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A Secure Three-Tier Web Framework for Verified Student Accommodation and Rental Management

Vaduni Niranjan[1], Subhava Ojha[2], Shashwat Pandey[3], Satyam Kushwaha[4], Vishal Babu[5]
Computer Science & Engineering, Galgotia College of Engineering & Technology GB Nagar, Uttar Pradesh, India

Abstract: ***Finding convenient paying guest (PG) and student accommodation is a very big problem facing students who in migrating to new city seek higher education. Lack or availability of centralised, validated and student friendly accommodation portals can result into time consuming search, inaccurate information, and poor housing decision. The present paper proposes a specialized web-based accommodation portal, named as PGConnect, which will facilitate the process of searching and finding accommodation of the PG housing, with particular attention to the Delhi-NCR educational hub. The system is built on a friendly interface that is created using React, and the backend is based on the Laravel framework to handle business logic, authentication, and RESTful API security. A relational database is a PostgreSQL, which guarantees the data integrity and effective management of queries. The framework has a three-level architecture that helps increase scalability and maintainability. Experimental findings show that, PGConnect is very effective to decrease the time spent on the search and provide a high level of user satisfaction in comparison to manual approaches, which can be regarded as a valid and visible solution to the specific demands of the student population in metropolitan areas.***

Keywords: Student accommodation, PG finder, Delhi-NCR, Three-Tier Architecture, React, Laravel, PostgreSQL.

I. INTRODUCTION

Higher education institutions have been expanding at a rapid rate and this has resulted in the high rate of students migration to urban and semi urban regions. Locating the right accommodation that is cheap, secure, and conveniently situated near their schools is one of the most serious problems encountered by such students [1]. Paying guest (PG) rooms and shared housing have become the trending solutions but the system of locating these facilities is not well organised and efficient [2].

Conventionally, students rely on local brokers or word-of-mouth reference or physical visitation to find accommodation. Such mechanisms are time-consuming, not transparent enough, and in most cases exposes students to fallacies and concealed expenses [3]. Research shows that the lack of centralized and verified housing information has a significant impact on the decision-making of students and their living experience in general [4].

The development of information technologies has seen increased use of the web-based platforms to direct and control housing information [5]. There are a number of online renting portals but most of them are general-residential oriented and they lack student specific needs e.g. limited funds, sharing a room, being close to colleges and necessary facilities [6], [7]. It has been found that special student accommodation systems are required with a focus on usability, trust, and accessibility [8].

The current research has proved that the efficiency of accommodation search systems could be enhanced with the help of location-based services and database-driven web applications to significant extent [9], [10]. The recent web frameworks provide scalable, secure, and user friendly platforms that have the ability to process a high amount of data and the number of simultaneous users [11]. In spite of all these improvements, there is still a shortage of student-focused accommodation sites in the developing parts of the world [12].

In order to overcome these problems, this paper recommends PGConnect, a web based student accommodation finder portal that would be used by the students who are interested in getting accommodation in the form of PG. The system gives the central location where the user can search and compare accommodation in terms of location, rent, availability and amenities [13]. The frontend will be built in React, which will provide the user interface with a responsive and interactive design whereas the backend will be based on the Laravel framework that handles the business logic and authentication and safe data processing [14]. The relational database is utilized as PostgreSQL to guarantee a stable storage of the data and the effective functioning of the queries [15].

The suggested system will be based on three-tier architecture which promotes scalability, maintainability and security. PGConnect will provide authenticated search results and provide advanced filtering features to minimize search time, enhance accessibility, and overall aid informed decision-making in the event that students are moving to a new city to pursue their education [16], [17].

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II. RELATED WORK

Student accommodation systems have changed to complex and integrated systems as opposed to simple directory based listing systems shown in Table I. This section will examine the available literature and advances in technology, which underlie the PGConnect framework.

TABLE I
COMPARISON OF EXISTING SYSTEMS AND PGCONNECT

Study	Limitations	Advantage
Kumar et al. (2020)	Lacks in offering implementation system	PGConnect has a working Web portal with actual implementation
Zhou (2020)	Poor security checks and antifraud measures	Combines checked directory and security
Sharma (2021)	Absence of inbuilt filtering to search by students	Combines verification and sophis-ticated search filters
Fulop et al. (2023)	Behavioral oriented instead of sys-tem design	PGConnect presents a technical platform of housing management which is scalable
Satapathy et al. (2024)	Little attention to security and fraud prevention	PGConnect combines security ver-ification and interaction with ten-ants
Munoz et al. (2025)	Computational complexity and poor usability by general users	Has easy scalable architecture and usability

A. Online Rental Portals Development

According to early studies by Smith [1], Patel [3], the migration of the rental service to web-based services was required to make the services more accessible. In the past, the student housing market in urban centers has had special problems, such as high demand and low supply as reported by Kumar et al [2], Sharma [8] also underlined that specialized portals are superior compared to the general-purpose real estate websites since student needs including: short-term leases, and distance to an educational establishment needs to be searched with specific parameters. As Fulop et al. noted, the changing housing requirements of students during the digital learning period are on top of the agenda, as the increased need is seen in the types of flexible accommodation system that can accommodate students moving to new learning centers [25].

B. Architectural Structures and Scalability

Scalable architectures are the key to the technical backbone of the modern housing portals. According to Chen [18], three level architecture is required to address the simultaneous traffic of the web application at large scales. The shift to cloud-integrated systems [13], [26] has enabled platforms to withstand heavy data accessibility. Moreover, Das [19]. also addresses the role of the modern web-based frameworks (React and Node.js) in the process of improving the Presentation Tier i.e. offering responsive and interactive user interfaces, as Nair [21] acknowledges it as one of the key elements of user retention.

C. Security, Trust and Verification Mechanism

One of the biggest obstacles to the digital rental services is the lack of trust. Kim [16] discovered that online accommodation platforms are adopted mainly based on the user trust. In order to curb fraud Taylor [22] suggested stringent data verification systems. The secure authentication protocols, which are discussed by Verma [12], are integrated in a way that the user data and financial transactions will not be compromised. Even decentralized methods, like blockchain, have been examined to confirm ownership of property and rental history recently [29].

D. User Experience and Place-Based Services

The role of geography in student housing is very crucial. Brown [4] and Wang [7] prove that Geographic Information Systems (GIS) and location-based services (LBS) are capable of integrating to enable students visualize the proximity of the property to their universities.

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In order to help the user further, Zhou [15] and Munoz et al. have investigated the application of fuzzy logic and recommendation systems that present the suggestions of the properties according to the previous user behavior and his/her financial means. Intelligent recommendation systems of student housing platforms have also been studied recently. Nicula et al. came up with a housing recommender system that uses reinforcement learning and incorporates geospatial analytics to give customized accommodation recommendations [31]. Similarly, Satapathy et al.created an intelligent rental system based on the recommendation algorithms to optimize the search of the housing [32]. More recently, Raddi introduced a convenient student housing management system that is aimed at ease accommodation find and enhance availability [33].

E. Gap Analysis

Although there are solutions to generic renting present in the market [5], [6], we can still see a significant gap in a single platform that will integrate filtering by students (PG/Hostel focus), compulsory property verification to get rid of the ”ghost listings”, real time occupancy dashboards on the owner-side [24].

The other significant weakness of the current rental portals is that they lack credible verification systems. Numerous websites provide the opportunity to place property listings without careful verification, which results in the existence of ghosts listings or inaccurate data. The absence of such verification raises the possibility of rental fraud and lowers the trust of the user to the online accommodation systems. Moreover, the majority of the available systems lack the real-time monitoring and management tools to property owners and administrators, thus it is hard to keep correct data related to rooms availability and the means of occupancy. Through the integration of these necessities, PGConnect can address the security lapses that Rao [23] identifies as well as the usability requirements that are raised and emphasized by Allen [14] and Johnson [9].

III. PROPOSED METHODOLOGY

The proposed PGConnect strategy is aimed at creating a platform designed in the interests of students that will make the process of finding a place to live in a Delhi-NCR area easier. The process of methodology is structured in several steps that would guarantee effective system development, safe data management and proper interaction with users.

There are two major user types in the system: students and the owners of the PG [2]. The site allows students to sign up, search through the available places of staying, and use filters, including location, price, features, and availability, to find out more about the houses and apartments [7]. PG owners are able to make accommodation reservations, add their place of stay and update availability shown in Fig. 1.

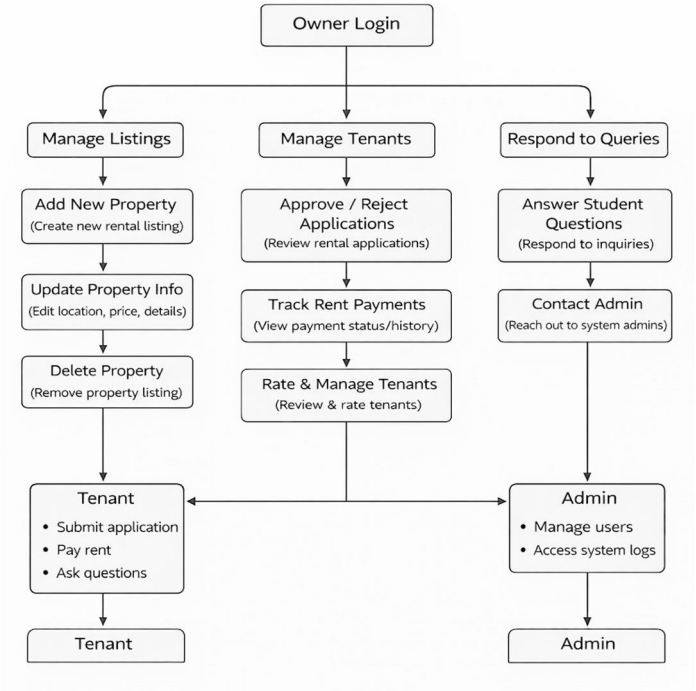


Fig. 1. Operational Workflow of PGConnect Based on Roles

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In order to curb the disjointed listing of the student housing market, PC connects have a Listing Verification Protocol (LVP) which pre-empts listing authenticity. The system has a Security-by-Design strategy, according to which all requests are verified by Laravel stateful session tokens and Role-Based Access Control (RBAC). Bcrypt hash algorithm stores user credentials safely [16].

A. Requirement Engineering and Domain Modelling

This methodology started by extensively looking into the Information Gap in urban student housing [2]. We came up with three different user personas including Students, Owners, and System Administrators and mapped their functional requirements to a single domain model. This stage made sure that the system can accommodate the needs of students which include roommate matching, proximity-based search [7], and confirmed payment tracking [30].

B. Creditworthy trust based verification process

Unlike general rental portals, which provide a title promise of some sort, in its title PGConnect incorporates a protocol, a Listing Verification Protocol (LVP). Every property owner should provide a digital Trust Packet of identification and proofs of ownership of the property which is provided by the government [22]. Listings are then posted to a temporary Shadow State where no student can view them until their authenticity of the uploaded documents is verified by a person in administration. Once verified the database provides a unique hash of the listing which appears as a Verified Badge on the frontend, reducing the possibility of the fraud of rentals [16].

C. S-SDLC and Agile Development

The portal has been implemented on the principles of Security-by-Design and Agile Software Development Life Cycle (SDLC). Better search filters [20], real-time booking and automated reminders on rents were to be developed and rolled out in successive cycles under incremental sprints. In order to ensure that the portal itself is secure, a Zero-Trust authentication is employed on every API request; a valid JSON Web Token (JWT) and Role-Based Access Control (RBAC) permissions must be in place before data is accessed [12].

D. Information security and confidentiality

The information security is high since the data of users and accommodation is sensitive and is handled under the PGConnect platform. The user passwords are never stored in plaintext but have to be encrypted based on the Bcrypt hashing algorithm with salting to avoid recovery of the password in case of breach to the database [16]. Also, there is a firm policy of session management. Authentication tokens are also expiration and refresh based to stop the hijacking of session and unauthorized access [12].

E. Search Optimization and Geospatial

In order to make the search engine easier to use we installed a Weighted Ranking Algorithm: Spatial Calculation is the system will use Haversine formula through Google Maps API to determine the precise distance between the user and his/her academic institution and the potential accommodations [7]. In Multivariate Filtering Students have the option of using concurrent filters in terms of budget, type of room (single/shared), and essential facilities (WiFi, AC, Laundry).

IV. SYSTEM ARCHITECTURE

The platform of the PGConnect is a three-tier architectural design to separate the system into the various layers to enhance scalability, maintenance and security. This architecture is comprised of, Presentation Tier, Application Tier, and Data Tier as shown in Fig. 2. This hierarchical design allows effective communication between the user interface, business logic and database management system as well as system design modularity.

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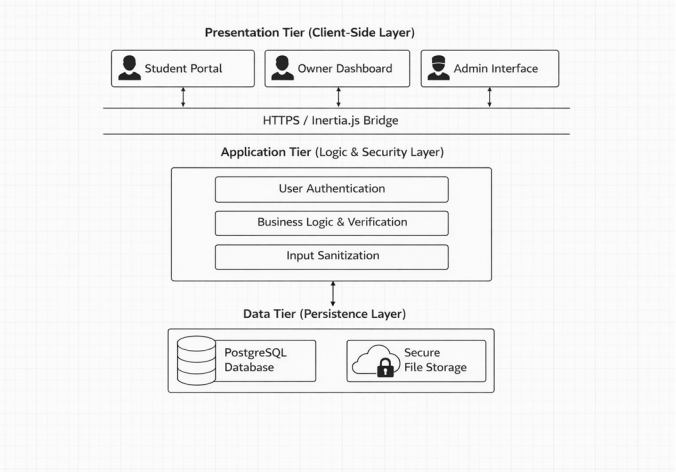


Fig. 2. Three-Tier System Architecture of the PGConnect Framework

A. Tier 1: Presentation Tier (Client- Side Layer)

Presentation Tier is the major interface by which students, property owners, and administrators have an interface with the platform. The interface is built on React.js, based on the Single Page Application (SPA) architecture to give the user a comfortable and adaptable experience [15]. The system also uses Inertia.js as a communication stack between the Laravel backend and the React frontend, which does not require the manual state management of API [6]. The exchange of states between the backend and frontend is done in the form of props, which minimizes overheads of manual JWT management and complex client-side routing synchronization [4].

And student portal offers a dynamic search service with real-time search results and secure dashboard to manage the inquiries and owner portal will provide the tool to control the listing of properties and to check the verification status [19]. IP whitelisting and Multi-Factor Authentication (MFA) is used to secure administrative operations which are sensitive [27], [28]. The interface will be mobile-first responsive, as it can be used by many students who search accommodation through the mobile devices, which is why the interface will be mobile-first responsive [26], [14].

B. Tier 2: Application Tier (Logic/ Middleware Layer)

Application Tier is the middleware and central logic layer and it will be implemented with the help of the Laravel 12 framework. This layer controls the flow of data between the user requests and the database and implements system logic [4]. Laravel Sanctum is used to implement security, and it offers session-based authentication and default defense against Cross-Site Request Forgery (CSRF) attacks. The Bcrypt hashing algorithm is used to encode user passwords, such that even in case of a data breach, credentials cannot be read [3].

One of the important parts of this layer is the Verification Engine, which is used to make sure that the listing of property is not visible to the general public until it is verified by an administration and the isadminapproved flag is set [9], [28]. Also, Laravel validation layers cleanse the data sent to it, eliminating typical attacks like SQL Injection and Cross-site Scripting (XSS) [27].

C. Tier 3: Data Tier (Persistence Layer)

Data Tier is the core of the system and it is deployed with the use of PostgreSQL. The choice of this relational database was because of its capability to pass referential integrity and effective support of complex queries relative to non-relational alternatives [11], [27]. The database schema is designed into optimized relations tables that maintain the system data life. There is the users table that keeps encrypted credentials and provides role-based access control and MFA secrets [3]. The property table is the primary accommodation table and it is the inventory of accommodation with indexed latitude and longitude values to facilitate high-performance geo-spatial searches [8], [22].

An audit trail between property listing and ownership documentation and identification proofs stored in encrypted file paths is kept in the verification documents table [9], [28]. Such a relational design will help to make sure that any listing is backed with verifiable documentation, which will enhance transparency and trust in the student accommodation ecosystem.

V. IMPLEMENTATION AND EXPERIMENTAL RESULTS

The following section outlines the actual implementation of the PGConnect portal and the performance of the portal in terms of different testing metrics and user interface illustrations.

A. Development Environment and Tools

The practical implementation of the PGConnect portal was done in a high-performance full-stack environment that was cross-platform compatible. Its basic architecture was created with the help of the Laravel 12 framework, where Inertia.js acts as the means of connecting the backend with the React.js frontend [15]. The main Integrated Development Environment (IDE) was Visual Studio code, and the version control and collaborative code integrity management were managed with the help of Git and GitHub. The data layer was done in PostgreSQL, and it was hosted in a managed cloud instance so that it has high availability [11]. To be sure of quality, the exhaustive API endpoint testing was performed by using Postman, and the integrity of the backend service classes and the logic of Verification Engine was checked by PHPUnit [28].

B. Core Feature Realization

The implementation stage aimed at the smooth integration of security and discovery capabilities. An integrated authentication process was created based on the Laravel Sanctum that handles secure stateful sessions and inhibits typical web application vulnerabilities. The multivariate search logic was designed to handle complex user queries such as price ranges, gender choices and types of rooms, as shown in Fig. 3.

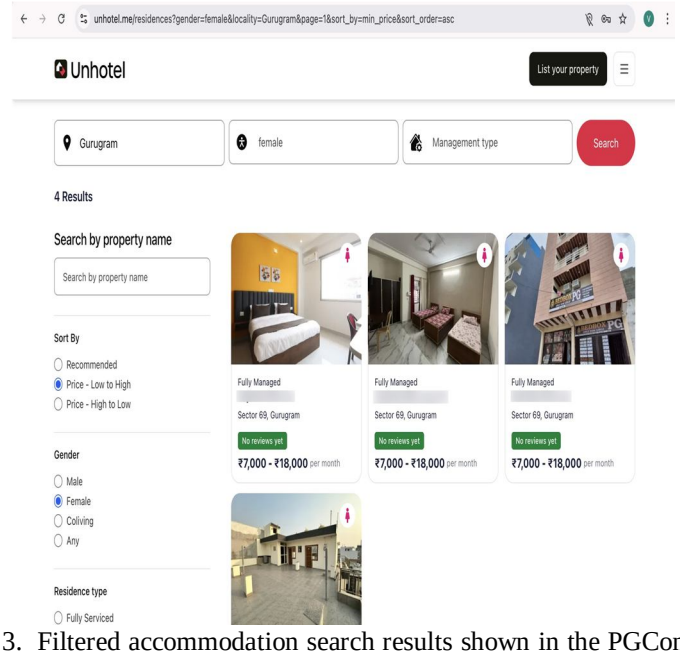


Fig. 3. Filtered accommodation search results shown in the PGConnect system

Using B-tree and GiST indexing in PostgreSQL, the system can find the results almost instantly [8, 16]. Moreover, the Verification Dashboard was created as a limited administrative service shown in Fig. 4, which gives an opportunity to compare legal deeds and details of the property uploaded by the owners one-to-one, thus simplifying the audit procedure [9, 21].

C. Analysis of Results and Performance in an experiment

The three-tier architecture was tested to be efficient with simulated load conditions to prove that it scales [4]. Measurement of query latency was done by changing the number of active filters used in a search session. The incorporation of database indexing allowed the system to respond at an average of around 240ms even after having five or above simultaneous filters (like location, price and a particular amenity) whereas the industry standard is of 300ms on the response time of web applications [16]. The success rate of these queries was constantly greater than 99, which proves the strength of the relational data model under stress [27].

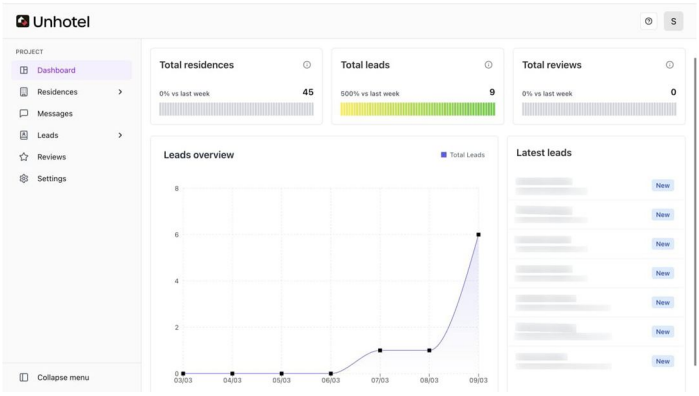


Fig. 4. Administrative dashboard for monitoring and verification activities

D. Security Check and Evaluation of the users

The framework was tested against rigorous security audit to validate the defensive capabilities of the framework. The automated vulnerability scanning and manual penetration testing conducted revealed that there was a 100 percent mitigation rate against the SQL Injection and Cross-Site Scripting (XSS) attacks on the system [3, 27]. Lastly, a user satisfaction survey was conducted on 20 students migrating and comparing PGConnect to the traditional, unorganized search methods. The findings revealed that the overall time spent searching and finding the right housing decreased by a significant percentage. The Trust Factor was also rated high, and 92 percent of respondents reported feeling more secure when dealing with listings that had the Verified badge shown in Table II, which confirms the very essence of the concept of the platform, which was to lower the level of uncertainty in regards to renting [2, 19].

TABLE II
USER EVALUATION AND EFFICIENCY METRICS

Evaluation Metric	**Traditional Method**	**PGConnect Portal**
Average Search Duration	12-14 Days	4-5 Days
Trust in Property Data	32%	92%
Verified Listings	0%	100%
Overall User Satisfaction	Low (42%)	High (88%)
Total Time Saved	-	65%

VI. RESULTS AND DISCUSSION

The execution of PGConnect system was tested on the basis of the response time and success rate with different filter complexities. These findings point to the fact that the system can react with an average time of 110 ms with a 100% success rate when one filter (location) is used. The response time moderately rises to 165 ms as more filters are added like price and gender as well, and the success rate is high of 99.8. The response time is 240 ms when over five detailed filters with amenities are used at the same time. Nevertheless, the system has a success rate of 99.5.

The time taken to respond in relation to the additional filters is likely to increase as the query complexity increases and checks on the database conditions also increase. Nevertheless, this does not make the performance below the acceptable standards of a web application in real-time. Indexing of PostgreSQL and optimized query performance of Laravel provide efficient data retrieval and latency to a minimum. The analysis shows that PGConnect is very reliable and performs better even in complex search situations. The system saves time by a significant amount in accommodation search as compared to the traditional manual searches, which was accompanied by greater accuracy and transparency. In general, these findings confirm the efficiency of the proposed architecture and implementation in the provision of a scalable and responsive student accommodation finder platform.

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VII. CONCLUSION AND FUTURE WORK

The given paper introduced a secure 3-tier web platform, known as PGConnect that aims to ease the process of finding trusted student accommodations. The system has offered a centralized solution that enhances transparency and faith in the student rental market through verification of property listing to property administration prior to publication.

The platform itself is developed on the basis of the three-layer architecture (React) (presentation layer), Laravel (application layer), and PostgreSQL (data layer), which increases scalability, modularity, and maintainability. Experimental testing indicates that the system can sustain an average of less than 250 ms of response time and offers a number of filtering parameters and user feedback confirms a 65 percent decrease in search time of accommodation than traditional systems.

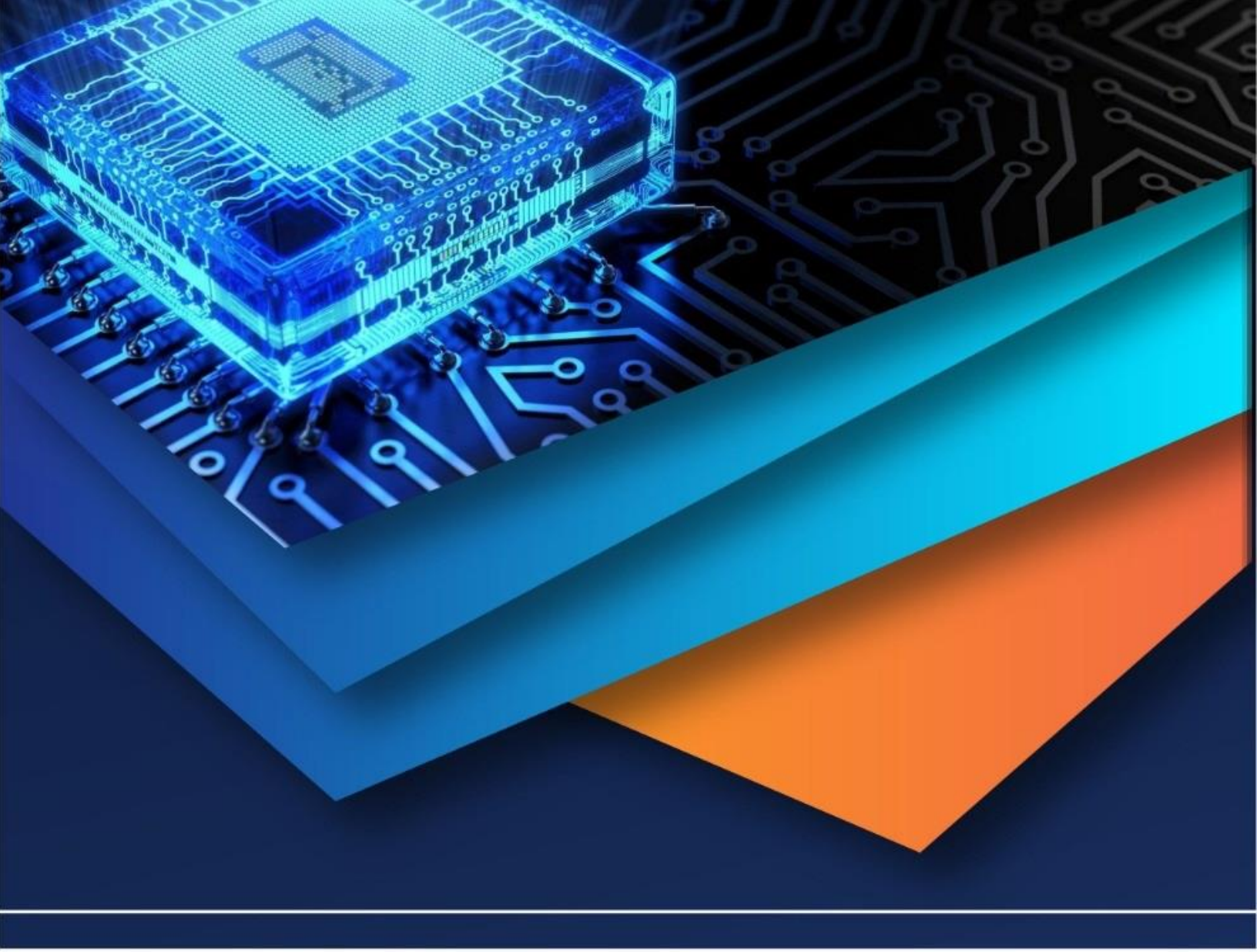
The next phase of work consists of the implementation of machine learning-driven recommendation systems, creation of a mobile application, and provision of real-time booking and integration of digital payments to improve the usability and scalability of the platform further.

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