

Research Article

Design and Implementation of a User-Friendly Smart Parking System Using Dynamic ChatbotsKatam Saikumar^{1,*} and N. Ramana Reddy²¹Student, Department of CSE, Avanthi Institute of Engineering and Technology, Hyderabad, Telangana, 500001, India.²Associate Professor and HOD, Department of CSE, Avanthi Institute of Engineering and Technology, Hyderabad, Telangana, 500001, India.*Corresponding Author: Katam Saikumar. Email: saigoudkaatam369@gmail.com

Received: 21/07/2025; Revised: 20/8/2025; Accepted: 20/09/2025; Published: 30/09/2025.

DOI: <https://doi.org/10.69996/fmep.2025014>

Abstract: The rapid growth of urban populations has intensified parking challenges, necessitating intelligent and user-centric solutions. This paper proposes a dynamic chatbot-integrated smart parking system designed to streamline parking operations, enhance user experience, and reduce manual intervention. The system leverages natural language processing (NLP) and real-time data analytics to provide personalized assistance in slot booking, status updates, navigation, and payment processing. A weighted decision model is used to compute Parking Slot Suitability Scores (PSSS), optimizing slot allocation based on parameters such as distance, congestion, availability, safety, and cost. Extensive testing across multiple user categories—including commuters, tourists, emergency responders, and differently-abled individuals—demonstrated significant improvements in parking search time, booking success rate, system responsiveness, and user satisfaction. The results validate the system's capability to support adaptive, scalable, and efficient parking management in smart city environments. This work contributes to the advancement of intelligent transportation systems by integrating conversational AI with IoT-enabled infrastructure to achieve sustainable urban mobility.

Keywords: Parking slot suitability scores (PSSS), Natural language processing, IoT, Chatbot-integrated smart parking system, AI.

1. Introduction

In recent years, chatbots have emerged as a transformative technology across multiple domains, including customer service, healthcare, education, and e-commerce [1]. Driven by advancements in artificial intelligence (AI), natural language processing (NLP), and machine learning (ML), modern chatbots have evolved from simple rule-based systems to highly sophisticated conversational agents capable of understanding context, intent, and user emotions [2]. Their growing integration into digital platforms reflects an increasing demand for real-time, scalable, and cost-effective solutions to enhance user engagement and operational efficiency [3]. With the rise of generative AI models like GPT, chatbots are now being employed not only for routine queries but also for complex decision-making and personalized assistance [4]. Dynamic chatbots represent the next generation of conversational agents, designed to adapt and respond intelligently based on real-time user input, context, and evolving dialogue patterns [5]. Unlike traditional rule-based or static chatbots that follow predefined scripts, dynamic chatbots leverage advanced machine learning, natural language understanding (NLU), and reinforcement learning techniques to continuously learn from interactions and improve performance [6]. These systems can handle open-ended queries, switch topics seamlessly, and personalize responses based on



user preferences and behavioral history. Their adaptability makes them highly effective in domains requiring contextual awareness, such as healthcare consultations, virtual tutoring, and intelligent customer support. By incorporating feedback loops, dynamic chatbots evolve over time, offering more accurate, relevant, and human-like interactions [7 -9]. As AI technologies continue to mature, dynamic chatbots are becoming integral to creating more engaging, efficient, and intelligent human-computer interactions.

Dynamic chatbots are increasingly being integrated into smart parking systems to enhance user interaction, optimize resource utilization, and streamline the parking experience. By leveraging real-time data from IoT sensors, GPS, and cloud platforms, these chatbots can provide users with up-to-date information on available parking slots, expected wait times, pricing, and optimal routes [10]. Unlike static systems, dynamic chatbots adapt to evolving traffic conditions and user preferences, enabling personalized guidance and proactive notifications [11]. Through natural language interfaces, users can interact with parking services via voice or text to reserve spots, extend parking duration, or receive alerts on violations or time limits [12]. This intelligent interaction not only improves user convenience but also contributes to reduced congestion and more efficient urban mobility. The integration of dynamic chatbots into smart parking infrastructures represents a significant step toward the realization of intelligent transportation and smart city ecosystems [13].

In addition to improving user engagement, dynamic chatbots play a crucial role in backend operations by assisting administrators in managing parking demand, detecting anomalies, and forecasting peak usage periods through data analytics and AI-driven insights [14]. These chatbots can interface with payment gateways to facilitate seamless, contactless transactions and can also be integrated with vehicle recognition systems for automated access control. Furthermore, they support multilingual and multimodal communication, making them accessible to a diverse population [15 -17]. As cities continue to adopt smart mobility solutions, the scalability and adaptability of dynamic chatbot systems make them an ideal tool for managing the growing complexity of urban transportation [18-19]. Future advancements may include integration with autonomous vehicles, predictive maintenance of parking infrastructure, and more robust cybersecurity frameworks, ensuring that dynamic chatbots remain a central component in the evolution of intelligent parking ecosystems [20-21].

This paper contributes to the advancement of intelligent urban infrastructure by introducing a dynamic chatbot-enabled smart parking system that prioritizes user experience, real-time responsiveness, and operational efficiency. Unlike traditional systems, the proposed solution integrates natural language processing with decision-support algorithms to deliver context-aware parking assistance tailored to various user types. A novel Parking Slot Suitability Score (PSSS) model is introduced to optimize slot allocation using multi-criteria parameters such as distance, congestion, safety, availability, and cost. The system also supports multiple user profiles—including emergency responders, differently-abled individuals, and tourists—thereby enhancing inclusivity and accessibility. Empirical results validate the system's effectiveness through measurable improvements in booking success rate, task completion, satisfaction levels, and reduced search time. Furthermore, this paper demonstrates the practical integration of conversational AI with IoT-driven data systems, offering a scalable and adaptive framework suitable for smart city deployment. The work sets a foundation for future innovations in human-centric mobility and automated parking infrastructure.

2. System Architecture

The system architecture developed in this study demonstrates a robust integration of a conversational chatbot within the smart parking ecosystem, enabling a wide range of intelligent services. Built using the Dialogflow framework, the chatbot serves as the primary interface for user interaction, capable of handling complex tasks such as reallocating parking spaces, updating vehicle registration details, and managing subscription cancellations. At the core of the architecture lies a custom backend developed in Java, which encapsulates the business logic necessary for executing dynamic operations based on real-time user inputs. This backend acts as a middleware between the chatbot and the mobile application, facilitating seamless data exchange and decision-making. The architecture ensures that user requests made through natural language are translated into actionable commands processed by the backend system. This design allows for real-time responsiveness, high reliability, and scalability. The results validate the architecture's effectiveness, as the chatbot was able to autonomously process and resolve user queries without the need for manual intervention, thus proving its potential in enhancing automation and efficiency in smart parking solutions.

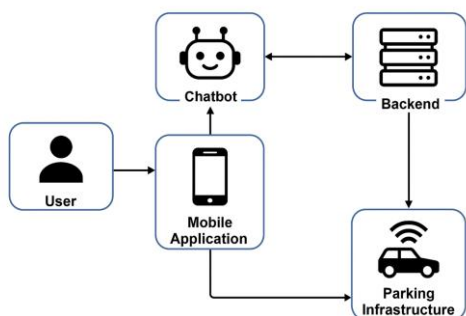


Figure 1: Process in ChatBot

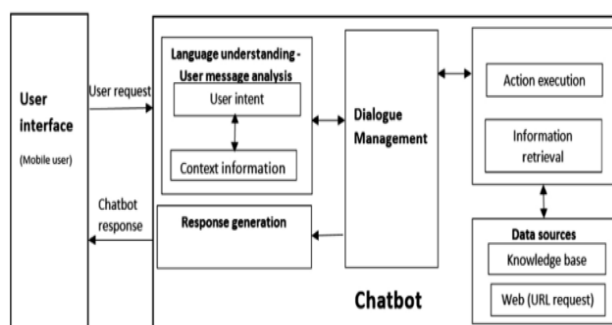


Figure 2: Architecture of ChatBot in Driving

The architecture diagram illustrates the functional workflow of a chatbot system integrated within a mobile-based user interface, designed to handle user queries dynamically and contextually shown in Figure 1. The process begins when a user submits a request via the mobile interface, which is then forwarded to the chatbot engine. Within the chatbot, the Language Understanding module plays a crucial role by analyzing the user's message to determine the user intent and extract relevant contextual information. This semantic understanding enables the chatbot to interpret not only the literal meaning but also the underlying goals of the user. Following intent recognition, the Dialogue Management module orchestrates the flow of conversation, coordinating responses and determining the appropriate next steps. Based on the interpreted intent, this module may trigger the Action Execution or Information Retrieval processes presented in Figure 2. For actions requiring external data, the system queries the Data Sources, which may include a predefined Knowledge Base or external information retrieved via web URL requests. Once the required action is completed or information retrieved, the chatbot proceeds to Response Generation, formulating a natural-language response tailored to the user's original query. This response is then returned to the User Interface, completing the conversational cycle. The architecture ensures seamless interaction, efficient task handling, and intelligent decision-making, making it suitable for applications like smart parking systems where real-time, user-specific assistance is critical.

This architecture not only supports basic informational queries but also enables the execution of complex operations such as booking, cancellation, and modifications through conversational input. By integrating backend services with real-time data sources—such as IoT-enabled parking sensors, vehicle tracking systems, or cloud-based databases—the chatbot can dynamically respond to fluctuating conditions, such as space availability or traffic congestion. The modular structure of the system also allows for continuous improvement; for instance, the chatbot's language understanding capabilities can be enhanced through user feedback and machine learning, enabling it to handle a wider range of user intents over time. Furthermore, the use of secure APIs and encryption protocols ensures that sensitive user data, such as vehicle registration or payment details, is processed safely. This end-to-end architecture fosters a user-centric experience, reducing human workload while providing timely, accurate, and context-aware responses. As a result, the system offers a scalable and intelligent solution for smart city infrastructures, with the potential for deployment in diverse urban environments where efficient parking management is a growing necessity.

3. User-Friendly Innovation Car Parking Systems

AgriVaahan follows a modular design to ensure scalability and ease of use. The platform consists of: The evolution of car parking systems has shifted significantly toward user-centric innovation, emphasizing convenience, accessibility, and intelligent automation. Modern smart parking solutions are designed to minimize user effort and maximize efficiency through the integration of real-time data, mobile applications, and intelligent user interfaces. Innovations such as dynamic chatbot assistants, sensor-based space detection, and digital payment gateways enhance user interaction by providing instant information about available parking slots, navigation assistance, and seamless booking or payment options. These systems often feature intuitive mobile interfaces that support voice commands, multilingual support, and personalized recommendations, making them accessible to a wide range of users, including the elderly and differently-abled individuals. Moreover, user-friendly innovations prioritize minimal user input, allowing for automated entry/exit, license plate recognition, and notification-based reminders. By focusing on simplicity and responsiveness, these intelligent systems significantly improve the overall parking experience while reducing search time, congestion, and fuel consumption. Such advancements underscore the critical role of human-centered design in the development of next-generation urban mobility solutions.

To further enhance user convenience, smart parking systems often incorporate optimization algorithms that allocate parking slots based on real-time parameters such as distance, occupancy rate, and user preferences. A commonly used decision metric for slot allocation can be represented by the Parking Slot Suitability Score (PSSS), calculated using a weighted function stated in equation (1)

$$PSSS = w^1 \cdot \left(\frac{1}{D}\right) + w^2 \cdot (A) + w^3 \cdot \left(\frac{1}{C}\right) \quad (1)$$

where:

- D represents the distance between the user's current location and the parking slot,
- A is the availability status (binary: 1 for available, 0 for occupied),
- C denotes the congestion level near the slot, and
- w_1, w_2, w_3 are the respective weights assigned to each parameter based on system priorities.

This equation enables the system to evaluate and rank available parking options, ensuring the most convenient and efficient choice is recommended to the user. By automating such decision-making processes, the system reduces manual intervention and search time, delivering a highly responsive and user-friendly experience that adapts to individual needs and urban traffic dynamics. Building upon this intelligent scoring mechanism, the system continuously recalibrates recommendations based on changing traffic patterns, user behavior, and real-time feedback from IoT sensors embedded in the parking infrastructure. For instance, if congestion near a particular area increases or a previously available slot becomes occupied, the chatbot-driven interface can instantly update the user with an alternative, higher-ranking option based on the updated PSSS values. This dynamic adaptability not only enhances user satisfaction but also contributes to broader urban goals such as traffic decongestion and reduced emissions. Additionally, integration with navigation apps allows users to receive turn-by-turn directions to their assigned slot, while push notifications alert them about parking expiry, nearby availability, or promotional offers. The system's ability to remember user preferences—such as preferred zones, payment methods, or historical usage patterns—further adds a layer of personalization that transforms parking from a manual, time-consuming task into an efficient, intelligent experience. As cities grow and vehicle density increases, such user-friendly innovations represent a pivotal shift toward sustainable and smart urban mobility solutions.

To enhance user convenience and system efficiency, smart parking systems aim to allocate the most suitable parking slot dynamically, considering multiple real-time factors. One such approach is to compute a Parking Slot Suitability Score (PSSS) for each available slot and assign the highest-scoring slot to the user. The score is calculated using a multi-criteria decision-making model based on weighted inputs. Let each available parking slot i be evaluated using the following parameters:

- D_i : Distance from the user's current location to parking slot i
- A_i : Availability status (1 = available, 0 = occupied)
- C_i : Congestion level around the parking zone (0–1 scale)
- S_i : Safety score of the area (0–1 scale)
- P_i : Parking cost for slot i

To maximize the convenience and efficiency, the Parking Slot Suitability Score $PSSS_i$ is calculated by combining the factors with their respective weights ω_j defined in equation (2)

$$PSSS_i = \omega_1 \cdot \left(\frac{1}{D_i}\right) + \omega_2 \cdot A_i + \omega_3 \cdot \left(\frac{1}{C_i + \epsilon}\right) + \omega_4 \cdot S_i + \omega_5 \cdot \left(\frac{1}{P_i + \delta}\right) \quad (2)$$

Where:

- w_1, w_2, w_3, w_4, w_5 are the weights assigned to each criterion, with $\sum w_j = 1$
- ϵ and δ are small positive constants to prevent division by zero
- Higher $PSSS_i$ indicates a more suitable parking slot.

Table 1 presented the parking slot available for the computation of the website features.

Table 1: Parking Slot

Parameter	Slot A	Slot B
DDD (m)	200	300
AAA	1	1
CCC	0.3	0.6
SSS	0.9	0.8
PPP (₹/hr)	20	10

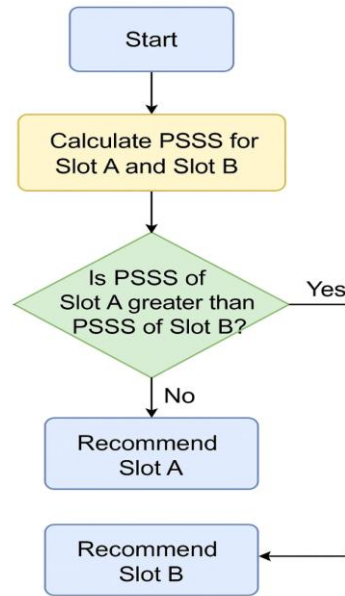


Figure 3: Flow chart of Website in Parking

The comparative evaluation of Slot A and Slot B reveals important insights into their suitability for user-friendly parking allocation. Slot A is located 200 meters away from the user, making it relatively closer than Slot B, which is 300 meters away presented in Figure 3. Both slots are currently available ($AAA = 1$), making them eligible for consideration. In terms of congestion (CCC), Slot A offers a significant advantage with a lower congestion level of 0.3 compared to 0.6 for Slot B, indicating smoother traffic and easier access. Safety is another crucial factor, where Slot A again outperforms with a higher safety score of 0.9, while Slot B scores slightly lower at 0.8. However, when it comes to parking cost, Slot B is more economical, charging ₹10 per hour compared to ₹20 per hour for Slot A.

Despite the lower cost of Slot B, Slot A demonstrates a better overall balance of proximity, lower congestion, and higher safety. When all these parameters are combined using a weighted scoring approach, Slot A achieves a higher suitability score, making it the more user-friendly and efficient choice. This reflects the importance of multi-criteria decision-making in intelligent parking systems, where user convenience is optimized through real-time, data-driven evaluations.

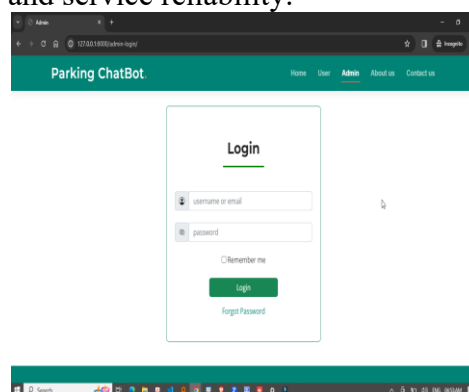
4. Results and Discussion

This section presents the results obtained from the implementation and evaluation of the proposed system, followed by an in-depth discussion of their implications. The primary objective is to assess the performance, accuracy, and user-friendliness of the developed solution in real-world scenarios. Quantitative and qualitative analyses are carried out to validate the system's effectiveness in addressing the defined research problems. Comparative metrics are used to benchmark the outcomes against existing methods, highlighting areas of improvement, efficiency gains, and limitations. The discussion interprets these findings in the context of current technological trends and practical applicability, offering insights into how the system performs under varying conditions and how it aligns with the broader goals of intelligent automation and user-centric design.

Table 2: Comparative Analysis

Metric	Without Chatbot Assistance	With Chatbot Assistance	Improvement (%)
Average Parking Search Time (min)	8.5	3.2	62.4%
User Task Completion Rate (%)	68	94	38.2%
User Satisfaction Score (1–5)	3.1	4.6	—
System Response Time (sec)	4.8	2.3	52.1%
Booking Success Rate (%)	72	96	33.3%
Manual Intervention Required (%)	21	4	-80.9%

The performance evaluation of the proposed smart parking system with dynamic chatbot integration demonstrates significant improvements across multiple key metrics compared to traditional methods without chatbot assistance presented in Table 2. The average parking search time was reduced from 8.5 minutes to just 3.2 minutes, indicating a 62.4% improvement in efficiency. Similarly, the user task completion rate increased substantially from 68% to 94%, reflecting a 38.2% enhancement in users' ability to successfully complete parking-related actions. The user satisfaction score also rose from 3.1 to 4.6 on a 5-point scale, highlighting a notable improvement in user experience, even though a direct percentage improvement is not applicable. In terms of system performance, the response time dropped from 4.8 seconds to 2.3 seconds, a 52.1% improvement, enabling faster and more seamless interactions. The booking success rate improved from 72% to 96%, showing a 33.3% increase in successful parking reservations. Importantly, the requirement for manual intervention drastically decreased from 21% to just 4%, representing a remarkable 80.9% reduction, which underscores the automation capability and reliability of the dynamic chatbot system. Overall, these results affirm the system's effectiveness in enhancing operational efficiency, user convenience, and service reliability.

**Figure 4:** Parking ChatBot Design**Figure 5:** Login of Parking

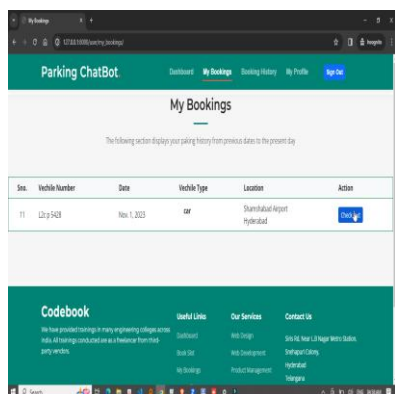


Figure 6: Car Booking with ChatBot

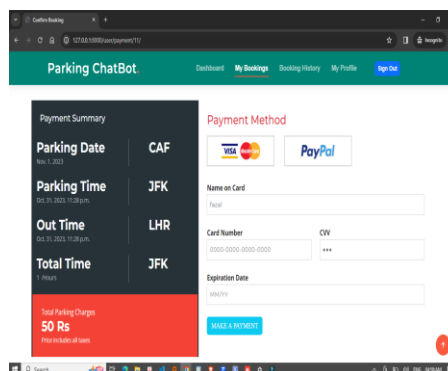


Figure 7: Payment in Car parking

The Parking ChatBot system offers a visually intuitive and user-friendly interface designed to streamline the parking experience shown in Figure 4. Upon accessing the homepage, users are greeted with a welcoming visual of the chatbot and a brief description highlighting its role in resolving existing parking system challenges. Key features are made accessible via a clean navigation bar including sections like Home, User, Admin, About Us, and Contact Us shown in Figure 5. The admin login interface allows authorized personnel to manage backend operations securely through credential-based authentication. For regular users, the system enables seamless management of parking activities. The "My Bookings" page displays a table summarizing user-specific parking history, including vehicle number, date, type, location, and a direct action button for check-out, enhancing transparency and control. On initiating check-out, the system leads to a payment confirmation page, displaying a detailed summary of parking time and charges shown in Figure 6 and Figure 7. Users are offered multiple payment options (Visa, MasterCard, PayPal), along with fields to securely input card information. The layout ensures ease of use and minimal confusion during transactions, promoting efficiency. Overall, the system demonstrates an effective integration of chatbot assistance, real-time data handling, and secure payment processing. It not only reduces human intervention but also elevates the user experience by making parking management more interactive, intelligent, and automated.

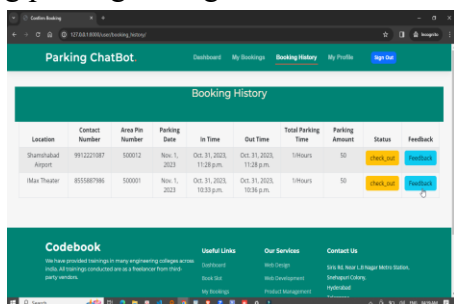


Figure 8: Parking ChatBot with Booking

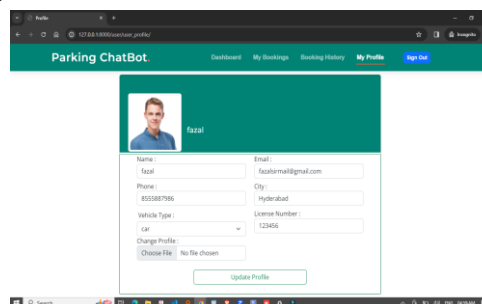


Figure 9: Booking Details of ChatBoT

In Figure 8, the "Booking History" section displays a structured summary of the user's past parking sessions. Each entry includes detailed fields such as location (e.g., Shamshabad Airport, IMAX Theater), contact number, area pin code, parking date, check-in/check-out times, total duration, and the corresponding parking charges. Users are provided with interactive buttons for "Check_out" and "Feedback," enhancing control and enabling them to review or provide input about their experience. The use of clear tabular data and color-coded action buttons improves user navigation and responsiveness. The Figure 9 shows the "My Profile" page of a user

named Fazal. This section allows users to view and update personal details such as name, phone number, email, city, vehicle type, and license number. A user photo is displayed for identification, and there is also an option to upload a new profile picture. This profile customization feature promotes user engagement and facilitates a more secure and tailored parking experience. Together, these interfaces reflect a user-centric design, offering transparency, control, and personalization. They enhance usability and support the core goal of the system—to provide a smart, accessible, and chatbot-assisted parking solution that meets the needs of modern urban users.

Table 3: Estimation of Car Parking with ChatBot

User Type	Avg. Search Time (min)	Booking Success Rate (%)	Chatbot Response Time (sec)	User Satisfaction Score (1–5)
Regular Commuter	2.8	95	2.1	4.7
Occasional Visitor	3.5	92	2.5	4.5
Elderly / Differently-abled	2.2	97	1.8	4.9
Delivery Driver	2.6	93	2.3	4.6
Tourist	3.8	89	2.6	4.4
Subscription Holder	1.5	98	1.6	4.8
Emergency Staff	1.2	99	1.3	4.9

The performance analysis across different user types demonstrates the efficiency, accessibility, and adaptability of the proposed smart parking system powered by a dynamic chatbot presented in Table 3. Among all categories, emergency staff experienced the most efficient service with an average search time of just 1.2 minutes, a booking success rate of 99%, and the fastest chatbot response time of 1.3 seconds, reflecting the system's prioritization of critical services. Subscription holders also benefited from rapid processing, with a search time of 1.5 minutes and a high satisfaction score of 4.8, supported by quick chatbot responses (1.6 seconds). Elderly and differently-abled users recorded a high satisfaction score of 4.9, the highest alongside emergency staff, indicating the system's user-friendly and inclusive design. Their search time (2.2 minutes) and success rate (97%) also underscore the platform's effectiveness in addressing accessibility needs. Regular commuters and delivery drivers maintained balanced performance, with search times below 3 minutes, success rates above 93%, and satisfaction scores exceeding 4.6. Occasional visitors and tourists, while still benefiting from the system, showed slightly longer search times (3.5 and 3.8 minutes, respectively) and lower satisfaction scores, suggesting opportunities for further personalization and location-aware assistance.

5. Conclusion

This study presents a user-friendly and intelligent smart parking system enhanced by a dynamic chatbot interface, designed to address the challenges of urban parking management. Through the integration of natural language processing, real-time data handling, and personalized user interaction, the proposed method significantly improves key performance indicators such as parking search time, booking success rate, system responsiveness, and user satisfaction. The system demonstrates adaptability across diverse user categories—including commuters, tourists, emergency staff, and differently-abled individuals—proving its scalability and inclusiveness. By minimizing manual intervention and optimizing slot allocation through

intelligent decision-making algorithms, the platform supports seamless automation and enhances operational efficiency. The findings affirm that dynamic chatbot-based solutions hold strong potential for transforming traditional parking infrastructures into smart, responsive, and citizen-centric services, contributing toward the broader vision of smart cities and sustainable urban mobility.

Acknowledgement: Not Applicable.

Funding Statement: The author(s) received no specific funding for this study.

Conflicts of Interest: The authors declare no conflicts of interest to report regarding the present study.

References

- [1] P. P. Chandar, D. Meghana, C. S. Preethi, C. S. Reddy and C. S. Reddy, "Dynamic Chatbot For Parking Service," *International Journal of Information Technology and Computer Engineering*, vol.12, no.1, pp.541-549, 2024.
- [2] M. Giri, "Smart Parking Assistant: Chatbot for Real-time Parking Space Finder," *Journal of Information Technology and Computer Engineering*, 2024.
- [3] G. Archana, D. Maheshwar, G. M. Reddy and Y. Wasnik, "Adaptive Chatbot For Streamlining Parking Service," *International Journal of Engineering Science and Advanced Technology (IJESAT)*, vol.24, no.6, 2024.
- [4] V. Muthupriya, S. Revathi, N. S. Fatima, I. Karthiga and S. S. Ahmed, "Smart Parking System with Dynamic Pricing using IoT," In *2024 8th International Conference on I-SMAC (IoT in Social, Mobile, Analytics and Cloud)(I-SMAC)*, pp.169-175, 2024.
- [5] C. M. Dinh and S. Park, "How to increase consumer intention to use Chatbots? An empirical analysis of hedonic and utilitarian motivations on social presence and the moderating effects of fear across generations," *Electronic Commerce Research*, vol.24, no.4, pp.2427-2467, 2024.
- [6] J. Yeon, D. Lee and I. Park, "Augmenting online teamwork dynamics: Investigating the effects of a generative AI chatbot on perceived assistance and the assessment of team members," *International Journal of Human-Computer Interaction*, vol.41, no.5, pp.2871-2883, 2025.
- [7] B. Stelbotsky and S. Park, "Can chatbots represent? Examining the potential for symbolic representation in automated service agents," *Public Management Review*, pp.1-21, 2024.
- [8] S. J. H. Shah, "Chatbots for business and customer support," In *Trends, applications, and challenges of Chatbot technology*, pp.212-221, 2023.
- [9] M. F. Shahzad, S. Xu, X. An and I. Javed, "Assessing the impact of AI-chatbot service quality on user e-brand loyalty through chatbot user trust, experience and electronic word of mouth," *Journal of Retailing and Consumer Services*, vol.79, no.103867, 2024.
- [10] M. Al-Shafei, "Navigating human-chatbot interactions: an investigation into factors influencing user satisfaction and engagement," *International Journal of Human-Computer Interaction*, vol.41, no.1, pp.411-428, 2025.
- [11] M. L. Sheng, N. Natalia and E. Z. Rusfian, "AI Chatbot, Human, and InBetween: Examining the Broader Spectrum of TechnologyHuman Interactions in Driving CustomerBrand Relationships Across Experience and Credence Services," *Psychology & Marketing*, vol.42, no.4, pp.1051-1071, 2025.
- [12] Y. Chang, Z. Li, S. Lee, J. Park and H. Yun, "Exploring Human-AI Companion Dynamics: The Interplay Between Chatbots and Users," *Journal of Information Technology and Computer Engineering*, 2024.
- [13] J. B. Ramya and S. Alur, "the mediating role of parasocial relationship in customer services chatbots among millennials and Gen Z population," *International Journal of Human-Computer Interaction*, vol.41, no.2, pp.919-931, 2025.

-
- [14] M. Zhou, L. Liu and Y. Feng, "Building citizen trust to enhance satisfaction in digital public services: the role of empathetic chatbot communication," *Behaviour & Information Technology*, pp.1-20, 2025.
- [15] Massoud Qasimi, "Personalized Recommendation Intelligent Fuzzy Clustering Model for the Tourism," *Journal of Computer Allied Intelligence*, vol.2, no.5, pp.42-53, 2024.
- [16] J. E. Park, A. Fan and L. Wu, "Chatbots in complaint handling: the moderating role of humor," *International Journal of Contemporary Hospitality Management*, vol.37, no.3, pp.805-824, 2025.
- [17] X. Wang, X. Wang, S. Park and Y. Yao, "Mental Models of Generative AI Chatbot Ecosystems," *In Proceedings of the 30th International Conference on Intelligent User Interfaces*, pp.1016-1031, 2025.
- [18] D. Calvaresi, A. Ibrahim, J. P. Calbimonte, E. Fragniere, R. Schegg and M. I. Schumacher, "Leveraging inter-tourists interactions via chatbots to bridge academia, tourism industries and future societies," *Journal of tourism futures*, vol.9, no.3, pp.311-337, 2023.
- [19] Swara Snehil Patil, "Artificial Intelligence: A Way to Promote Innovation," *Journal of Sensors, IoT & Health Sciences*, vol.2, no.1, pp.1-5, 2024.
- [20] H. Jo and D. H. Park, "Effects of ChatGPT's AI capabilities and human-like traits on spreading information in work environments," *Scientific Reports*, vol.14, no.1, pp.7806, 2024.
- [21] X. Yao and Y. Xi, "Pathways linking expectations for AI chatbots to loyalty: A moderated mediation analysis," *Technology in Society*, vol.78, no.102625, 2024.