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A Secure and Intelligent Web-Based Hostel Management System with Role-Based Access Control and Blockchain-Enabled Data Integrity

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ABSTRACT

Hostel Management System (HMS) is an online solution that was created to automate and computerize the administration processes in student hostels. It is a centralized system, which ensures interaction among five diverse stakeholders, including Admin, Students, Wardens, Heads of Departments (HODs), and Parents. With the help of the HMS, students are able to register, make out passes, monitor the status of requests and send a feedback in an electronic format. Wardens have the power to track student activities, check on the feedbacks as well as communicate directly with parents whereas, the HODs have the authority to approve or disapprove out pass requests. Parents can have a real-time view of the activities in their child hostel and reply to messages by the wardens. The Admin underlies complete control with user management which includes student, warden in addition to HOD records besides providing analytical reports. The system is developed on the frontend interface based on HTML5, CSS 3 and JavaScript, and Python Django on the backend layer. Priority is given to security by determining the use of the encryption by using the Hash Algorithms Sha-256 to protect the personal information of the students and maintain confidentiality and integrity. This automated platform removes serious issues with the traditional hostel management which are manual error, sluggish approvals, and communication breach as well as data security lapses. The HMS helps in terms of decreasing the administrative workload, increasing the operational efficiency, and creating a more effective communication between all the stakeholders by simplifying the workflow and enhancing the level of transparency. The system has also provided a secure effective and user-friendly platform of administering a modern hostel system, which in the long-term benefits the students, parents and the staff of the institution.

Keywords: Hostel Management, Automation, Student Registration, Room Allocation, Out pass Requests, Warden Monitoring.

1. Introduction

Education institutions across the globe must deal with the growing challenges on how to manage the hostel operations effectively and at the same time maintaining data security and stakeholder satisfaction. The Hostel Management System (HMS) is a technologically developed, multi-

faceted product aimed at converting the manual hostel administration system into a high-tech, automated, digital environment. The system provides essential solutions to the sensitive issue of centralized control over the various hostel operations such as student enrolments, out passes, feedback and multi-stakeholder communications. The development of this system is as a result of the continued inefficiencies in the traditional methods of management of hostels. The conventional systems are very much dependent on paper records, manual approval processes and disjointed communication paths. The result of such practices would always remain a high rate of delay in handling student requests and more human errors in data handling and reduced transparency to the parents who want to have updates on their children. Moreover, manual systems lack strong security measures, and therefore, sensitive information of students is revealed to all threats of hacking into and security breaches. The HMS will also provide a paradigm shift by establishing a comprehensive digital platform employing which all the actors, which include students, wardens, HODs, parents and administrators, will be able to engage each other in a seamless manner, in real time. The convenience of online out pass application and real time tracking of the status is beneficial to students. Wardens become equipped with strong instruments to monitor activities of students and stay in constant touch to the parents. Arts Education HODs have an effective supervisory system via approving a digital platform. The level of transparency between the parents and real-time access to the activities of the hostel of the child and a direct channel of communication with the wardens is unprecedented. The administrators have all-purpose user management and data-driven reporting services. The HMS technical architecture integrates the latest web technologies with efficient security measures. The frontend is developed with HTML5, CSS3, and JavaScript to provide a user-friendly and a responsive interface. It uses the backend that is built on the Django framework of Python, which is known to be scalable, secure, and develops quickly. The introduction of a SHA-256 encryption is also critical to the integrity of the system because it will make certain that the sensitive data regarding students is safely stored and cannot be accessed in inappropriate manners, unauthorized access.

The project can be considered the yellow wave in the field of educational technology since it illustrates how considerate automation is capable of meeting administrative problems in the real world, improving user experience and keeping high control standards. In addition to increasing efficiency in the operations, the HMS helps create a more interrelated and open hostile environment that eventually leads to improved student welfare and institutional effectiveness.

2. Related work

In this paper, the author will work on the design of the Hostel Management System (HMS) incorporating RFID technology and QR codes in real-time attendance tracking. It automates some of the main activities like registering students, assigning rooms and out pass requests, which have a high rate of errors when done manually. The system is efficient, efficient in terms of records of attendance and generation of reports is easy to the administrators. The data is centrally stored hence providing a sense of security and improved monitoring of student activities [1].

The article by Jain and Kumar is predictive maintenance where the machine learning models are applied to oversee the infrastructure in the hostels. A system that acquires sensor data monitors equipment health (probably plumbing and electrical)[2]. It can then forecast equipment failures using the tool of Random Forest and SVM models, and the knowledge regarding this helps administrators to perform the timely maintenance of equipment and avoid the waste of money on the repair. This system works efficiently in both the work of the hostel facilities and the security of the infrastructure system and is a sign of the use of AI in the management of facilities [3].

The paper discusses one of the web-based hostel management tool, which was developed to computerize the business processes such as, student registration, room assignment, and student feedback. It also has user-friendly interfaces to both the wardens and the students and administrators of the institution and role specific access [4]. Integration of real time communication between the students and the hostel authorities is one of the remarkable contributions and this will not only increase the level of satisfaction but also improve transparency. The importance of centralized data management in alleviating the errors and improving the decision-making processes is also discussed in the paper [5].

Mishra and Pandey are concentrating on the hostel visitor management enhancement by means of the face recognition and RFID technology. Their system is automatic in the checking of the visitors and their movements and reporting them to the warden. The paper discusses the negative aspects of the conventional security checkups and highlights how AI is useful in improving the safety of a hostel. Such an approach will eliminate unauthorized access, a good audit trail, and such will guide the hostel managers to respond adequately to security threats [6].

The paper is the research on the data security concerns with the hostel management systems. Patel and Desai consider the vulnerabilities that have generally arisen in the normal systems that have failed to adequately secure the information of the student. Their proposal would include a 3-grounded security platform having the access control functions based on roles, and the Sha-256 encryption, which would be regarded as a worthwhile assurance in storage and communications of sensitive data. This applies to the security by design and offers a framework that can be integrated into hostel management systems in the future to minimize possibility of the theft of data [7].

The authors present a web-based hostel management application which is dedicated to optimization of such activities as registration of students, room assignment, and maintenance. The paper is based on modular design in order to make the system scalable to accommodate different hostels. The other aspect that the paper will discuss is performance assessment where the system greatly reduces processing time and manual intervention. The fact about centralized databases that will be critical in enhancing efficiency and consistency of data is noted in their paper [8].

This paper will be focusing on a multi-hostel management system that may enable the management to run multi hostel in an academic institution. This means that it will be modular with administrators being able to control student records, room management and facilities management logistics of all the hostels using a central dashboard [9]. The system makes the various hostel entities controlled in a better way and the information remains consistent and any human error is reduced. It is also being used in particular in institutions that have very large campuses with multiple hostels requiring an administrative system that is not elaborate [10].

The presented study investigates the opportunity to use AI and IoT technologies to structure the hostel management. It is also interested in automation of operations such as reserve of rooms, out pass registration and maintenance management. One of the capabilities mentioned in the study is the ability of the system to enhance the accuracy of the data and reduce the number of individuals, who are required to operate manually using the linked devices to keep an eye on the situation in the real-time [11]. The artificial intelligence algorithms also offer predictive modes of application, thus that administrators will be most likely to utilize resources and arrangements better regarding planning maintenance. The paper is also highly intelligent providing ten years on (2020) solution to automation of hostels [12].

The article talks of having a full automated system of food hosting management that simplifies the process of ordering and billing the food to both the administrators and the students. The system will also allow the students to place their orders online as well as monitor their attendances. It also features an automated meal-billing/feedback system with traditionally manual run processes. The system will reduce manual interference therefore faster processing of the records and more accurate records. The paper has also discussed the future of meal notifications that should be integrated through mobile [13].

This paper presents a fully comprehensive hostel management program that identifies some of the key concerns in the administration of these facilities including student management, out pass, and monitoring the facilities. The authors present role-based system according to which all the users such as wardens, students and administrators would be granted with specific access privileges. In their findings, automated tasks incur less delays, fewer errors, wastes and operational overheads and increase the level of transparency in decision making processes. The system is user friendly and hence is easier to operate by different stakeholders [14].

The paper concerns the security of the data of the students who are under the care of the hostel and recommends the use of the hash algorithm, easily known as SHA-256, to encrypt the data that is sensitive. The study contributes to the problem of having a secured storage and communication with the aim of securing student records against cyber-attack. This security can

be proposed in hostel management software by use of web based applications as outlined in the paper [15].

3. Proposed System

Hostel Management System (HMS) makes many activities of the hostel easy and automated reducing the reliance of having human hands to the hostel operations and enhancing the efficiency of the operations. The system will begin with the enrolment of students in which they will create accounts by providing personal information required. Allocation of rooms takes place after the registration and students get assigned rooms based on their preferences and availability that is shared in central database. The system can be utilized by students to make out pass requests and an authorization request to be out of the hostel. These requests are approved and disapproved by the Head of Department (HOD) or a warden depending on the policies of the institutions. The system also informs the students about their requests real time therefore updating them in time. The warden monitors student activities and establishes an open line of communication with the students hence creating the check that there is no issue within operations in the hostel. The system enables the admin to perform all the functions of the system including managing the data of students, rooms, and produce reports. In addition, parents may access the system to know the performance of the child at the hostel like checking the attendance and conduct of the child at the hostel thus a better communication among the parents and the hostel authorities. The biggest problem the system has inherently integrated is the problem of security and consequently, the system has utilized the use of SHA-256 in order to encrypt sensitive data such as the student records and out passes requests. This system also brings about integrated data and unauthorized access is not provided hence, is efficient and secure. The system will streamline the administration and student life in the hostel by automating the administrative functions and enhancing contact with and among with the students.

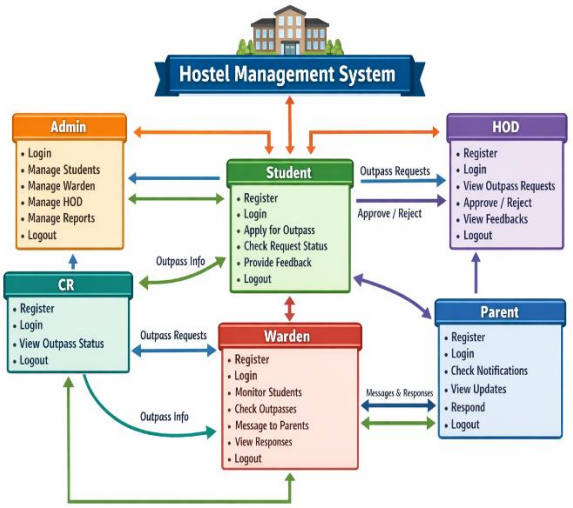

Figure 1 Project Flow

4. Methodology

Hostel Management System (HMS) is established systematically under the existing guidelines of web technologies and data security that guarantee that operations of hostels are automated. The roles are set to permit multiple roles and they are Admin, Students, Wardens, HODs and parent which have their respective access and facilities. The system has a front-end which forms an interface friendly to all the stakeholders since it is built in HTML, CSS, and JavaScript. The back-end is constructed on Python and Django software that will guarantee scalability and security and facilitate accessibility among the front-end and back-end components. Django ORM is employed to communicate with the database and this would be easy with its assistance in managing the records of the students and assigned rooms and out passing requests. To safeguard data, the system will integrate the implementation of the use of Sha-256 in encryption of sensitive information within the system, an information containing student data, out pass request and feedback. This would ensure that any information is stored and transmitted in a secure way and there is no unauthorized access to the information. The system embraces a centralized database whereby all records are stored with the help of central database and data retrieval to create reports in the system becomes simple. Role-Based access control (RBAC) is installed to ensure that user has access to the features and the data only which are relevant to them and help in providing feedback and real time updates. This system will contribute to the optimal use of hostel management, reduce the

workload of administration and the interaction between the parties to it. The system is also made to incorporate real time notifications to ensure that all stakeholders are updated on the primary activities in the form of out pass status, room assignments and any news regarding the hostel activities. This will provide good communication without any difficulty and obstacles that will be seen during the communication process.

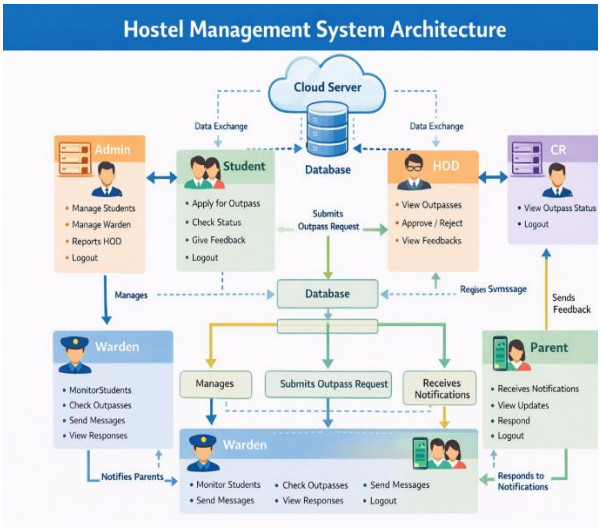

Figure 2 Architecture

A. Block chain Integration

The secure data storage can be used to set the procedure of delivering the integrity, the confidentiality of the information in the transactions and availability of the data. This information is enrolled into a block chain system, the data is the record of transaction, which is stored at a decentralized location, which may be accessed by confirming the transaction with the block chain the storage repository or block chain, as it is more often referred to. Each of block and transaction had an order of record, and this was not revocable and that is the block and transaction were linked to one another using cryptographic hash of the prior block. Such structure in this instance makes it virtually impossible to effect changes and modify the information that is stored and gives authenticity of every transaction. In the process of ensuring that information which would otherwise be used to finalize the transactions is not distorted by the persons of unauthorized access, hash (e.g. Keccak-256 or SHA-256) cryptographic functions are used. This knowledge regarding the transaction can be hashing and combining it with the block chain and hence making it an unfalsifiable record in case it possesses one in the paper. In addition to this, sensitive information can be coded and then encoded and only the value individuals can be able to communicate on the information on the action.

B. Keccak Algorithm

Keccak algorithm is a hash algorithm the hash-function of which is cryptographic hash (a hash-function), it is the pro-type of Sha-3 family of hash functions. The Keccak, in contrast to the classical constructions of Merkle-Damgard is a sponge-based construction, and thus, it can be safely and legally extended to hash the input data. This is achieved in two general processes of absorption and squeeze. Absorption stage entails the intake of the input bits into one of the states, which is in the form of 1600 bits. This condition is again remodeled by the combination of series of operations in the manner that Keccak-f, series of operation is transformation again in the following mode 0 (Theta), 5 (Rho), 2 (Pi), 1 (Chi) and 0 (Iota) as a combination. They are coupled operations of bits in the state therefore, they are very diffusive and as well as non-linear operations. Once all the input is read by the algorithm, the algorithm moves onto the step of squeezing and at this point the algorithm will recall a fixed sized bit of a hash output of the internal state. The hash size can be modified to suit the need of the degree of security. Keccak is designed to resist many cryptographic attacks such as preimage resistance, collision resistance and a well thought decision in blockchains and in digital signature.

$$Si = Keccak\_f(Si - 1 \oplus Pi)$$

Where:

- Si means the internal state upon which the i-th block has been processed.
- Si-1 is the internal condition of absence of the i th block.
- Pi is the i th block of data to be inputted.
- X = XOR will be denoted by the use of $\oplus$.

C. Secure Transactions Stocking

The procedure of offering the integrity, the confidentiality of the information on the transactions and the availability of information may be configured by use of the secure data

storage. This data is registered in a block chain storage network, the data reflects the transfer record, which is stored in an unstructured repository that could be accessed by validating the transfer by the block chain storage repository or block chain. The block and transaction received an order of records, which was final and that they were connected by the hash cryptographic value of the previous block. This form in this case renders it impractical to alter or adjust the information that is stored and provides genuineness of all the transactions. Cryptographic functions such as hashing (e.g. Keccak-256 or SHA-256) are also used in the guaranteeing that information which would have otherwise been utilized to make the transactions are not distorted by individuals of unauthorized access. Provided that there is stored transaction the information on the transaction can be hashing and concatenating it with block chain and thus making it an irrevocable and verifiable record. Along with this, the sensitive information can be encrypted then stored in the form that only the authorized people can discuss the information about the transaction. This approach provides secrecy of data and prevents unauthorized alteration or manipulation of data and unauthorized intervention. Also, the decentralized quality of block chain is such that there is no one point of failure as this can counter attack or system failures. Consequently, this model enhances the integrity of transactions and security of transactions and also ensures that the parties can check the veracity and authenticity of the records of the transactions.

5. Results

A. *Home Page*

The "Hostel Management System" is an integrated platform designed to streamline hostel operations, enabling real-time tracking, digital out pass requests, and seamless communication between students, parents, and hostel authorities. It features role-specific dashboards for various stakeholders, including Admin, Student, HOD, Warden, and Parent.

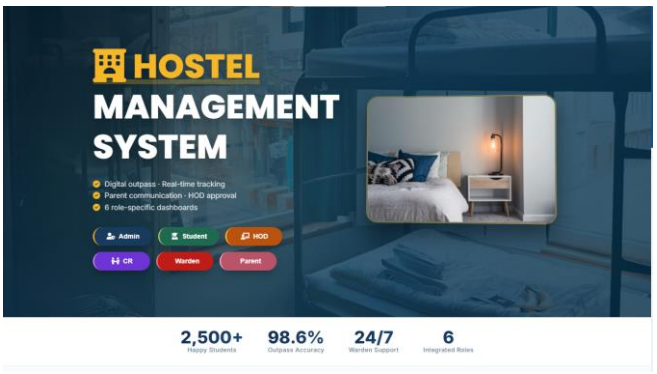

Figure 3 Home Page

B. *Admin dashboard*

The image shows the "Admin Dashboard" of the Hostel Management System (HMS), where the admin can view key statistics such as the number of students, staff, pending out passes, and today's feedback. It also includes sections for managing students, staff, and out pass requests, along with warden management.

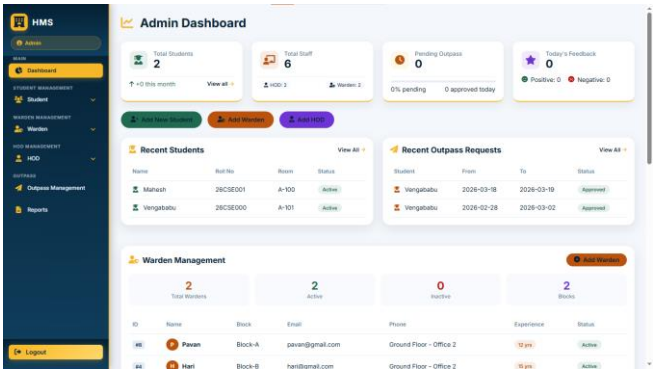

Figure 4 Admin dashboard

C. *User Management*

The image shows the "Manage Students" section of the Hostel Management System (HMS) admin panel, where the admin can view and manage student information, including approval status, department, and contact details. It allows for easy addition of new students and tracking of their status within the system.

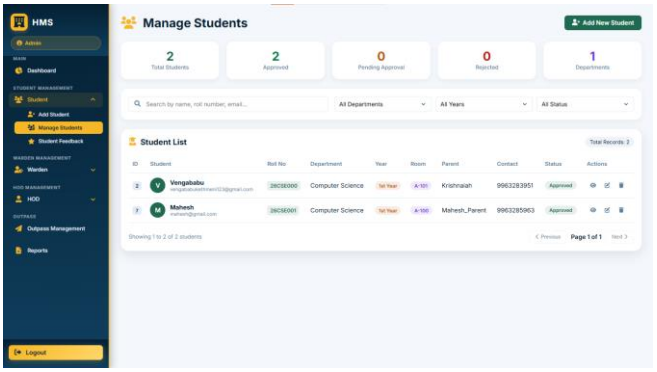

Figure 5 User Management

D. Apply Outpass

The image shows the "Apply for out pass" section in the Hostel Management System (HMS), where students can request an out pass by selecting the dates, providing a reason, and following important guidelines. The interface allows students to submit their request, reset the form, or cancel the action.

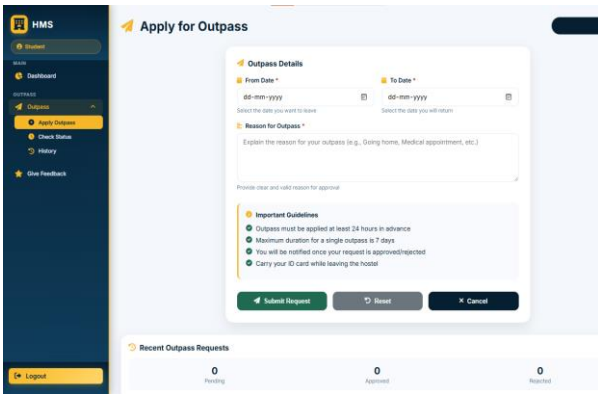

Figure 6 Apply Out pass

E. Out pass Status

The image shows the "Out pass Status" where students can track the status of their out pass requests.

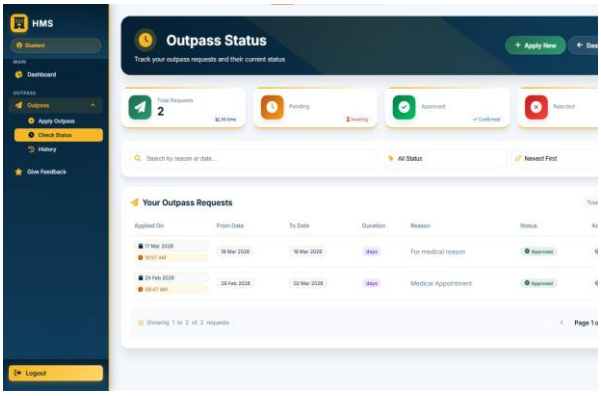

Figure 7 out pass Status

F. Manage Out pass

The image shows the "Manage Out passes" section of the Hostel Management System (HMS), where the admin can review, approve, or reject student out pass requests. It displays the total number of requests with statuses such as Pending, Approved, and Rejected.

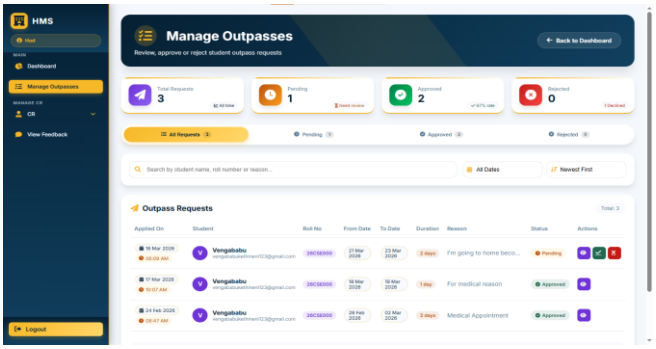

Figure 8 Manage Out pass

G. Check Out pass

The image shows the "Check Out pass" for the Warden. It allows the warden to review and manage student out pass requests, displaying total requests, along with their approval, pending, or rejection status.

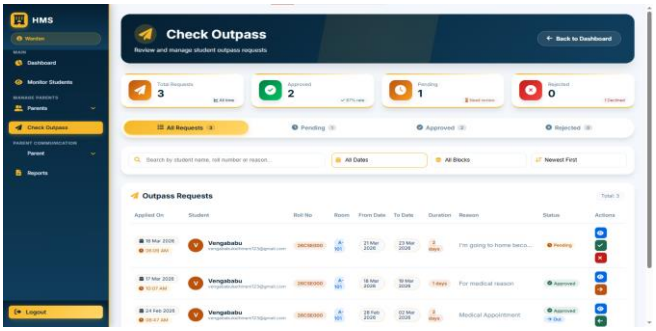

Figure 9 Check Out pass

H. Parent Responses

The image shows the "Parent Responses" where the admin can view and manage responses from parents regarding student out pass requests. It displays the total number of responses, with statuses such as "Responded" and "Pending."

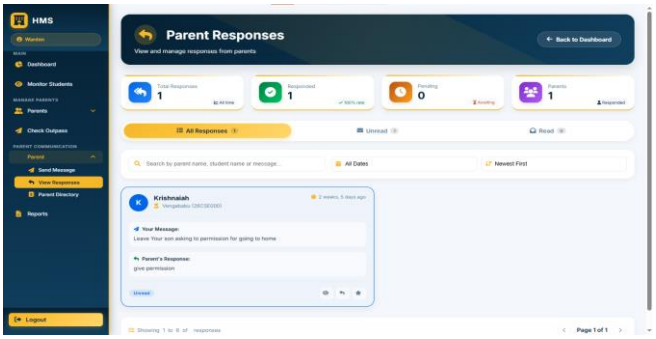

Figure 10 Dep Parent Responses

6. Discussion

The Hostel Management System (HMS) that is presented in the current project proposes the solutions to the issue of inefficiency and difficulties associated with the traditional and manual hostel management approaches. The system provides a more efficient method of handling key processes like registering students, granting them a room and out passes thus it saves on time as well as reduces the possibility of error. The centralized database whereby student data could be easily accessed and managed is one of the major benefits of this system that contributed towards the enhancement of decision-making and transparency. The real-time notifications are another important aspect that the system provides because both the hostel authorities and a student can be updated on vital activities including the approval of out pass requests or room allocation change. This saves on time wasted in communication and enables prompt reaction. Furthermore, the system operates with the encryption of SHA-256 which guarantees a safe storage and inaccessibility of responsible and sensitive data, e.g., the personal information of students and out passes requests. Nevertheless, the initial implementation and training of hostel admission and students to be accustomed to the new system can become a potential challenge. Although the system should be user-friendly, a learning curve could still exist. This can be enhanced by incorporating features of mobile app support in the long run to make it easier to access and allow direct communication with all the stakeholders on what to do.

7. Conclusion

The Hostel Management System (HMS) to be created in this project is an efficient and automated method of facilitating the otherwise manual hostel management processes. The system promotes efficiency in operations because it incorporates major features like student registration, allocation of rooms, out pass requests and real-time communication amongst many others. The centralized database of the system also allows an easy management of the data and access to this data to limit redundancy and possible mistakes. It is also secure in that it uses SHA-256 encryption to offer protection to sensitive information like student information and out pass information. The first advantage of this system is that it saves on the administrative overhead of having to automate the lesser processes so that the hostel staff can concentrate on other more important tasks. Communication and role-based access control (RBAC) is improved with the use of real-time notifications and will optimize the transparency of the system so that students, wardens, and parents are kept informed. The system is also designed in user friendly manner such that, all the users irrespective of their level of expertise are able to easily use and navigate the system. However, with the merits, such a system may be successfully installed provided the staff and students of the hostels have proper training and adjustment. Additional improvements in the future may be the integration of mobile application to have a more convenient and easier access to the system, which will enhance the channels of communication and the user experience. To sum up, the Hostel Management System suggested would not only streamline the processes in the management but also create transparency, security and efficiency. It offers a scalable approach that can be replicated to other schools, which is beneficial to students, administrators, and parents because of enhanced communication and working processes.

Future Scope

The Hostel Management System (HMS) that was formed in this project has equipped a sturdy ground on enhancing the efficiency and management of the hostel operations. Nevertheless, it has a lot of room to develop and enlarge its functionalities in future. The mobile app integration is one of the aspects that can be further developed. Even though the existing system can be accessed through a web browser, developing a mobile application would enable the students, wardens, and parents to get easy access to key variables through the application, mobile devices in an easy and on-the-go fashion; these include out pass requests, room assignments, and notifications. Communication would also be easier and faster conducted through a mobile app, particularly to parents who do not always have a computer at their disposal. Addition of real time analytics and reporting is another area that can be improved. More features to the system could include the administrators to create extensive reports regarding the occupancy of the hostels, information on the maintenance, student activities among others. The management of the hostel would use such insights to make meaningful decisions using data and enhance

the operations in general. Also, the system may include AI-controlled proactive capabilities of maintenance, such as predicting when a room might need repair based on the usage. This would help to avoid significant problems and enhance the maintenance of hostel centres. Lastly, the second generation of the system might be integrated into the rest of the management systems of the campus, like the library system or student portal, so that all the operations of a student could be managed efficiently.

Conflict of Interest

The authors declare that there are no conflicts of interest regarding the research, development, or publication of this work.

Data Availability

The data used in this study are obtained from publicly available sources and referenced literature. No confidential or restricted data were used. Further details can be provided by the corresponding author upon reasonable request.

Author Contributions

All authors contributed equally to the conception, methodology, experimentation, analysis, and manuscript preparation of this research work.

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Ethical Approval

Ethical clearance was not required for this research, as it utilized anonymized, publicly available data. No direct interaction with human subjects or use of confidential personal data occurred during the research.

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