these challenges, traffic congestion has emerged as a pivotal issue for cities, compounded by the inadequate availability of parking spaces. While parking spaces do exist within city landscapes, a lack of awareness regarding their locations and suboptimal utilization exacerbate the problem.

This paper focuses on a comprehensive survey conducted in Connaught Place, Delhi, shedding light on the critical importance of efficient parking solutions. The research aims to identify the major issues of parking in the city and proposes technology to optimize the utilization of available spaces. Through this investigation, we strive to contribute insights that can inform effective urban planning and alleviate the challenges posed by burgeoning urban populations, particularly in the context of vehicular parking.

2. **Keywords**: Parking, cost, technology

3. Introduction

Urban centers across India are grappling with a pronounced and escalating challenge: parking inadequacies. While the impact of parking on transportation efficiency may seem minimal, its repercussions extend to the longevity of vehicle engines. The surge in traffic across the country has thrust parking-related issues to the forefront, joining the ranks of concerns such as pollution and substandard road quality.

Parking, broadly classified into two types: off-street and on-street, plays a pivotal role in urban planning. Off-street parking, prevalent in expansive shopping complexes, theaters, and large offices, serves the needs of employees and customers alike. On the other hand, on-street parking, governed by market dynamics and individual preferences, exacerbates traffic issues, transforming it into a matter of public interest.

Despite some dismissing parking concerns as secondary to broader urban transport challenges, overlooking its significance has contributed to its exclusion from policy frameworks. This oversight has fueled traffic bottlenecks, adversely impacting urban transport quality, land utilization, and escalating social and environmental costs.

In contemporary times, the parking predicament is intrinsically tied to spatial constraints. Minimizing parking space is imperative to mitigate issues arising from fuel loss, diminished air quality, and congestion, all of which are repercussions of inadequate parking infrastructure. Certain cities have introduced highly paid parking in bustling markets to not only offset the cost of land but also regulate demand, averting market distortions.

Research endeavors are underway to optimize space utilization and reduce maintenance costs, recognizing parking as fundamentally a spatial dilemma. With the burgeoning dependence on automobiles in Indian cities, the demand for parking spaces has soared, surpassing the rate of infrastructural expansion. The resultant scarcity of parking areas manifests in various urban challenges, including congestion, fuel wastage, dispersed land use, and compromised air quality, as showed in figure 1. Addressing this predicament necessitates a multifaceted solution that provides ample parking space while concurrently managing and curbing the escalating demand for parking facilities.

4. Methodology

This section presents a detailed elucidation of the research methodology employed throughout the study. Initially, a comprehensive description of the study area is provided, shedding light on challenges faced by the commuters for parking. The subsequent discussion in the section delves into the collected dataset, comprising responses from 1550 participants. This segment of the study is presented through descriptive statistics, offering insights into the dataset's characteristics.

4.1 Study Area

The study revolves around evaluating parking locations in diverse regions of Delhi, Connaught Place, each characterized by distinct land use patterns such as commercial, business, and market areas. (Figure 2)

The 'Connaught Place' in Delhi have become the epicenter of a parking crisis, prompting local shopkeepers to seek intervention from the traffic police. On weekends, the situation intensifies to the point where finding parking becomes nearly impossible. This congestion not only impedes vehicular movement but also compels commuters to opt for more spacious malls, abandoning the Connaught Place stretch. In a bid to outshine competitors, some traders flag down passing vehicles directly in front of their shops, enticing potential customers to make impromptu purchases. Despite these endeavors, the challenges faced by commuters and shopkeepers, grappling with an unmanageable crowd, persist without due recognition.

The collective frustration among shopkeepers has prompted united action against the declining commercial prospects associated with their trade. Facing persistent parking issues, they have submitted a joint petition to civic authorities, the administration, and the police, seeking relief from this predicament.

Figure 1: Traffic Jams due t the parking

Figure 2: Parking Problem at Connaught Place

4.2 Data Collection

The requisite data for this study underwent meticulous collection through questionnaire surveys, utilizing a hybrid approach of face-to-face interviews. This method ensured the acquisition of a comprehensive dataset for subsequent analysis. The data collection initiative unfolded over both weekdays and weekends, encompassing the period from February 1 to April 1, 2022, to capture a representative snapshot of typical parking scenarios.

The study hours extended from 09:00 AM in the morning to 07:30 PM in the evening.

In order to gain a nuanced understanding the parking issues faced by the commuters, a series of in-depth face-to-face interviews were conducted at twenty prominent car parking facilities strategically located within the designated survey area. The questionnaire utilized in these interviews was meticulously crafted to extract detailed information from the drivers. A substantial number of questionnaire forms, approximately 1550 in total, were distributed during these face-to-face interviews. However, a stringent filtering process was applied, resulting in the exclusion of around 20% of the forms due to missing answers, leaving a final count of 1250 survey forms that met the criteria for completeness and acceptability. This rigorous approach was implemented to uphold the integrity and reliability of the data collected through the interviews.

4.3 Descriptive Analysis

In this section, an in-depth exploration is conducted into the various socio-economic attributes of commuters, aiming to unveil the intricate relationships between these characteristics and parking-related issues. The dataset encompasses information pertaining to age, gender, income, area of residency, as well as the reasons, duration, and frequency of specific driver attributes, all of which play pivotal roles in the decision-making processes underlying parking choices. These key insights are succinctly summarized in Table 1.

The survey predominantly attracted male respondents, constituting a majority of 79.35%, while women accounted for 20.65% of the participants. Notably, the most prominently represented age group was individuals aged between 31 and 50 years, comprising 49.63% of the respondents. Furthermore, the educational background of the participants fell within three primary categories.

A notable revelation from our data is that the majority of interviewees spent an average of 20 minutes daily in the pursuit of a vacant parking space. However, this figure exhibited considerable variance, with 15.5% of respondents spending less than five to ten minutes and a substantial 38.2% dedicating more than twenty minutes to this endeavor. These variations can be attributed to the intricate interplay between the supply and demand for parking, intricately linked to the unique needs and preferences of drivers.

Determinants of Parking Violation in Connaught Place, Delhi

Our study sheds light on the key determinants factors of parking violation of drivers in Delhi, as presented in Table 2. Following are the factors for violation of parking:

1. Parking availability:

Description: Limited availability of parking spaces poses a significant challenge for commuters in Delhi.

Impact: Increased competition for limited parking spots results in congestion and frustration.

2. Don’t have exact parking location:

Description: Lack of awareness about precise parking locations creates difficulties for drivers.

Impact: Wasted time and increased traffic as drivers search for suitable parking spaces.

3. Don't have exact status of parking:

Description: Uncertainty regarding the availability of parking spaces (filled or insufficient) adds to the challenges.

Impact: Inefficiency in the parking search process, leading to congestion and delays.

4. Problem in Existing System:

Description: Issues within the current parking systems contribute to inefficiencies and user dissatisfaction.

Impact: Reduced effectiveness in managing parking spaces, exacerbating the overall problem.

5. High Cost:

Description: Elevated parking fees act as a deterrent for some users.

Impact: Encourages illegal parking practices and dissatisfaction among users.

6. Not Required:

Description: Perception that parking services may not be needed contributes to non-utilization.

Impact: Underutilization of available parking spaces, potentially exacerbating congestion.

7. Walking Distance is Too Much / Connecting Vehicle Unavailable:

Description: Inconveniently long walking distances from parking areas or a lack of connecting vehicles present challenges.

Impact: Discourages individuals from utilizing available parking, leading to congestion in more accessible areas.

8. Less or No Traffic on the Road:

Description: Low traffic volume may create a false sense of available parking spaces.

Impact: Increased competition for limited parking spots when traffic unexpectedly rises, causing congestion.

Table 1: Summary of the survey data of evaluating the problem in existing parking system

Question:	**Answer 1**	**Answer 2**	**Answer 3**
Gender	Male: 79.35%	Female: 20.65%	NA
Age	Upto 30 Yrs: 31%	Middle Age (31-50 Yrs): 49.63%	Old (Above 50 Yrs): 20%
Education Level	Nil to primary: 25.5%	Secondary School (7-12): 34.3%	Graduate and above: 40.2%
Car Usage	Regularly: 75.3%	Occasionally: 20%	Rarely: 4.7%
Purpose Trip	Work/College: 40%	Market: 49%	Other: 11%

Get Parking	Easily: 12%	Occasionally: 22%	Rarely: 66%
Parking Place	Any convenient location on the road: 32%	At some location near from Destination: 42%	At authorized parking: 26%
Parking Time	Less than 2 Hrs: 24%	2- 4 Hrs: 22%	More than 4 Hrs: 54%
Parking Search	5-10 minutes: 15.5%	10-20 minutes: 38.2%	More than 20 minutes: 46.3%
Parking Difficulty	Always: 45%	Most of the times: 32%	Sometimes: 23%
Interested in online application for parking	Yes: 67%	No: 15%	May be: 18%

Table 2: Summary of the survey data of factors for Parking Violation:

S.NO	Factors	Percentage
1.	**Don't know exact parking location**	**29%**
2.	**Don't know exact status parking (many times filled or facing insufficient place)**	**22%**
3.	**Problem in Existing system**	**9%**
4.	**High Cost**	**14%**
5.	**Not required**	**8%**
6.	**Walking distance is too much from parking / Connecting vehicle is not available**	**12%**
7.	**Less or no traffic on the road**	**6%**

Table 3: Summary of the survey data of factors for Parking Search

S.NO	Factors	Percentage
1.	**Parking Availability**	**35%**
2.	**Optimal/ shortest Route to the destination**	**13%**
3.	**Short Walking Distance**	**6%**
4.	**Parking Type (on street/ off street)**	**8%**
5.	**Parking Cost**	**8%**
6.	**Vehicle Safety**	**11%**
7.	**Parking services (lift/ elevators/ lightening/ etc)**	**6%**
8.	**Accessibility to Parking**	**13%**

Details of Parking Factors Influencing Vehicle Parking Choices in Delhi:

Our study also sheds light on the key factors on which the drivers search parking choices of drivers in Delhi, as presented in Table 3

1. **Parking Availability:** Commuters in Delhi prioritize parking availability, seeking spaces that are easily accessible and not overly congested.

2. **Optimal/ Shortest Route to the Destination:** Drivers consider the convenience of reaching their destination, opting for parking spaces that align with the optimal or shortest route to minimize travel time.

3. **Short Walking Distance:** Proximity to the final destination is a crucial factor, with drivers preferring parking locations that entail a short walking distance to their intended destinations.

4. **Parking Type (On-Street/ Off-Street):** The distinction between on-street and off-street parking plays a pivotal role. Some drivers may prioritize the convenience of on-street parking, while others may opt for more organized off-street facilities.

5. **Parking Cost:** Cost considerations significantly impact parking choices. Drivers assess the affordability of parking options, weighing the cost against their budget constraints.

6. **Vehicle Safety:** The safety of parked vehicles is a paramount concern. Drivers favor parking spaces with adequate security measures to safeguard their vehicles from theft or damage.

7. **Parking Services (Lifts/Elevators/Lighting, etc.):** Additional services provided in parking facilities, such as lifts, elevators, and adequate lighting, contribute to the overall appeal. Well-equipped parking spaces enhance the user experience and may influence choices.

8. **Accessibility to Parking:** Easy accessibility to parking locations is crucial. Factors such as proximity to major roads, entry and exit points, and overall convenience in reaching the parking facility impact driver decisions.

5. Solutions for Alleviating Parking Challenges:

Addressing the prevailing parking scarcity entails a multifaceted approach incorporating both spatial optimization and demanding information for the parking. The proposed solutions are outlined as follows:

1. Expansion of Parking Spaces: Increasing the overall capacity of parking spaces to accommodate a higher volume of vehicles.

2. Enhanced Accessibility and Pedestrian Paths: Improving accessibility and pedestrian pathways around parking spaces to facilitate convenient movement from the parking area to the destination, mitigating inconveniences associated with distant parking.

3. Optimal Space Utilization: Maximizing the utilization of available space through the promotion of public transportation over private alternatives, considering both cost-effectiveness and environmental considerations.

4. Time-Variable Pricing: Implementing time-variable pricing to adjust charges based on peak hours, thereby managing demand during periods of high traffic.

AI based space Optimization technology

In the dynamic landscape of Delhi, where unprecedented growth brings forth myriad challenges, our innovative application endeavors to address the perpetual issue of parking. Despite extensive efforts to augment infrastructure and accommodate the burgeoning vehicular population, the quest for a parking space in the city remains a time-consuming and fuel-wasting endeavor, with more than a litre of gasoline per hour per 1000 cars being squandered in the search.

Our solution adopts a distinctive approach, offering users the ability to reserve parking spaces in advance through the application. Catering to the needs of parking space owners, including malls, airports, municipal corporations, and vehicle owners, the app establishes connections to efficiently utilize available parking spaces. Users can proactively secure parking spots before embarking on their journeys, searching for available spaces through a map view and completing the transaction by making a secure online payment.

The application provides a seamless experience, guiding users to the destination if the selected parking space is unavailable and allowing cancellations in case of changes in plans, subject to the policies of the specific parking space. While the parking predicament remains substantial, the app empowers users to navigate this challenge by reserving parking spots in advance.

How Our App Works:

1. Download and Sign-Up: Users can download the app, complete the sign-up process by providing basic details and a mobile number.

2. Route Selection: Enter the starting point and destination, press "View Route" to identify the nearest parking space.

3. Real-Time Information: Check rates, view pictures (if available), and access real-time data on the number of available slots.

4. Rate and Feedback: Users can rate and provide feedback on the app's functionality.

5. Contribution to Map: If users discover new, legal parking spaces (public or private), they can add them to the map with details such as space type, rates, pictures, and the number of slots.

6. Space Holder Features: Space holders can sign up, locate their space on the map, and provide details about their business, parking area, rates, available slots, and real-time data.

6. Recommendations:

Following are some recommendation for the parking, based on the field survey conducted for the study.

Recommendation for Parking Management and Enforcement:

1. Local Area Management Plan: Enforce a local area management plan for prominent commercial areas like Sarojini Nagar, optimizing available legal parking spaces for maximum efficiency and financial viability.

2. Efficient Management Strategies: Implement efficient management strategies for existing parking, both on-street and off-street, to enhance overall efficiency. Designate and demarcate legal parking areas, enforce penalties for violations, and integrate parking for non-motorized transport into the overall plan.

3. Technology Considerations: Reconsider the technology for future parking structures, especially those located in heavy traffic areas. Automated systems, while attractive, may face glitches and delays, requiring stringent management and operational measures.

4. Site Selection and Integration: Ensure appropriate siting of parking structures, avoiding proximity to commercial and market complexes. Integrate management for both multi-level structures and surface area parking, preventing bifurcation that could hinder operational and pricing practices.

5. Utilize Multi-Level Parking to Curtail Surface Area: Leverage multi-level parking structures to reduce surface area parking, enforce legal parking, and eliminate illegal and free parking in the vicinity.

Recommendation for Parking Pricing:

1. Reflect True Value of Land: Parking rates should reflect the true value of the land, as stated by the National Urban Transport Policy (NUTP). Government-led parking should avoid subsidies if parking charges do not cover the full costs.

2. Rationalize Rates: Rationalize parking rates for structured and surface parking, ensuring higher rates for surface parking to encourage structured parking utilization. Implement time-variable rates, eliminate free parking, and charge higher rates for larger vehicles.

3. Move Towards Full Cost Pricing:
Cities need to move towards full cost pricing, potentially transitioning to market-driven rates with strong enforcement of legal parking. This aligns with the emerging global trend, recognizing that parking provision for personal vehicles is not a public good.

Recommendation for Parking Revenue:

1. Privately Managed Public Parking:
Consider moving towards privately managed public parking, where the government sets terms for parking leases to augment revenue. Utilize revenue from parking for public transport improvement, aligning with the NUTP.

2. Tax Policy for Parking:
Design tax policies for parking that ensure parking spaces are taxed at the same rate as if the land were used for other developments. This helps offset revenue losses from potential alternative land uses.

3. Enhance Revenue from Parking:
Enhance revenue from parking by increasing charges, ensuring revenue-sharing mechanisms, and tapping into rental earnings from developers. Revenue estimates should not solely rely on parking earnings but also consider rental earnings.

Improving Connectivity for Mode Shift:

1. Public Transport Connectivity:
Incorporate good public transport connectivity into local area planning to influence commuting behavior. Enhance bus services and design feeder connections with metro stations to reduce reliance on surface parking.

2. Multimodal Integration:
Creatively deploy parking within the framework of multimodal integration to encourage alternative modes such as buses, cycling, and walking. Prioritize parking needs for different modes within the influence zone of mass transit networks.

3. Parking Legislation:
Assess and detail prerequisites for parking legislation, aligning with travel demand management principles and considering the MOUD parking guidelines.

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