ISSN No: -2456-2165 https://doi.org/10.38124/ijisrt/26apr2387

Enhancing Hostel Grievance Management Through Permissioned Blockchain: A Step Toward Transparent and Accountable Campus Living

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Publication Date: 2026/05/16

Abstract: Hostels are an essential part of campus life in technical institutions, directly influencing student welfare, safety, and satisfaction. However, traditional hostel grievance management systems often face issues of delayed responses, lack of transparency, and potential data manipulation, resulting in a trust gap between students and administrators. This paper reviews how permissioned blockchain technology can transform hostel grievance systems by ensuring transparency, accountability, and tamper-proof recordkeeping. A hybrid blockchain architecture integrating institutional databases with a distributed ledger is examined for its ability to maintain verifiable complaint histories while protecting privacy. The study highlights the potential educational and administrative benefits of adopting such systems, including faster grievance resolution, fair decision-making, and improved trust within hostel communities. Recommendations are provided for technical institutions aiming to modernize hostel management through blockchain-based digital governance.

How to Cite: Pratibha D. Patil; Parikshit Daivadnya; Sakshi Kulkarni; Dhawal Chhindam; Yugant Manekar (2026) Enhancing Hostel Grievance Management Through Permissioned Blockchain: A Step Toward Transparent and Accountable Campus Living. *International Journal of Innovative Science and Research Technology*, 11(4), 4703-4708. https://doi.org/10.38124/ijisrt/26apr2387

I. INTRODUCTION

➢ *Building Trust in Grievance Systems*

In most technical institutions, hostels serve as a second home for students and play a vital role in their overall educational experience. Managing hostel grievances effectively—such as maintenance issues, hygiene complaints, food quality concerns, or interpersonal conflicts—is crucial for maintaining student satisfaction and campus harmony. Traditional hostel grievance mechanisms, often paper-based or centralized digital portals, lack transparency and accountability. Complaints may be overlooked or altered without proper records, leading to mistrust among hostel residents. Permissioned blockchain technology, such as Hyperledger Fabric, provides a modern solution by introducing immutable recordkeeping, traceability, and fair digital processes into hostel grievance management. This paper explores how blockchain-driven grievance systems can build trust and enhance transparency in hostel administration, creating a more accountable and student-centred environment.

II. RELATED WORK AND RESEARCH GAP

Most existing hostel grievance platforms focus on automating complaint collection and resolution, but do not address the underlying issues of trust and data integrity. Studies that apply blockchain in educational or hostel settings rarely analyze how this technology can improve administrative accountability and strengthen student confidence. This review bridges that gap by focusing on blockchain's role in transforming hostel grievance mechanisms within educational campuses into transparent and tamper-proof systems.

Karuppasamy et al. [1] in "Streamlining Hostel Administration Through Real-Time Event Triggers and Priority-Based Complaint Sorting Algorithm with React

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Native and AWS Integration" (IEEE AIMLA, 2025) proposed a hostel management framework that uses React Native, AWS Cloud, and MongoDB to automate complaint handling and feedback management. The system features real-time event triggers and a priority-based complaint sorting algorithm, which improved grievance resolution efficiency by 40% compared to traditional systems. It also includes features like JWT-based authentication, GDPR compliance, and cloud scalability to improve security and reliability. However, the prioritization method is rule-based instead of adaptive, and the lack of AI-driven analytics or sentiment processing restricts its ability to learn from complaint data. The study does not include blockchain-based methods to ensure data immutability or auditability, which leaves a gap in transparency and traceability.

Singhal et al. [2] in "Student Grievance Redressal System" (JETIR, 2024) presented a web-based platform designed to simplify and automate grievance reporting and tracking in higher education institutions. The system lets students submit complaints online and allows administrators to view, track, and respond to these complaints through a centralized dashboard. The authors highlight enhanced transparency and accountability through automated notifications and graphical reports. However, the system still relies on centralized data storage, making it susceptible to unauthorized changes. It lacks AI-based prioritization or privacy-preserving measures, meaning urgent or sensitive complaints are not automatically flagged or protected against tampering.

In a conceptual model, Kaushal et al. [3] described a grievance management system built on Hyperledger Fabric. The design was intended to ensure the security and unchangeable nature of complaint records, while also promoting transparency. Testing with Hyperledger Caliper showed good performance, with a throughput of 93.6 transactions per second and a latency of 0.45 seconds. However, the system remains theoretical and has not been implemented in a real-world setting. Important areas like multi-organization scalability and integrating real-time AI are still not tested.

In terms of automation, Kasar et al. [4] developed a standard web application to improve communication and responsibility between students and administrators. The system allows for easy complaint submission and tracking via a simple interface. But it has a major weakness in relying on a central database, which makes it vulnerable to unauthorized alterations. It also lacks advanced tools such as AI-based prioritization or predictive analysis to identify problems before they occur.

Patil and Kadam [6] used IoT and cloud computing to create a system that automates the entire process of handling complaints, from initial registration to resolution. This improves communication and speeds up responses. Despite these improvements, the system lacks smart analytics, AI-driven prioritization, and strong security features. Additionally, the study did not test how well the system performs under heavy usage, so there are still questions about its ability to scale and function reliably in bigger hostel networks.

- *The Hybrid Model: A Pragmatic Compromise*

A hybrid architecture offers a strategic solution that balances the distinct advantages of centralized and decentralized systems. This model operates on the pragmatic principle of data segregation: it leverages the performance and flexibility of a conventional database (like MySQL) for managing high-volume, operational data such as user profiles, while dedicating the blockchain's immutable ledger solely to the task it excels at—securing the critical, auditable lifecycle of a grievance.

An implementation of this design is the "Decentralized Hostel Complaint Resolver" (DHCR) by Daivadnya et al., which integrates a Spring Boot/MySQL application with a Hyperledger Fabric network. The result is a targeted application of blockchain technology that guarantees the integrity of the grievance process without creating a performance bottleneck, thus offering a practical and scalable solution.

- *Identifying the Research Gap*

The evolution of grievance management systems, as documented in the existing literature, shows a clear trajectory from manual processes toward digital centralization and, most recently, to decentralized, blockchain-native platforms. However, a significant research gap exists: there is no comprehensive, comparative analysis that systematically evaluates these three architectural paradigms—centralized, decentralized, and hybrid—against one another. An academic review is needed to provide a holistic overview of their respective architectures, performance trade-offs, and the practical implications of their implementation. This paper aims to fill that void by providing such an analysis, thereby offering a valuable resource for practitioners and researchers designing future grievance systems.

III. FOUNDATIONAL PRINCIPLES OF BLOCKCHAIN FOR GRIEVANCE MANAGEMENT

The effectiveness of blockchain in managing grievances is rooted in a set of core technological traits that directly address the limitations of older systems related to trust and accountability. It replaces the vulnerable single-server model by distributing the official record across multiple computers. This shared data model makes it impossible for any single individual or group to alter the information secretly, as any changes require consensus from the network. The shared record is also immutable; entries are permanently locked into place through cryptographic links, creating an unchangeable and verifiable history for each complaint.

This results in a unified and trustworthy record accessible to all authorized users, allowing them to track the progress of their grievances in real-time. Auditors can also easily review the complete, unaltered history of any case, ensuring continuous and reliable oversight. Finally, the

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system's operational rules are automated through smart contracts (or ' chain-code' in Hyperledger Fabric). These programmable rules ensure procedures are followed consistently. For example, a rule can be set to automatically forward a complaint to a higher authority if it isn't resolved within a specified timeframe. This shifts governance from human discretion, which can be inconsistent, to impartial enforcement by the code itself.

- *Hyperledger Fabric: An Enterprise-Grade Framework for Secure Grievance Systems*

For enterprise environments like a grievance system, where data privacy and strict access rules are critical, a permissioned blockchain is required, and Hyperledger Fabric is a prominent example of such a framework. Unlike public blockchains, where participants are anonymous, Fabric operates on a model where all members have a verified digital identity. This identity-based system is crucial for managing user permissions effectively (e.g., distinguishing between students and staff) and adhering to data protection regulations.

Fabric's unique architecture is a key contributor to its efficiency and scalability. The network's core functions are handled by specialized nodes: Peers maintain the ledger and execute smart contracts, a dedicated ordering service is responsible for sequencing all transactions chronologically, and a Certificate Authority (CA) acts as a digital gatekeeper by managing identities.

The transaction process is broken into three distinct phases: execution, ordering, and validation.

- A transaction is first proposed to and executed by endorsing peers who simulate it and sign off on the result.
- The transaction is then sent to the ordering service, which places it into a correctly sequenced block.
- Finally, this block is sent out to all relevant peers, who validate each transaction before permanently adding it to their ledger.

This separation of tasks allows many steps to happen concurrently, preventing the slowdowns common in monolithic blockchain designs and enabling the system to handle a large volume of transactions.

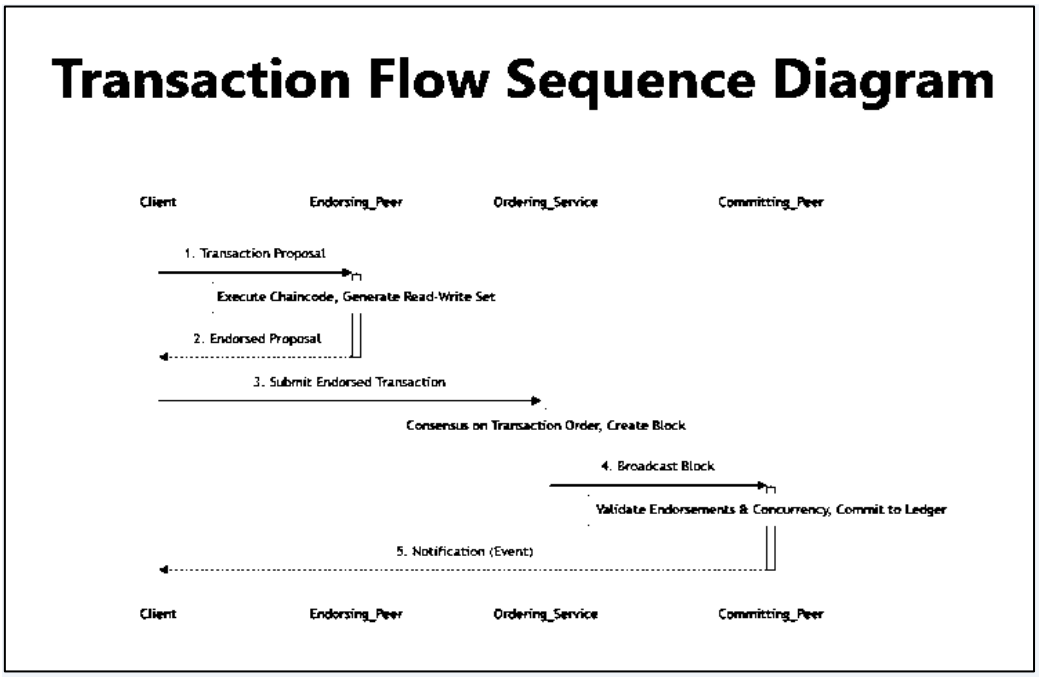

Fig 1 Hyperledger Fabric's Execute-Order-Validate Transaction Flow

- *Architectural Models for Blockchain-Enabled Grievance Management*

A well-planned system design is essential for introducing blockchain into hostel grievance management. Because blockchains are not intended to store large volumes of data, keeping every complaint record directly on the ledger would reduce efficiency and increase cost. A hybrid architecture therefore, provides the best balance between performance and transparency.

In this model, general and personal information related to grievances is stored securely in the institution’s existing database, ensuring smooth operation and compliance with data-protection norms. The blockchain component records only essential reference details—such as a complaint ID, time stamp, status, and a digital fingerprint of the off-chain record—creating a tamper-proof audit trail without exposing private information.

This arrangement allows hostel administrators to maintain fast, flexible data management while guaranteeing that every complaint and its resolution are verifiable and cannot be altered retroactively. The result is an efficient and trustworthy grievance system that aligns with the goals of transparency and accountability in hostel governance within technical institutions.

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- *Case Study: The Decentralized Hostel Complaint Resolver (DHCR)*

The Decentralized Hostel Complaint Resolver (DHCR) serves as a conceptual model demonstrating how blockchain can enhance hostel grievance management through transparency and accountability. The system follows a hybrid architectural approach, combining the strengths of a conventional institutional database with the immutability of a permissioned blockchain network.

In this model, general grievance details and student information are stored in the local hostel database for quick access and administrative convenience, while the blockchain records essential reference data—such as complaint IDs, timestamps, and verification codes—to maintain a tamper-proof audit trail. This ensures that every step of the grievance process, from submission to resolution, remains verifiable and cannot be modified without detection.

The DHCR model also incorporates role-based access control, ensuring that each participant, such as a student, warden, or hostel administrator, has defined access privileges consistent with institutional policies. Only authorized users can view or update complaint information, preserving privacy while ensuring responsibility for each action taken.

This case study illustrates that integrating blockchain into hostel grievance systems can provide traceable decision-making, reduce data manipulation risks, and build greater trust among students and administrators. When implemented thoughtfully, such systems contribute to a culture of transparency, accountability, and digital governance within technical education institutions.

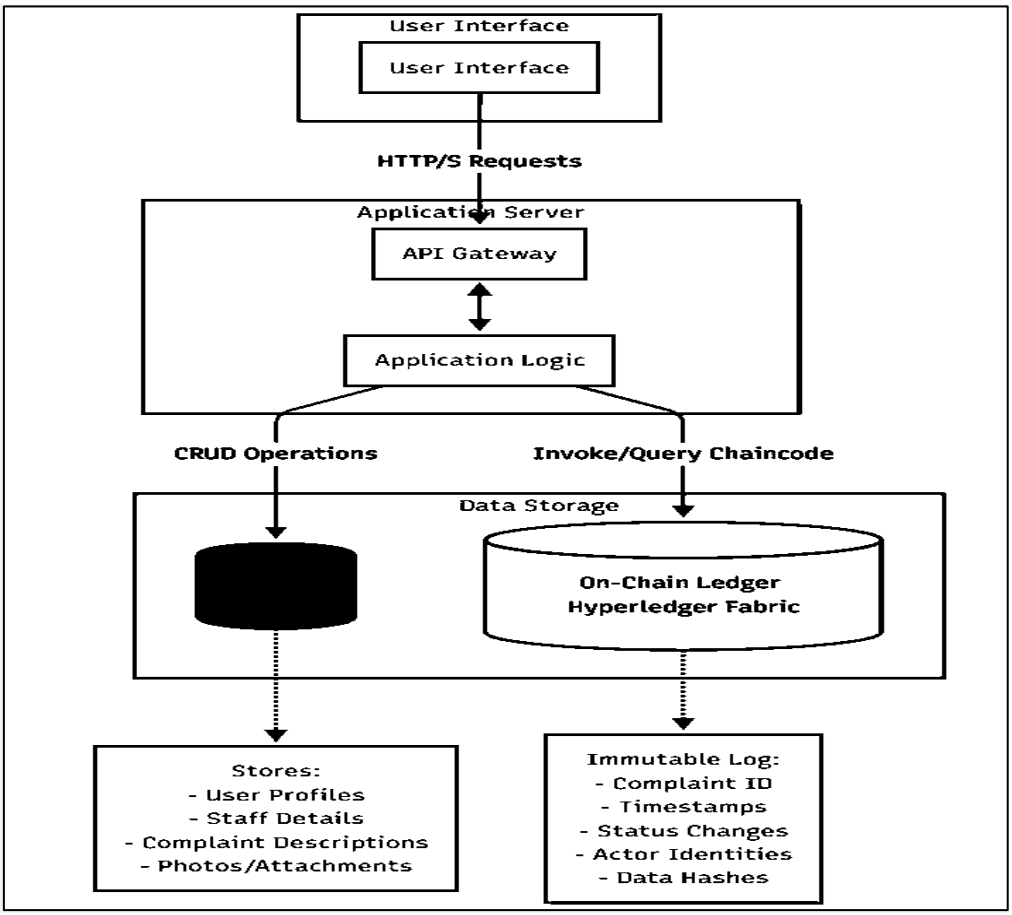

Fig 2 Conceptual Design of the Decentralized Hostel Complaint Resolver (DHCR)

IV. SECURITY AND PRIVACY CONSIDERATIONS IN A DECENTRALIZED SYSTEM

In hostel grievance management, maintaining confidentiality and data integrity is essential for ensuring fairness and trust among students and wardens. Blockchain technology supports these objectives through a permissioned framework where only verified participants—such as students, hostel wardens, and administrators—can access or update grievance records. Each transaction is securely recorded and digitally signed, preventing any unauthorized modification or deletion.

The use of private channels in blockchain networks allows sensitive complaints, such as disciplinary or personal issues, to be handled confidentially by designated authorities, maintaining privacy while ensuring accountability. Role-based access control ensures that every user interacts within their defined responsibilities—for example, students can lodge and track complaints, while wardens can update resolution status.

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These features collectively protect student data, strengthen trust in hostel governance, and align with institutional objectives for secure, transparent, and ethical administration within technical education environments.

➢ *Performance Analysis of Hyperledger Fabric Networks*

For hostel grievance management systems, reliability and consistency are more critical than raw computational speed. While traditional centralized databases can process requests faster, they often lack verifiable audit trails and can be prone to unauthorized modifications. Blockchain-based systems, on the other hand, ensure that once a grievance record is stored, it cannot be altered or erased without detection.

This built-in integrity helps administrators handle complaints confidently and assures students that their issues are being addressed fairly. Even if blockchain frameworks may involve slightly higher processing times compared to conventional systems, the trade-off results in improved transparency, accountability, and long-term data trustworthiness—qualities essential for hostel governance in technical institutions.

Hence, the overall performance of such systems should be measured not only in terms of speed but also in how effectively they improve communication, fairness, and record authenticity within hostel operations.

➢ *Challenges and Limitations to Widespread Adoption*

Implementing blockchain-based grievance management within hostels offers many benefits, yet several practical challenges limit widespread adoption across technical institutions.

- *Technical and Operational Readiness:*

Hostel administrations often lack the in-house technical expertise required to configure and maintain blockchain systems. Integrating a new platform with existing campus information systems—such as student databases or complaint portals—can be complex and time-consuming. While permissioned networks ensure better control and security, they still demand consistent maintenance and user training.

- *Organizational and Governance Constraints:*

Many hostels and institutions remain dependent on centralized administrative practices. The shift toward transparent and auditable records may encounter resistance from staff unaccustomed to shared digital accountability. Additionally, limited budgets and the need for training can make initial deployment financially challenging, especially in smaller colleges or government-aided hostels.

- *Balancing Transparency & Privacy:*

Hostel grievance data frequently contains sensitive information regarding interpersonal disputes, safety concerns, or disciplinary matters. Achieving transparency without compromising privacy is therefore a major concern. Blockchain's immutable nature conflicts with situations that require data correction or removal. A hybrid approach, where personal data is stored in a secure institutional database and only tamper-proof references are recorded on the blockchain, can help balance compliance, confidentiality, and accountability.

- *Change Management and Capacity Building:*

Adoption depends not only on technology but also on people. Administrators, wardens, and students must understand both the purpose and limitations of blockchain to use it effectively. Regular orientation sessions and gradual, phased implementation can help overcome scepticism and ensure the system becomes a trusted part of hostel governance.

V. FUTURE DIRECTIONS AND EMERGING RESEARCH FRONTIERS

The future of hostel grievance management in technical institutions lies in adopting technology not just for automation but for transparent and student-centric administration. Integrating blockchain-based grievance systems with existing campus platforms, such as maintenance and feedback portals, can help create a unified hostel management ecosystem. Artificial-intelligence tools may assist in analyzing grievance trends and improving response efficiency, while small-scale pilot projects can validate feasibility before wider adoption. Equally important is capacity building—training hostel staff and involving students in governance to ensure long-term acceptance. Collaborative policy frameworks across institutions can further standardize secure and ethical data handling. Thus, future development should treat blockchain as a foundation for accountable, efficient, and trustworthy hostel governance rather than merely a technical innovation.

VI. CONCLUSION

Effective grievance redressal in hostels is pivotal to student welfare and the overall quality of campus life in technical institutions. This review shows that permissioned blockchain offers a promising approach to strengthen transparency, prevent record tampering, and build trust between students and administrators. However, the technology alone is not a silver bullet: successful adoption depends on careful design choices that protect privacy, realistic planning to manage cost and complexity, and strong stakeholder engagement.

We recommend that technical institutions consider small, well-scoped pilot deployments, invest in training for administrators, involve students in governance, and measure outcomes with clear metrics (for example, resolution time, repeat complaints, and student trust scores). When introduced thoughtfully, blockchain-anchored grievance systems can meaningfully improve hostel governance and student experience—while also serving as a practical educational platform for students to engage with contemporary digital governance challenges.

ISSN No: -2456-2165 https://doi.org/10.38124/ijisrt/26apr2387

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