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SMART PARKING SYSTEM FOR RANCHI SMART CITY: A CONCEPTUAL FRAMEWORK

Arunima Asthana, Ph.D. Scholar, Dept. of Management, Birla Institute of Technology, Mesra, Ranchi, India-835215, Emai ID: aruasthana27@gmail,.com
Tanmoy Kr. Banerjee[1], Asst. Professor, Dept. of Management, Birla Institute of Technology, Mesra, Ranchi, India- 835215, Email ID: tanmoykumar@rediffmail.com
Vandana Bhattacharjee, Professor, Dept. of Comp Sc. & Engg, Birla Institute of Technology, Mesra, Ranchi, India-835215, Email ID: vbhattacharya@bitmesra.ac.in

Highlights

- Urbanization has led to traffic congestion, fuel use, and environmental damage.
- There is a critical need for an effective parking solution for smart cities.
- The study emphasizes Ranchi highlighting adverse effects of unplanned parking.

Abstract

Rapid urbanization has led to severe traffic congestion and parking issues, fuel consumption and environmental harm (Yee et al., 2014). The rise of "smart cities" emphasizes the urgent need for an efficient parking management solution (Chou et al., 2008). This study holds significant relevance, addressing the adverse effects of unplanned parking on Ranchi's "green city" environment. Our survey of the local population revealed the inadequacies in current measures taken by authorities to alleviate commuter problems. Implementing a smart parking system emerges as a solution to enhance the city's traffic flow, contributing to Ranchi's environmental well-being. In summary, this research proposes a methodology to establish a conceptual framework for a smart parking system, tailored to transform Ranchi into a Smart City. The approach incorporates innovative techniques to improve parking accessibility, and mitigate environmental impact, with a specific focus on prioritizing the well-being, safety, and convenience of women and differently-abled communities.

Keywords: Smart Parking, Sustainable Development, Smart Cities and Sustainable Governance.

Introduction

In the core of bustling urban landscapes, the quest for parking spaces has become a modern-day Odyssey, testing the patience and fortitude of drivers and posing significant challenges to city planners and commuters alike. As cities continue to expand and the number of vehicles on the road surges, the already precarious equilibrium between available parking spots and the growing demand for them becomes increasingly strained. This pressing issue has given rise to a conundrum that plagues metropolises worldwide: the dearth of efficient, intelligent, and convenient parking solutions. In response to this urban dilemma, the innovation of reservation-based smart parking systems with filtered parking spaces has emerged as a beacon of hope in the battle to reshape urban mobility. The advent of reservation-based smart parking systems heralds a transformation in the way we approach the perennial problem of parking. Gone are the days of aimless circling in search of elusive parking spots, the frustration of missed appointments, and the environmental toll of unnecessary emissions. Instead, these systems offer a paradigm shift towards precision, efficiency, and sustainability in urban transportation. By leveraging cutting-edge technology, data analytics, and real-time communication, these systems promise to optimize parking resources, minimize traffic congestion, reduce environmental impact, and enhance the overall urban living experience.

[1] Corresponding Author:
Tanmoy Kumar Banerjee, Department of Management, Birla Institute of Technology, Mesra, Lalpur, Ranchi – 834001; Phone: +91-9832702577; E-Mail: aruasthana27@gmail.com

However, it is not merely the concept of reservation-based parking that warrants attention; rather, it is the integration of filtering mechanisms within these systems that holds the potential to revolutionize how we perceive, allocate, and utilize parking spaces. Filtered parking spaces are not just physical locations for vehicles but dynamic assets within a broader urban ecosystem. They are spaces that adapt to the evolving needs and preferences of both commuters and cities, striking a delicate balance between convenience and sustainability. The integration of filtering mechanisms involves categorizing parking spaces based on various criteria, such as vehicle type, environmental considerations, accessibility requirements, and even user preferences, thereby optimizing their utilization and ensuring they align with the broader goals of urban development.

Now, as we shift our focus to the city of Ranchi, we find a microcosm of the broader urban challenges faced globally. Urbanization, a global phenomenon, has swept through Ranchi, driving rapid population growth in recent years. Factors such as rural-to-urban migration and economic opportunities have fuelled this transformation. While urbanization offers promises of progress and development, it also brings with it a host of complex challenges, with urban traffic congestion standing out as one of the most pressing. The once spacious roadways of Ranchi, designed for a smaller population, are now strained under the weight of increased vehicular traffic. What was once a relatively smooth journey to work or other destinations has become a daily struggle, with commuters spending a significant portion of their day navigating congested streets and hunting for parking spaces. The consequences of this traffic congestion are multifaceted, leading to immense frustration among residents and commuters alike. DharmaReddy et al. (2013) stated that the stress of being stuck in traffic, often for extended periods, takes a toll on individuals' well-being and quality of life. Additionally, the economic impact cannot be understated, as valuable working hours are lost in transit, affecting productivity and overall economic output. While traffic congestion is a city-wide issue, one of its most visible and troublesome manifestations is the struggle to find suitable parking. This challenge is exacerbated during peak hours when the demand for parking spaces peaks. Rahayu et al. (2013) discussed that when the vehicles enter the streets in search of an available spot, not only is time wasted, but fuel is consumed unnecessarily, contributing to increased carbon emissions and environmental harm.

It is essential to recognize that this parking predicament affects different segments of the population in distinct ways. Women, for example, often face unique challenges when seeking parking. The lack of well-lit, secure parking spaces can deter them from venturing out during the evening or night hours. Additionally, the interior parking slots, which may require navigating narrow alleys or poorly lit areas, may not provide optimal comfort or safety for women. Differently-abled individuals face their own set of challenges. Accessible parking spaces featuring flat surfaces, suitable ramps, and proximity to amenities are essential for their mobility and independence. The absence of these facilities not only hinders their ability to navigate the city but also perpetuates exclusion and inequality. Karbab et al. (2015) defines that the Smart Parking System empowers users to identify suitable parking zones, make reservations, and potentially extend them, all while allowing parking administrators to define and oversee parking spaces effectively. This innovative approach not only enhances the overall parking experience but also optimizes space utilization, reducing the need for expansive, inefficient parking lots that consume valuable urban real estate.

In conclusion, the challenges posed by urban traffic congestion and parking in Ranchi are complex, but they are not insurmountable. This research introduces a forward-thinking approach that combines technology, sustainability, and inclusivity to create a smart parking system tailored to Ranchi's unique needs. As we embark on this journey toward a more efficient, sustainable, and inclusive urban future, the adoption of intelligent parking solutions stands as a beacon of progress, offering a promising path to address the challenges of today while building a brighter, more sustainable tomorrow for Ranchi and its residents.

Women prioritize their safety when selecting parking spots outside their homes, often opting for slots near open entrances or elevators to avoid going deep into the interior of the parking area, which can

raise safety concerns. Similarly, individuals with disabilities seek flat and un-sloped parking spots that are in close proximity to elevators or entrances, minimizing the distance they need to travel to access their vehicles. Therefore, the principal aim of this study is to develop a conceptual framework delineating the integration of filtered parking spaces into the ambit of smart parking reservation systems, with the overarching goal of advancing Ranchi's urbanization as a smart city. The conceptual framework applied in this study follows a machine learning based system to assist users in selecting parking slots based on their preferences. This study holds significant relevance in the current context as it delineates a proposed methodology for establishing a filtered smart parking system in Ranchi, with a focus on innovative techniques that improve parking accessibility and reduce environmental impact. Notably, this research also indicates that the developed conceptual framework will greatly benefit individuals with physical disabilities and women, enabling them to effortlessly locate parking spots from the convenience of their homes. In the course of this research, an Applied methodology is employed, prioritizing to resolve the immediate societal challenges faced by the women and differently abled people. The data collection includes both primary and secondary data collection methodologies. The primary data was collected by in-person interview of the key decision makers for making Ranchi a smart city and the secondary data was collected through the reports and journals. The main finding of this research lies in the development of a conceptual framework aimed at transforming Ranchi's parking system into a smart solution. We have conducted a thorough examination of extant literature pertinent to smart parking systems, wherein a conspicuous research gap emerges concerning the incorporation of specialized parking accommodations for women and individuals with disabilities, a deficiency that will be expounded upon in the next section, "Literature Review."

Hence the following Research Questions (RQ) arises in context of the study:

1. What are the specific inadequacies in the current measures taken by authorities to alleviate commuter problems related to traffic congestion and parking in Ranchi?
2. How can the proposed smart parking system be designed and implemented to enhance traffic flow in Ranchi, considering the unique challenges of the "green city" environment, and what innovative techniques can be incorporated to improve parking accessibility?
3. In what ways can a smart parking system prioritize the well-being, safety, and convenience of women and differently-abled communities in Ranchi, and what strategies can be employed to ensure their active participation and benefit from the proposed system?

This paper is organized into the following sections: Section 2 provides a comprehensive review of pertinent literatures. In section 3 we have scrutinized the methodological approach employed in the execution of this research. Later in the next section i.e., Section 4, we will delve into the smart parking systems concept within the context of Ranchi and elucidate a conceptual framework for reservation-based smart parking systems. Lastly, in Section 5 the conclusion of the paper explaining the relevance, implications and the future research directions of the study will be dealt with.

Literature

In the domain of intelligent parking systems, Lam et al. (2002) investigated the impacts of financial measures such as road tolls and parking fees with the aim of harmonizing the equilibrium between road transportation demand and supply. Mimbela et al. (2007) further delineated vehicle detection technologies into two categories: intrusive and non-intrusive sensors. Subsequently, Satien et al. (2007) pioneered the concept of employing the use of sensors to ascertain the vehicle presence or absence, thereby enabling drivers to identify available parking spaces. Expanding upon these foundations, Chou et al. (2008) introduced an agent-based coordination network that leveraged negotiation algorithms, taking into account factors such as parking charges and distance considerations, to facilitate communication between drivers and parking facilities.

Azeem et al. (2009) highlighted the burgeoning vehicular population on roadways and advocated for the deployment of sophisticated parking infrastructure integrated with technological interventions. In response to this imperative, the smart parking system proposed by Resigo et al. (2012) is

conceptualised within the framework of a wireless sensor network architecture. This system entailed the utilization of sensor nodes positioned within individual parking spaces to discern their occupancy status. Subsequently, this occupancy data was relayed to web servers for centralized management. Building upon this framework, Bhinge et al. in (2013) undertook the task of adapting the wireless sensor network approach to the specific demands of parking garage surveillance and administration. Their enhancements encompassed the integration of RFID and ZigBee technologies into the system's architecture.

In line with the progressive advancement of intelligent parking systems, DharmaReddy et al. (2013) developed an astute parking guidance and information system cantered on an ARM8 microcontroller architecture. This system harnessed a diverse array of hardware components, including a webcam, a touch screen LCD display, and GSM (Global System for Mobile Communications) technology for facilitating slot reservations. In a parallel vein, Rahayu et al. (2013) harnessed wireless communication technologies to construct a parking space monitoring system, wherein they deployed digital infrared sensors in conjunction with ZigBee technology for the purposes of vehicle presence detection and real-time determination of parking space availability. Yee et al. (2014) introduced a sophisticated and secure parking reservation system grounded in GSM technology, encompassing robust password authentication mechanisms, and incorporating essential hardware components such as a PIC (Programmable Interface Controller) microcontroller and a motor driver.

The progression of wireless technology has facilitated the implementation of an automated parking system leveraging Bluetooth technology for access control (Al-Kharusi et al., 2014). In further elaboration, Suryady et al. (2014) introduced a cloud-based Platform-as-a-Service (PaaS) explicitly designed for intelligent parking systems. This PaaS offered fundamental tools and services, encompassing modules for backend data storage, device management, and data processing. Isen et al. (2014) delved into parking challenges and policies, framing parking within the context of transport demand management (TDM) and asserting that parking primarily relates to land use.

Addressing the intricacies of parking management, Karbab et al. (2015) proposed an automated car park management system integrating networked sensors and RFID technologies. Furthermore, Orrie et al. (2015) implemented a wireless system enabling remote parking space location via smartphones, streamlining the process of finding and paying for available parking spots. To harness the potential of the Internet of Things (IoT), Basvaraju (2015) devised an automatic smart parking system comprising a centralized server, Raspberry Pi, and various navigation and display components. In their research, Almeida et al. (2015) presented a novel dataset pertaining to parking lots, comprising a total of 695,899 photos which were collected from two separate parking lots, each equipped with three unique camera systems. The dataset was curated to capture static images exhibiting variations in illumination due to diverse weather conditions, including sunny, overcast, and rainy days.

Singh H. et al. (2017) implemented a robust and efficient system for managing and reserving parking spaces for vehicles, ensuring their safety and protection by relying on wireless technology. This scheme encompassed monitoring, reservation, and security modules to ensure efficient parking management. Gandhi et al. (2016) presented an IoT-based car parking management system tailored for smart cities. This system leveraged infrared sensors, RFID technology, and shared servers to provide parking space availability information, manage databases, enable slot booking, and prevent theft. Acharya et al. (2018) contributed a robust framework designed for the detection of parking space occupancy in outdoor environments. This framework harnessed the power of a deep Convolutional Neural Network (CNN) in conjunction with a binary Support Vector Machine (SVM) classifier. The classifier was trained and evaluated using features derived from publicly available datasets (PKLot), which encompassed diverse lighting and weather conditions, making it adaptable to various real-world scenarios.

Numerous significant studies have contributed to the development and understanding of this field. Lee et al. (2019) introduced a specialized method that utilized a Dilated Convolutional Neural Network (CNN) to achieve the primary objective of determining the current state of occupancy of individual

parking spaces within a parking lot using only a single input image. This approach represented a noteworthy advancement in automating parking space monitoring. Ahmed et al. (2019) presented an integrated smart parking system designed to bring together multiple parking service providers into a unified platform. This platform aimed to offer comprehensive parking information services to commuters in smart cities, simplifying the parking experience. Sakurada et al. (2019) focused on the development of an agent-based Cyber-Physical System (CPS) for smart parking. Their emphasis lay in the interconnection of software agents with physical asset controllers using Internet of Things (IoT) technologies. Notably, this approach was successfully implemented in two distinct parking systems, catering to both bicycles and cars, demonstrating its efficiency, modularity, adaptability, and scalability. Alves et al. (2019) conducted a study that revolved around comparing different approaches to resolving consensus problems within distributed smart parking systems. Their research particularly delved into negotiation strategies, shedding light on the decision-making processes in such systems.

In the following year, Ogas et al. (2020) conducted an extensive analysis in which they identified the different types of smart parking systems (SPS) available in the market. They also investigated the vehicle detection techniques (VDT) employed by these systems, along with the associated algorithms and methods, providing insights into the evolution of smart parking technologies. Ghorpade et al. (2020) proposed an innovative multi-objective grey wolf optimization technique for node localization within smart parking systems. The primary goal was to minimize localization errors, improving the precision and accuracy of these systems. Abidin et al. (2020) presented a comprehensive review of existing approaches to smart parking systems, with a particular emphasis on machine-vision-based technology. They highlighted the main features, advantages, and disadvantages of these systems, offering valuable insights for further research and development. Naufal et al. (2020) ventured into the development of a smart parking system that relied on video data analysis and deep learning techniques. Their system had the capability to automatically determine the availability of vacant parking spaces, contributing to the automation of parking management.

Furthermore, Biyik et al. (2021) conducted a detailed technical analysis of smart parking solutions, with a particular focus on the available systems and sensors. This research aimed to provide a comprehensive overview of the technological landscape in the field of smart parking. Fahim et al. (2021) undertook an exhaustive study, comparison, and in-depth analysis of smart parking systems. They assessed various aspects, including technological approaches, sensor utilization, networking technologies, user interface design, computational methods, and the services offered by these systems, offering a holistic perspective. Anwar et al. (2021) presented an exhaustive framework comprising secure parking, precision parking space allocation for diverse vehicle dimensions, eco-friendly localization, real-time voice and touch-based interaction. This framework's primary objective was to deliver an optimized solution for intelligent secure parking, with a concurrent investigation into the wider ramifications of 5G technology within smart urban environments.

Later, Canli et al. (2022) introduced a two-stage hybrid approach aimed at optimizing parking for drivers by minimizing both time and energy consumption. Meanwhile, Singh et al. (2022) presented a state-of-the-art Blockchain-enabled Secure Framework in 2022, focusing on energy-efficient smart parking solutions in sustainable urban environments. Ghorpade et al. (2022) introduced a node localization system tailored specifically for smart parking systems, enhancing the accuracy and reliability of location-based services within these systems.

Following the same, Rocco et al. (2023) introduced a smart parking architecture harnessing IoT technologies, catering to both public authorities and individuals seeking efficient urban parking management. Abdellatif et al. (2023) presented a design for high-precision license plate identification, comprising pre-processing, segmentation, and character recognition stages, bolstering security and monitoring in parking systems. Zhang et al. (2023) pioneered an integrated approach using structural equation modeling (SEM) and hierarchical regression modeling (HRM) to analyze the intricate relationship between parking efficiency and resource allocation optimization in urban areas, offering insights into optimized resource allocation. Shroud et al. (2023) conducted a thorough review of smart

parking sensor technology, assessing its applicability in open parking lots, providing practical insights into its use.

After conducting an extensive review of the existing literatures concerning smart parking systems, it is observed that there exists no research work related to designated parking areas tailored for the needs of women and individuals with disabilities. Women tend to prioritize their safety when selecting parking locations, often opting for spots near to the open entrances or elevators, while avoiding the more remote and less visible sections of parking lots. This safety-conscious behaviour is a direct result of their concerns for personal security. Similarly, individuals with disabilities prefer parking spaces that are flat rather than sloped and strategically located near elevators or entrances. This arrangement minimizes the distance they must travel to access their vehicles.

Therefore, the primary objective of this research is to propose a conceptual framework for the integration of specialized parking spaces, within smart parking reservation systems, that is sustainable and tailored categorically for the women and differently abled people, for making Ranchi a Smart City.

Table 1: Literature Review Table

S.NO	Title	Authors	Year of Publishing	Place Published
1	Intelligent parking management system based on image processing.	Al-Kharusi, H., & Ibrahim A.B	2014	World Journal of Engineering and Technology
2	A Blockchain-Based Architecture for Integrated Smart Parking Systems.	Ahmed, S., Soaibuzzaman., Rahman, M., & Rahaman, S.	2019	International Conference.
3	A Systematic Review of Machine-vision-based Smart Parking Systems	Abidin, M., & Pulugan R	2020	Scientific Journal of Informatics
4	PKLot – A robust dataset for parking lot classification.	Almeida, P. R. L., Oliveira, L. S., Britto, A. S., Silva, E. J., & Koerich, A. L.	2015	Expert Systems with Applications
5	Experimentation of Negotiation Protocols for Consensus Problems in Smart Parking Systems	Alves, B., Gleifer, V., Borges, A., & Leitão P.	2019	Lecture Notes in Computer Science book series
6	Automatic Smart Parking System using Internet of Things	Basvaraju, R.	2015	International Journal of Scientific and Research Publications
7	Smart Parking Systems: Reviewing the Literature, Architecture and Ways Forward.	Biyik, C., Allam, Z., Peiri, G., Moroni, M., Frafier, M., Connell E., Olariu, S., & Khalid M.	2021	Information and Communication Technologies (ICT) in Smart Cities

8	Deep Learning-Based Mobile Application Design for Smart Parking	Canli H., & Toklu S.	2022	IEEE Access
9	An Intelligent Parking Guidance and Information System by using image processing technique	DharmaReddy, P., Rajeshwari, A., and Dr Ahmed, S.M.	2013	International Journal of Advanced Research in Computer and Communication Engineering
10	A Prototype for IoT based Car Parking Management system for Smart cities.	Gandhi, B. M. K., & Rao, M. K.	2016	Indian Journal of Science and Technology
11	Traffic Management System and Travel Demand Management (TDM) Strategies.	Isen, P., Sibal D., & Mikel E.	2014	Transportation
12	A summary of vehicle detection and surveillance technologies used in intelligent transportation systems	Mimbela, L. Y., & Klein, L. A.	2007	New Mexico State University
13	Development of Agent-Based CPS for Smart Parking Systems.	Sakurada, L., Barbosa, J., Leitão, P., Alves, G., Borges, A., & Botelho, P	2019	)N 2019 Annual Conference.
14	Monitoring parking space availability via ZigBee technology.	Yee, H. C., & Rahayu, Y.	2014	International Journal of Future Computer and Communication
15	Investigating Factors for Travelers' Behavior Intentions in Changchun, China, under the Influence of Smart Parking Systems.	Zhang, Y., Song, X., Tao, P., Li, H., Zhan, T., & Cao, Q.	2023	Sustainability

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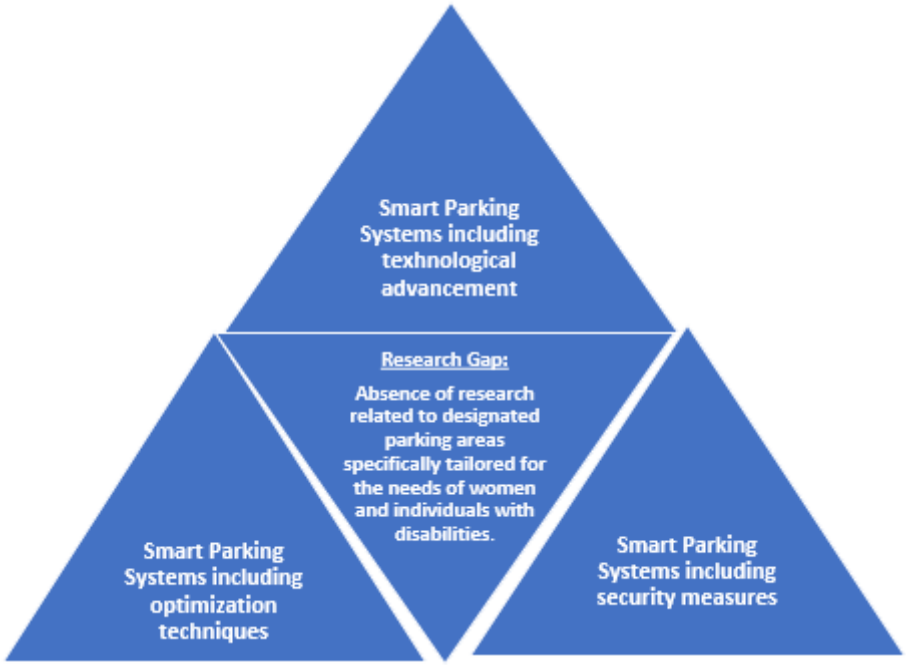

Fig 1: Gap Identification

Materials & Methods

Research Design:

The research design followed in this research is Applied in nature. Applied research aims to "find a solution for an immediate problem facing a society or an industry/business organisation" (Kothari, 2006). As in this research several models with implementation methodologies are proposed to solve a parking problem faced by the women and differently abled people, this research is applied in nature.

Sample Size:

The size of the sample interviewed in this research is five. These five people are the sole decision makers of making Ranchi a smart city, and therefore, we can say that these five people are the population as well. We had conducted interviews with each one of those five individuals to gain a better understanding of the smart parking concept, the problems and constraints faced by them and to acquire a more accurate image of how the smart city notion will be implemented in Ranchi.

Area under consideration:

The area primarily considered to implement a sustainable smart parking system, specifically designed to cater the women and the differently abled people, is the area under the purview of Ranchi Municipal Corporation in the Ranchi city, the capital of the state Jharkhand in India.

Data Collection Method(s):

This study includes both primary and secondary data collection methods. The primary data collection approach entails conducting face-to-face interviews with the study's target population. Meanwhile, the secondary data collection method encompasses an examination of reports from the Ranchi Smart City Corporation and a thorough analysis of peer-reviewed studies within the realm of Smart Parking Systems. Since we exclusively conducted in-person interviews with Ranchi Smart City's key decision-makers, the alternative research methods which could have been employed to enhance our data collection efforts is the distribution of the questionnaires to users, enabling us to gather valuable insights into the difficulties and challenges they encounter while searching for parking spaces. Another viable alternative method would have been the observation method allowing us to analyse real-time traffic challenges experienced by users at various locations.

Source of Information:

Ranchi Smart City Corporation's main decision-makers were the information sources who provided us with insights regarding the design and implementation of the Smart Parking Concept in Ranchi.

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Results and Discussion

Smart Parking Systems in Ranchi

Traditional parking systems in today's urban settings face challenges like inefficient space use due to the growing number of vehicles in densely populated areas, causing congestion and frustration. Manual payment and entry/exit processes are time-consuming and error-prone. Smart parking systems, using sensors, data analytics, and mobile apps, offer real-time space information, streamlined payments, and better management. They enhance driver convenience, reduce traffic congestion, lower emissions, and boost parking revenue. As urbanization grows, smart parking becomes crucial for sustainable and efficient cities. As mentioned in the website of the Ranchi Smart City Corporation, Ranchi, the capital city of Jharkhand, has been undergoing a rapid and transformative urban evolution since the state's inception. This evolution is driven by a substantial influx of individuals from rural areas, all in pursuit of an enhanced quality of life. However, this 23% surge in population between 2001 and 2011 has presented the city administration with a multitude of challenges, prominently within the realms of public transportation and mobility. Given that the city is now home to 1.2 million residents, these challenges have become increasingly paramount. As the population continues to grow, so does the city's carbon footprint, underscoring the need for sustainable solutions as an integral facet of urban planning.

The transportation landscape of the city is currently in a state of flux, with the public transportation system still in its developmental stages. Amidst this transition, intermediate modes of public transport, such as shared autos, have gained prominence without proper regulation. According to the data given on the website of urban development & housing department the shared autos account for a notable 28% of the modal share, while buses contribute a relatively modest 5%. Concurrently, the absence of effective parking regulations and management has resulted in substantial revenue losses, a concern that the city administration is eager to address.

To effectively confront the pressing transportation challenges faced by its residents, the city administration has wholeheartedly adopted an approach characterized by intelligence, innovation, and sustainability, all of which are closely aligned with its aspirations for the Smart City Mission—a distinction achieved in 2016. The city's visionary transport proposal places strong emphasis on the tenets of transit-oriented development, underscoring the creation of pedestrian-friendly infrastructure, provision for cycling facilities, efficient public transportation systems, and the establishment of well-regulated parking facilities.

The process of constructing a city from the ground up is undoubtedly intricate and multifaceted, and Ranchi is unwaveringly committed to this enduring journey. Notably, the city has opted for a sustainable trajectory to guide its progress, one that fully acknowledges the paramount importance of minimizing its carbon footprint and incorporating social elements such as the provision of reserved parking spaces for women and persons with disabilities, support for carpooling and Ride-Sharing and efficient space utilization within its parking and transportation systems. This integrated approach firmly establishes Ranchi's dedication to a holistic and sustainable urban transformation. The outline of the framework of the smart parking system is given below in fig.2 :

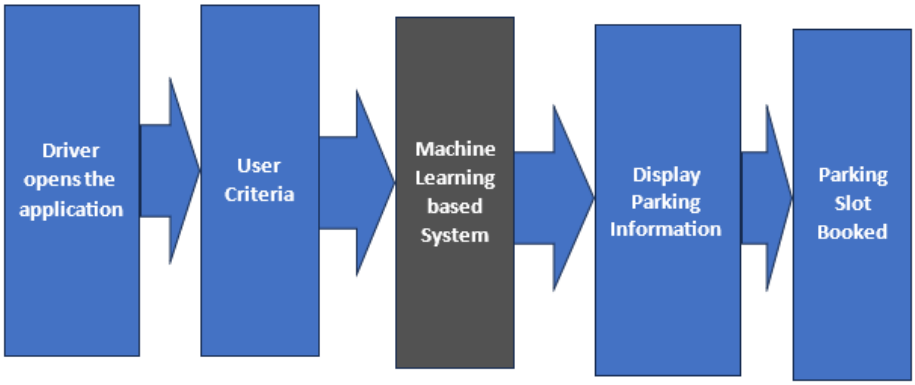

Fig 2: Outline of the framework

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Proposed Conceptual Framework

The Smart Parking System will be comprised of several interdependent components, the layered architecture of which is presented below in fig.3:

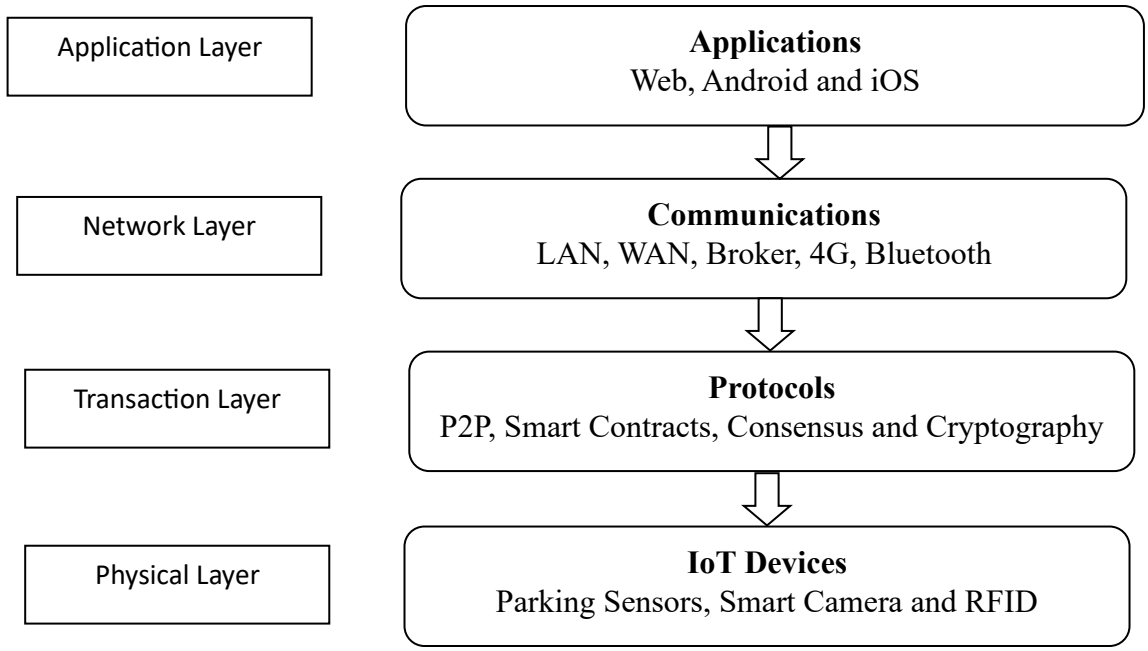

Fig 3: Layer Architecture

Here, the system will work in four different layers with security feature embedded in each of the four different layers. The first and outermost layer will be the Application layer where the common people (users) will be accessing the system. The rest of the three layers will be accessed by the developers, designers, and the system administrators. The security and access rights to these systems will be restricted strictly to the administrators and the data will be secured using the blockchain architecture.

The booking of a parking slot by this system will broadly be working in the following steps:
Step 1: Initialize the system and gather input from the user, including their preferences (e.g., gender, disability) and the desired location (e.g., near elevator, near entrance).
Step 2: Retrieve the parking lot data, including the available parking spaces, their attributes, and their locations.
Step 3: Apply the user filters to narrow down the search space:
a. If the user has specified a preference for women-only parking spaces, filter out all other spaces.
b. If the user has specified a preference for handicapped parking spaces, filter out all other spaces.
c. If the user has specified a preference for general parking spaces, exclude women-only and handicapped spaces.
Step 4: Determine the location preference of the user:
a. If the user has specified a preference for spaces near the elevator, prioritize those spaces by calculating the distance to the nearest elevator for each filtered space.
b. If the user has specified a preference for spaces near the entrance, prioritize those spaces by calculating the distance to the entrance for each filtered space.
Step 5: Sort the filtered spaces based on the calculated priorities, with the highest priority spaces appearing first.
Step 6: Present the sorted list of parking spaces to the user, indicating their availability and location details.

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A comprehensive conceptual framework for a Smart Parking System embedded with a filtration and selection criterion specifically designed for women and persons with disabilities is discussed now. This framework addresses the specific needs of these individuals by facilitating their search for parking slots located near elevators and/or entrances, ensuring convenient access to their vehicles. The main aim of this system will be to provide the necessary assistance to women and persons with disabilities using a smart machine learning based system. This machine learning based system will be the heart of the entire Smart Parking System that will drive the whole filtration and selection process in finding the women and physically challenged people the best suited parking space for them amongst a set of favourable locations, so that they can park their vehicles with utmost ease.

The complete conceptual framework of the Smart Parking System along with its machine learning logic is illustrated in the following diagrams fig 4 & 5:

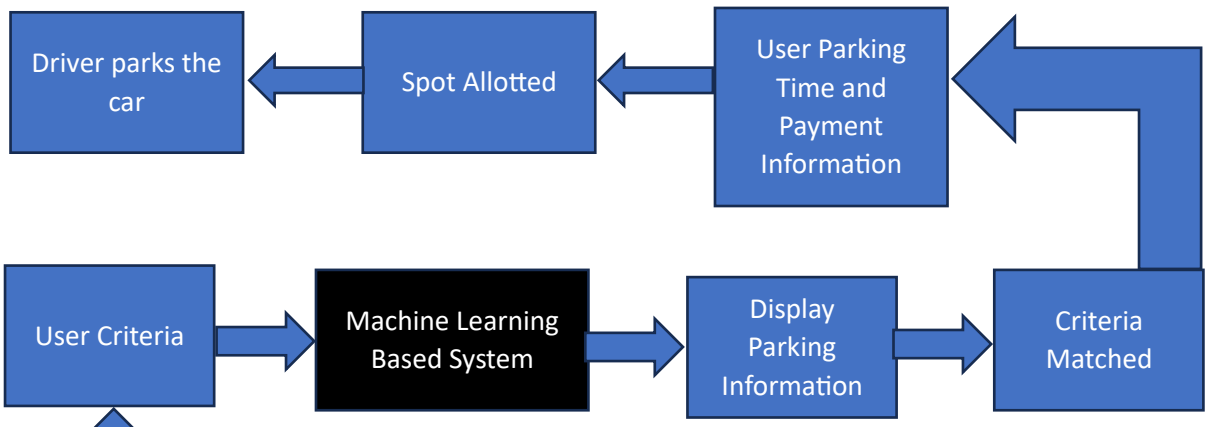

Fig 4: Smart Parking Framework

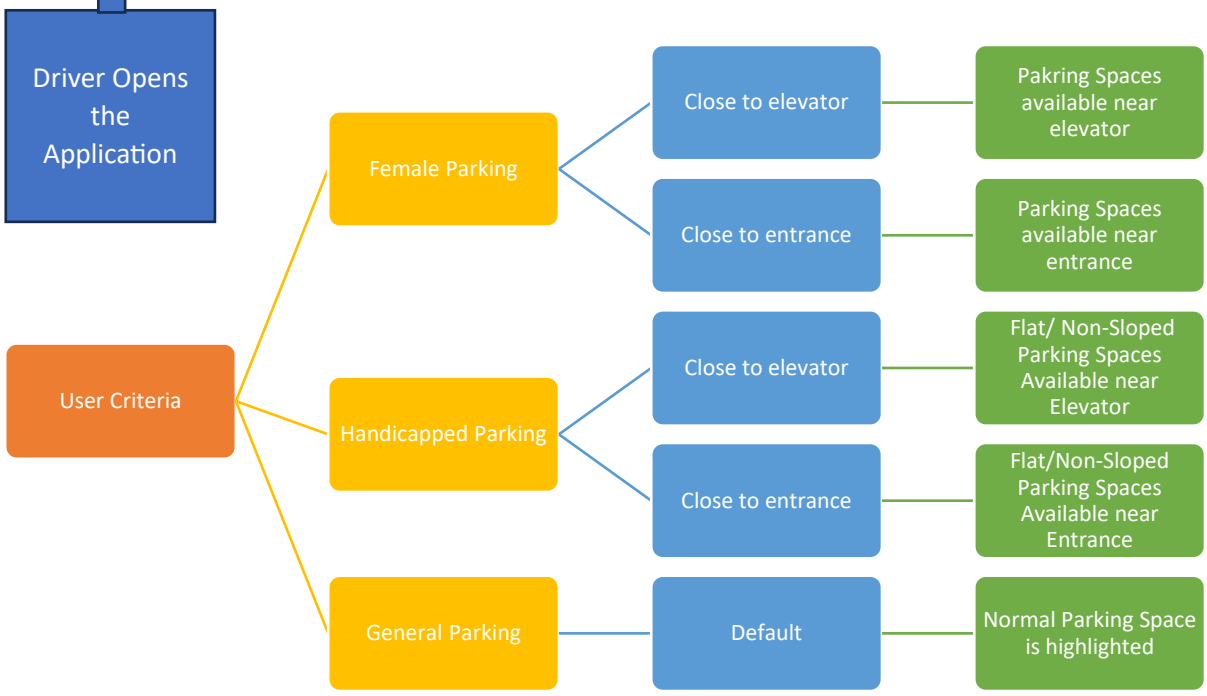

Fig 5: Machine Learning based System

Conclusion

Ranchi holds immense promise in its journey towards smart city status, primarily through the implementation of a forward-thinking smart parking system that allocates parking spaces with precision, catering specifically to the needs of women and individuals with disabilities. The core

findings of this study pivot around the formulation of a comprehensive conceptual framework for a reservation and filter-based smart parking system, meticulously calibrated to the unique urban dynamics of Ranchi. This ground-breaking system addresses a pressing need, underlining the imperative of reservation-based smart parking for individuals facing distinct challenges, particularly women and those with physical disabilities.

This study carries significant implications for both differently abled individuals and women by addressing their social support needs. The proposed conceptual framework not only promises a reduction in toxic gas emissions but also a noteworthy decrease in carbon footprints. Given the often frustrating and time-consuming search for parking spaces, this innovative reservation-based smart parking system offers a time-saving solution, allowing women to reserve their preferred slots in advance which in turn ensures enhanced security for them, as the entire process will be closely monitored by the authorities. Similarly with a reservation based smart parking system the differently abled people will be able to park their vehicles with much ease and comfort.

Securing a parking spot can often be a cumbersome and exasperating experience, particularly for these demographic groups, who contend with distinct obstacles and safety considerations. The study underscores the transformative potential of this reservation-based smart parking system as it takes centre stage in prioritizing the well-being, security, and convenience of traditionally underprivileged communities. Enabled through a dedicated mobile application, users can now effortlessly secure parking slots tailored to their precise requirements without the necessity of physically being present at the parking facility. This not only streamlines their daily routines but also bolsters their mobility and autonomy, thereby nurturing a more just and equitable urban ecosystem.

However, it is crucial to acknowledge the study's inherent limitations, as it is confined to only the area under the purview of Ranchi Municipal Corporation in the Ranchi city. Therefore, this conceptual model obtained in this research can be extended in future to the rest of the area in Ranchi district as well as to the entire area in the state of Jharkhand. Furthermore, the integration of green technologies, such as solar panels and rainwater harvesting systems in parking infrastructure to reduce environmental impact, can be also added to extend this conceptual framework for smart parking in future. Such progressive initiatives would not only contribute significantly to enhancing inclusivity and sustainability within the realm of smart cities but would also ensure that parking amenities remain finely attuned to the diverse and evolving needs of their inhabitants to metamorphose Ranchi into an authentically smart and equitable cityscape, fostering greater mobility, reduced congestion, and elevated standards of environmental sustainability.

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