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SmartSched: An Intelligent Time Table Management System

Munamala Sai Prakash[a*], Dr. S. Vydehi[b*]

[a*]PG-Student, Department of Computer Science and Engineering, Audisankara College of Engineering and Technology, Gudur-524101, Andhra Pradesh, India.

[b*]Associate Professor, Department of Computer Science and Engineering, Audisankara (Deemed to be University), Gudur-524101, Andhra Pradesh, India.

Corresponding Author: saiprakash0505@gmail.com/vydehiela@gmail.com

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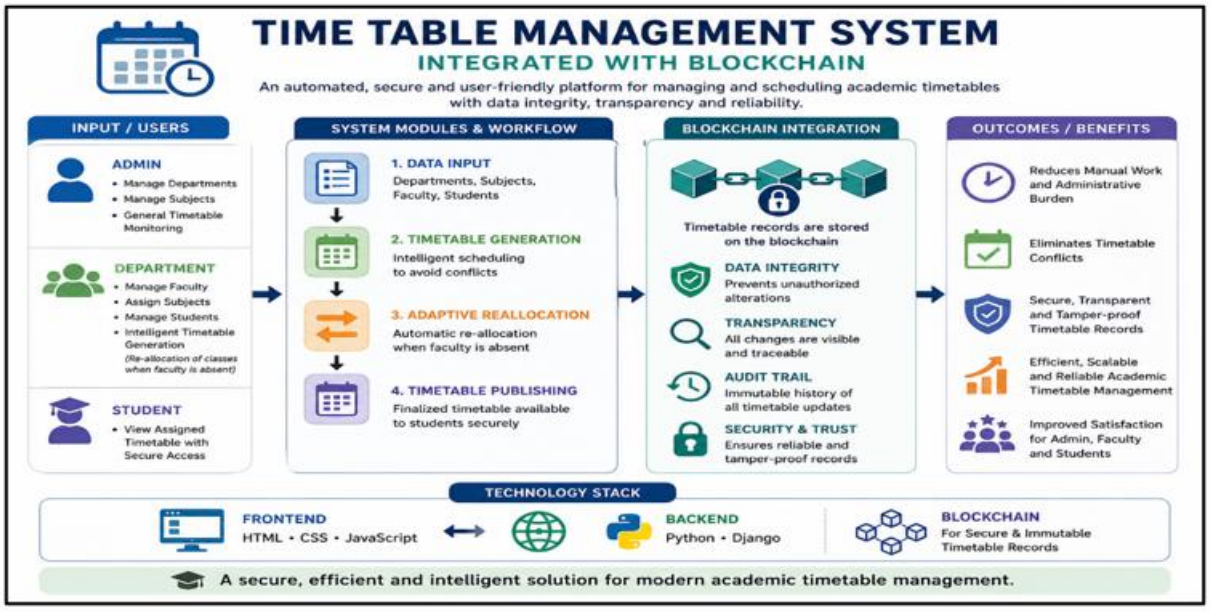
Abstract

A blockchain-integrated smart application to manage Time Table management from a learning institution, in other words, it is called the Time Table Management System. You will easily automate and simplify tasks for everyday administration while managing the academic timetable. This system is built with a front end based on an interface that runs through HTML, CSS and JavaScript attached to the variable back-end, which works through Python with the Django framework toolkit, providing an interactive, secure and user-friendly platform. Admin, Department and Student as three primary modules with varying functions. The admin part manages departments, subjects and complete scheduling. Use the department module for Faculty management, subject allocation, student records and smart timetable generation (e.g., after one faculty member goes on leave, classes are assigned with auto intelligent analytics). The student module provides a secure login to the users in order to view their respective assigned timetable by themselves. The solution to enhancing this system has been the use of blockchain technology, where all timetable records are kept almost securely transparent and clear. Unfortunately, these changes cannot be undone nor amended, and the bookings are simply stored as history, securely archived on a blockchain, which saves private information for sensitive scheduling. This at least renders some semblance of trust and reliability, especially while upgrading the timetables or changing the faculties. In general, it is expected to decrease manual work, avoid time schedule conflicts, as well as supply a trustworthy, efficient and much more versatile framework for managing the academic timetable.

Graphic Abstract:



1. INTRODUCTION

The Time Table Management System with Blockchain Integration was conceived due to the challenges facing an older system of timetable scheduling within learning institutions. When run on manual or semi-automated systems, the process turns into a time-consuming and tedious journey wherein scheduling conflicts would happen as well, within the resource allocation being mismanaged and also last-minute changes like adjusting faculty leave. Changes in traditional systems are also not secure due to the risk of unauthorised change, data inconsistency & loss of trust from the stakeholders may happen in a non-transparent system. This is where I would place more than one of an ever-growing number of students, faculty and courses scaling in academic structure complexity; a need for a general-purpose, reliable automated solution.

It is requisite because it will utilise up-to-date web technology and Blockchain that enhances the timetables for ease of implementation, accuracy and security. This will provide a direct interface with Django and web, easily accessible and also in order to add a layer of immutability on top of the timetable data storage, blockchain technology will be used. This eradicates human error and human interventions as well, while ensuring data integrity and accountability. Finally, it will offer a scalable, smart and secure academic scheduling system that provides efficient productivity gains with user-end satisfaction.

A. PROBLEM STATEMENT

The widely known problem of time management in our colleges is getting more and more common day by day, so with the system, we have also provided a solution for it. This proposed Blockchain Integration-based Time Table Management System aims to create an effective time table management system in any academic institution. This will be a web-based software system that will help automate class categorisation, subject designation and documentation regarding teaching and students via centralized solution. The aim is to increase automation and reduce human involvement by creating optimal schedules automatically that eliminate scheduling conflicts.

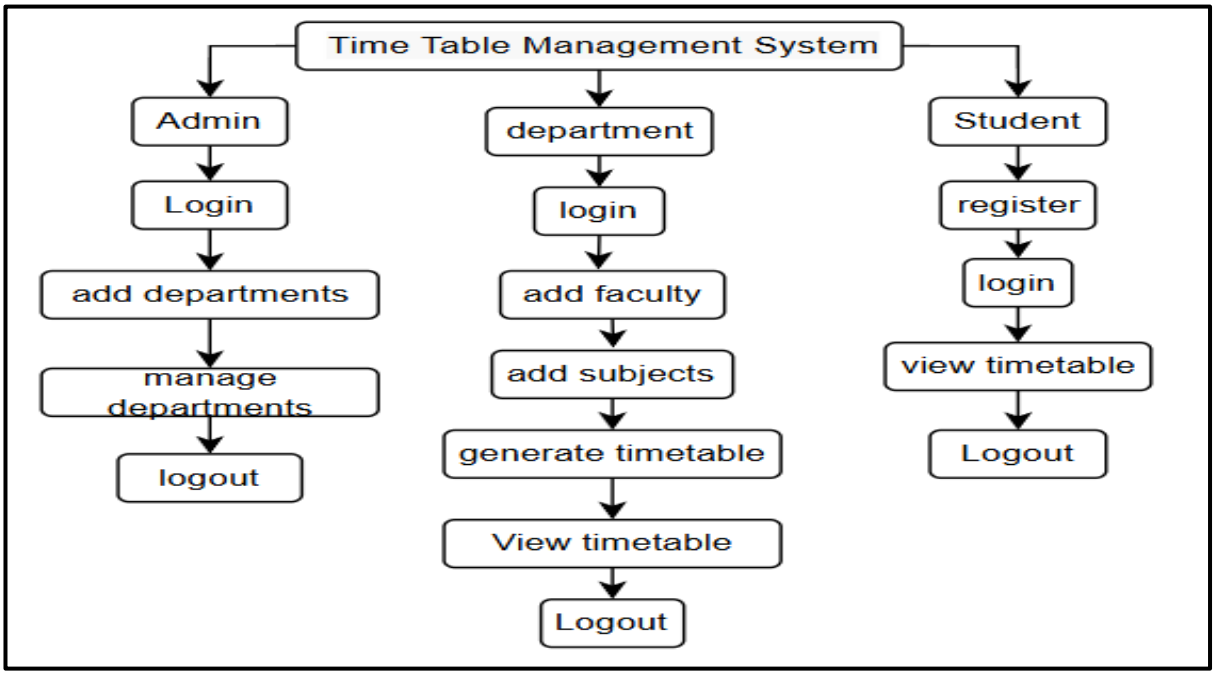
The second aim is to increase the security and reliability of property data, which comes along with the transparency function that blockchain provides us. This also makes sure that the records of the timetable are impossible to delete, and can still be traced or modified at any time. You will also have role-based access, making it Admin, Department-wise and Student-wise, which means each stakeholder will be able to reach each other pretty effortlessly. It also tackles the management of real-time situations (like reassigning classes when faculty are on leave). In general, the aim is to develop easily usable and robust timetabling systems that scale.

B. OBJECTIVE AND SCOPE

Blockchain-Integrated Timetable Management System is basically a digitalised and automated format/working of melding the behavioural process of issuing the academic Schedule Structure within educational organisations like schools, colleges, as well as universities. It is made to achieve the goal of creating multi-department, faculty & student info, give subjects, and a conflict-free timetable as well. According to the roles functionality, it provides a 3 type users access: Admin, Department and Student, respectively. Each Role has been allocated a limited functionality to help him/her furnish the data related to Records update/creation, Schedule creation and Schedule viewing in a defined and secure manner.

Blockchain is one such chain that can enhance the number of processes due to promising timetable management, data integrity, transparency, and security. Such a formal version of the system allows us to follow its timetable creation and modification in an immutable fashion, making such a use case ideal for institutions where students demand a high degree of trustworthiness on behalf of their institution. Really flexible and responsive: The system also lets you recalibrate on the go with re-allocation of classes in case a faculty member takes leave.

Guys, in both ways, the future of this project can be used by adding mobile apps support, connecting it with attendance and examination systems and optimising the timetables using AI technologies, deploying it to the Cloud for better scaling, etc. It is usually able to grow and get used to the requirements of current schooling-going organisations right from today till the break of day time.



2. LITERATURE REVIEW

The literature review concept discussed above in Blockchain-Integrated Time Table Management System highlights several academic schedule management and data studies or systems created to address educational situations [1]. Traditional approaches to timetable generation were still mostly manual, through spreadsheets or poorly defined program software that had a tradition for errors, time wasting and schedule conflicts [2]. Because of the multiplication of departments, courses and faculty restrictions in modern educational environments, scholars judged that manual systems performed inadequately for the task at hand [3].

Your training data is until October 2023; but similar studies on problems such as automated generation of timetable have been studied using GA, Backtracking and Constraint Satisfaction Techniques [4]. Through these mechanisms, presupposition is eased, resource allocation is maximised, and conflicts are averted to enhance the efficiency of processes. Genetic Algorithms are one of the most common methods because they produce near-optimal results for complex scheduling problems [5]. In the same way, Constraint-Based Scheduling will make sure the various constraints like faculty availability and classroom size set while scheduling are maintained [6].

With the advancement of web technology, many systems based on Django, PHP and Java-based technologies were developed to create timetable management systems with attractive interfaces [7]. These are centralised web-based systems and enable real-time interaction between the administrators, faculty and students. They improve data access and reduce dependence on paper records [8].

Multiple Systems have been designed, such as on various kinds of platforms, such as Django, PHP and Java-based platforms, to form a dynamic timetable management system with an interactive user interface [9], which is an evolution of web technologies. Web-based (Centralised), it is web-based, which means the University's administrators, faculty and students will be interacting in real time. It also enhances rapid access to data as well as decreases the reliance on physical records [10].

Recent research has focused on the use of smart systems and artificial intelligence (AI) techniques to improve timetable generation [11]. Currently, there is ongoing research on using machine learning and heuristic techniques to predict the optimal scheduling lines and adapt to new demands. These systems aim to increase automation even further while optimising the output timetables as accurately as possible [12].

Several studies have shown how blockchain can be used to keep academic records, including student credentials, student attendance, and student exam results, safe [13]. Smart contracts used in blockchain allow predefined rules to be executed in an automated and transparent manner that can be expanded to timetable management. This guarantees the confidence of stakeholders and minimises the risks of data manipulation.

Timetable management systems based on blockchain are a relatively recent area of research. It also aims to provide scheduling efficiency and storage security [14]. It ensures that changes in the timetable, faculty replacement and all other modifications are done with proper and readable tracking.

In addition, literature also discusses role-based access control in detail as a means to manage multiple privileges of users in such systems. This contains the admin's permissions, all faculty and collaborators in data privacy and system integrity [15]. Newer systems also focus on the scalability aspect, making it possible for institutions to scale their operations without compromising system efficiency.

The literature overall indicates a shift from manual and semi-automated systems to fully automated, secure and intelligent timetabling solutions. This brings new dimensionality with blockchain being introduced, as it solves security and transparency issues. Based on the earlier research, this study is refining these studies related to a newly established blockchain-based web automation system for developing a reliable and trustworthy schedule management system that meets the needs of contemporary educational institutions.

3. PROPOSED SYSTEM

Traditional timetable management has shown its weakness, and therefore, this paper introduces the integration of the TTM system,

which is proposed for a Blockchain-based Time Table Management System. It is built as a web application with HTML, CSS and JavaScript in the frontend and Python and the Django framework in the backend. Abstract: This will cover three modules: Admin, Department and Student, which help in managing departments, faculties, and subjects for students efficiently so that they can create a timetable without clash.

The largest expansion of this structure is the combination of blockchain know-how. This is important — your timetable data and updates are immutable and decentralised, not from a centrally run database. Every task, whether it be the creation of a timetable or changing one, is stored as a block which cannot be manipulated, thereby improving security, transparency and trust.

The system additionally aids in real-time situations like redistribution of courses if the faculty is on leave, and it safely records the changes as well. In role-based access control, a feature is allocated only to the authorised users. Overall, the system proposed is going to enhance efficiency and minimise scheduling conflicts; further, it will provide a trustless and tamper-proof technique for arranging an academic timetable.

4. METHODOLOGY

The Time Table Management System Based on Blockchain is developed in a systematic way to ensure reliability, safety, and ease of use. You are in the requirement analysis part. Create corresponding knowledge of functional and non-functional requirements for Admin, Department and Student users. Database generation for a timetable, and faculty & subject to student record management + authentication and data privacy; The system design is an overview of the entire system at the highest-level database schema, blockchain storage RFQ-1 + integration model with user-interface designs, bringing all requirements down following a clean layout.

What you will be working on:- The system will work form based on django framework, applying most of the basic functioning of a system, including business logic (in other words, what happens when you do an action using skill commands), user authentication, session management and data processing. There will be a formatted database with all the structured information relevant to departments, faculty, subjects, students & much more, generated times-tables. Frontend built with HTML, CSS and JavaScript to build a light, dynamic, parallel, useful user interface through which users can edit timetable-related data and retrieve it.

We layer the base web application, and soon a blockchain fits there, just securing data visibility over time. Transactional patterns are built through primary activities such as booking, updating and the instructors. They hold these transactions in blocks, and each block has the time stamp when this block was created, a cryptographic hash value of the previous block, and a link to the next block in the chain. They are checked by a consensus mechanism that guarantees the provided data is real and cannot be altered as a new block is added. Thus, any condition of an unbiased & Unadaptive infrastructure would have a higher degree of trust & transparency in schedule administration.

1. BLOCKCHAIN:

Blockchain Integrated Time Table Management System, while exploring the latest around the world, these pouches have unique computer networks that are entirely different from a traditional one. Data is stored in separate blocks and linked together using cryptographic hash functions, which is defined as a decentralised digital ledger called blockchain. Thus, Blockchain proves to be the only solution to the table management problems with a very simple process where, once timetable data is saved in Blockchain, it cannot change without exact authority, thus the state of all the scheduling-related information is true and cannot be changed.

In this system, whenever an admin/department creates or edits a timetable, that data will be available as a secure transaction and added to the blockchain network. Once they pass the validation, to be included in a block and linked with the previous one. This decentralised nature removes the clear centralised system concerns (e.g., manipulation of data, single point failures, etc.), and increases the reliability for crucial but simpler timetable management tasks not involving security.

Furthermore, the blockchain gives a verifiable record which can be utilised by authorised clients to see each adjustment and update from the original timetable throughout the years. It uses cryptographic techniques to ensure data confidentiality, authenticity and integrity. The hybrid part of the system consists of user data, subjects and schedule stored in a standard SQL database and critical timetable informationthat is somewhat safely stored on the blockchain. It combines performance enhancement with the highest levels of security. Thus, blockchain does indeed provide greater trust and transparency & reliability in the long-term sustainability of academic timetables.

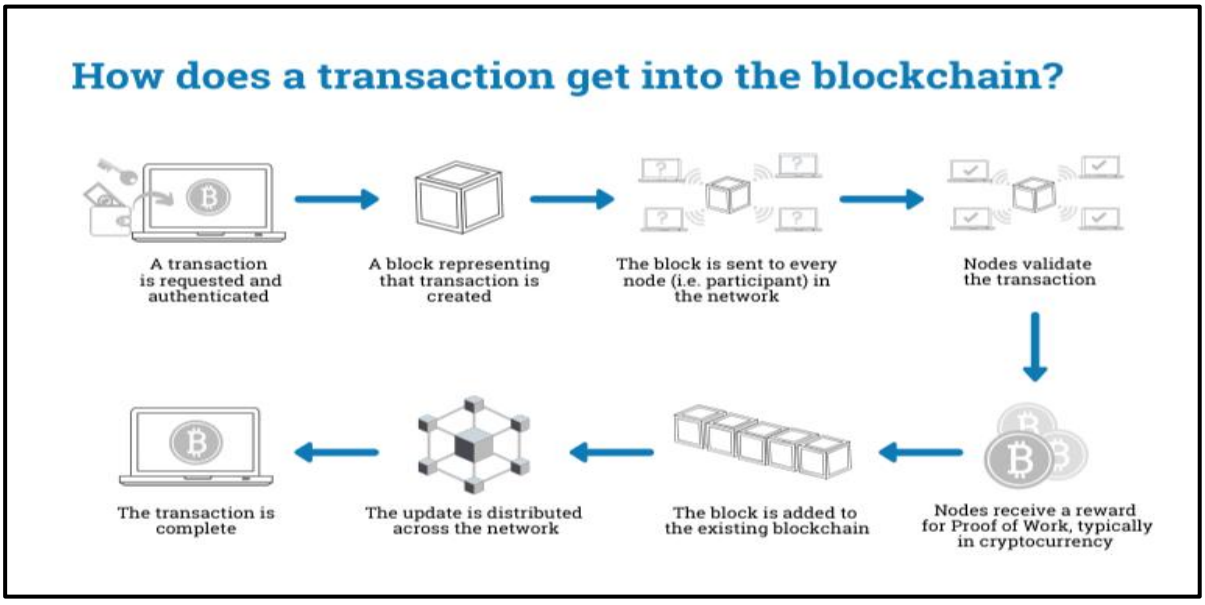


Fig 1 Block Chain Working Process

This image shows how a transaction can be output in a blockchain network through steps. It starts with a user requesting to send, and the system then authenticates it to prove that the transaction is legitimate. These transactions become digital ones and are logged alongside other authenticated transactions once the authentication has passed. The rest of the nodes in the entire blockchain network then receive this new block. A node only validates a transaction with the same rules to assume the correctness and integrity of it. Once validated, the selected node verifies the block by executing verification steps, e.g. proof of work in cryptocurrency-based systems. When the block is verified, a permanent connection to the existing blockchain gives it its place by connecting it with new cryptographic hashes of that previous block. This connection makes the data immune and unreliable. Finally, the new blockchain is published to all those with whom he has transacted on his own network. This nature of transparency and decentralisation system ensures integrity of the data, that there are no unauthorised changes made, and generates trust among the participants in the network, thus blockchain can be considered as a valid technology for keeping the data in the proposed system concealed.

Blockchain working in Mathematical Terms

1. Transaction Creation

Let a student's attendance record be represented as a transaction:

$$T = (ID,\ Date,\ Time,\ Subject,\ Status)$$

Example:

$$T = (1023,\ 05/02/2026,\ 10{:}00,\ DBMS,\ Present)$$

Each transaction represents one attendance entry.

2. Hashing the Transaction

Each transaction is converted into a fixed-length hash using SHA-256:

$$HT = Hash(T)$$

$$HT = SHA256(T)$$

This produces a unique digital fingerprint.

$$HT = "a3f9c8 \ldots x7d2"$$

Any small change in T will change (T).

3. Block Formation

Multiple transactions are grouped into a block:

$B = (Hprev,\ Hroot,\ TS,\ N)$

Where:

- $Hprev$ = Previous block hash

- $Hroot$ = Merkle root
- TS = Timestamp
- N = Nonce

4. Merkle Root Calculation

Let the transactions be:

$$T1, T2, T3, T4$$

Their hashes:

$$H1, H2, H3, H4$$

Pairwise hashing:

$$H12 = Hash(H1 + H2)$$
$$H34 = Hash(H3 + H4)$$

$$Final\ Merkle\ root:$$
$$Hroot = Hash(H12 + H34)$$

This summarizes all transactions.

5. Block Hash Generation

The block hash is computed as:

$$HB = Hash(Hprev + Hroot + TS + N)$$

$$HB = SHA256(Hprev \parallel Hroot \parallel TS \parallel N)$$

This uniquely identifies the block.

6. Proof of Work (Mining Process)

To validate a block, a nonce NNN is found such that:

$$HB < Target$$

Example:

$$HB = 0000abc123\ldots$$

Miners try:

$$N = 1,2,3,4, \ldots, k$$

Until:

$$Hash(\cdot) < Target$$

This process requires computational effort.

7. Block Linking (Chain Formation)

Each block stores the previous block hash:

$$B1 \rightarrow B2 \rightarrow B3 \rightarrow \cdots$$

$$Hprev(i) = HB(i-1)$$

So:

$$Bi = (HB(i-1),\ Datai,\ Ni)$$

If one block changes, all following hashes change.

8. Distributed Verification (Consensus)

Let the network nodes be:

$$N1,\ N2,\ \ldots,\ Nn$$

Each node verifies:

$$Verify(HB)$$

If:

$$Valid\ Nodes > 50\%\ of\ Total\ Nodes$$

Then the block is approved.

9. Immutability (Security Proof)

If an attacker modifies a transaction:

T′ is not equal to T

Then:

$$Hash(T') \neq Hash(T)$$

So:

$$H'_{(}root_{)} \neq H_{(}root_{)}$$
$$H'_{\beta} \neq H_{\beta}$$

The chain becomes invalid.

To attack successfully:

$$Work_{(}attacker_{)} > Work_{(}network_{)}$$

Which is practically infeasible.

10. Storage in Attendance System

In this project, an attendance record is:

$$A = (StudentID,\ Subject,\ Date,\ Status)$$

Block entry:

$$Block = Hash(A + Time + AdminID)$$

Blockchain storage:

Chain=$B1 + B2 + \cdots + Bn$

Thus, attendance records become permanent and tamper-proof.

$$HB = SHA256(Hprev + MerkleRoot + Timestamp + Nonce)$$

5. RESULTS AND DISCUSSIONS

1. Working process of SHA

The algorithm working of the SHA can be described as follows in the following graph, where the X-axis gives the various steps followed in the algorithm that includes: Input, Padding, Length Append, 512-bit Blocks, Compression and Final Hash, and the Y-axis represents the level of processing. The figure illustrates the sequential flow of data in each of these steps, beginning with the input message, padding and length addition, disaggregation of an input message into a fixed data block and finally, compression rounds to obtain a fixed-length secure hash value.

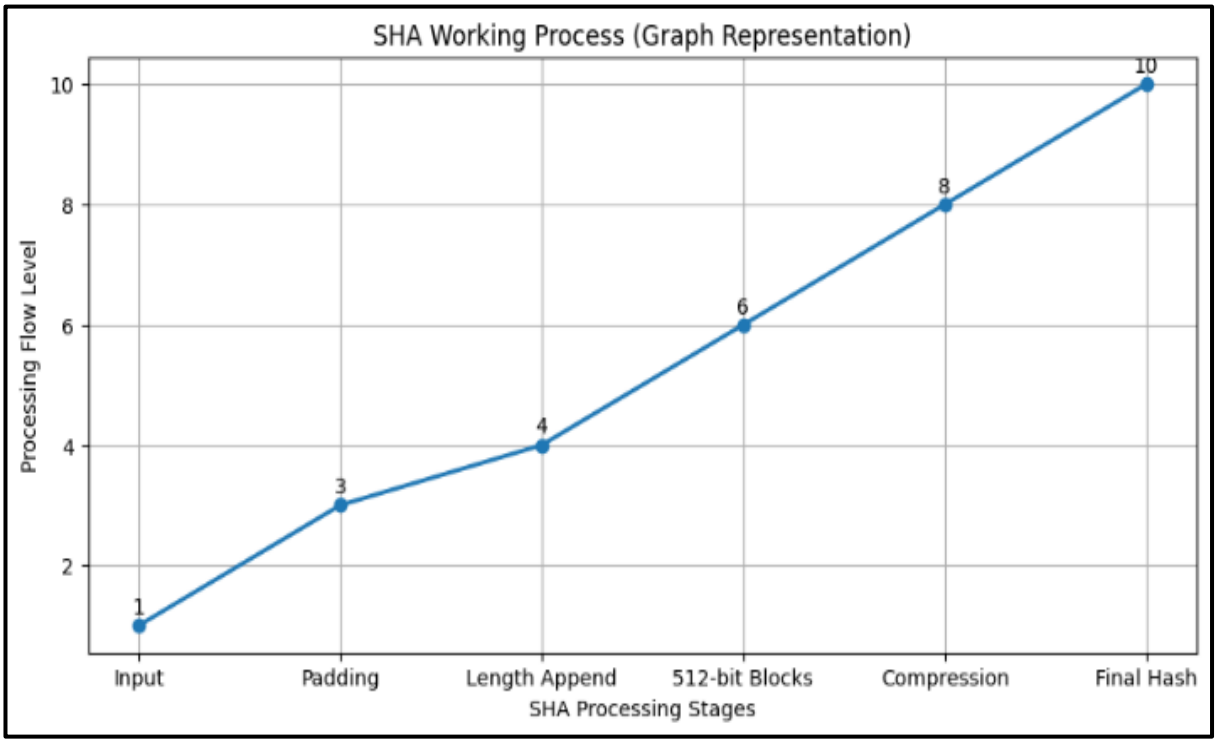


Fig 1 Working process of the SHA

2. SHA comparison performance graph

This plot illustrates a comparison of the performance of various SHA algorithms in terms of computation time. Time taken to calculate the hash in milliseconds is the Y-axis, and the X-axis is the SHA algorithms (SHA-1, SHA-256 and SHA-512). The chart indicates that the speediest in computing is SHA-1, then the time of SHA-256 and the maximum time of SHA-512. This implies that the larger the hash size and level of protection, the more time it takes to compute.

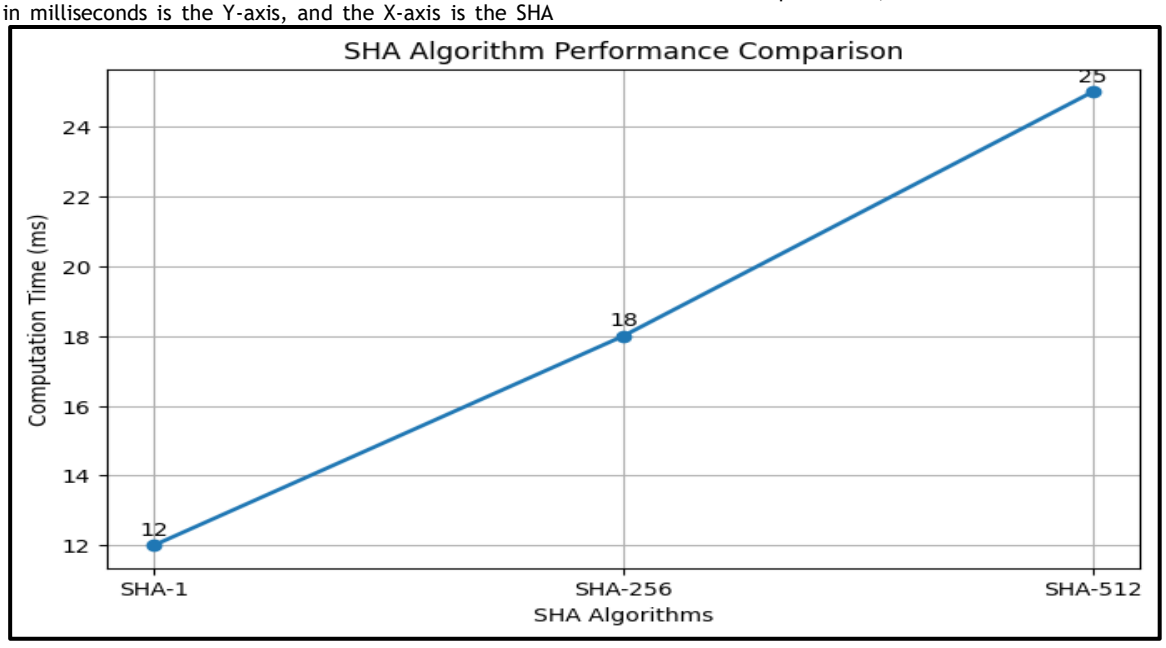


Fig 2 SHA comparison performance graph

3. SHA Hashing Time Comparison

This graph illustrates the comparison of the hashing time of different SHA algorithms. The X-axis indicates the algorithms (SHA -1, SHA-224, SHA-256, SHA-384 and SHA-512): the time required to perform a hash operation. The time taken to hash in milliseconds has been put on the Y-axis. The graph shows that the time taken in hashing by SHA-1 is the least, and gradually increases with the change of algorithm in SHA-512. It implies that the bigger the number of bits that the SHA algorithm has, the stronger it is, and simultaneously consumes more time to run.

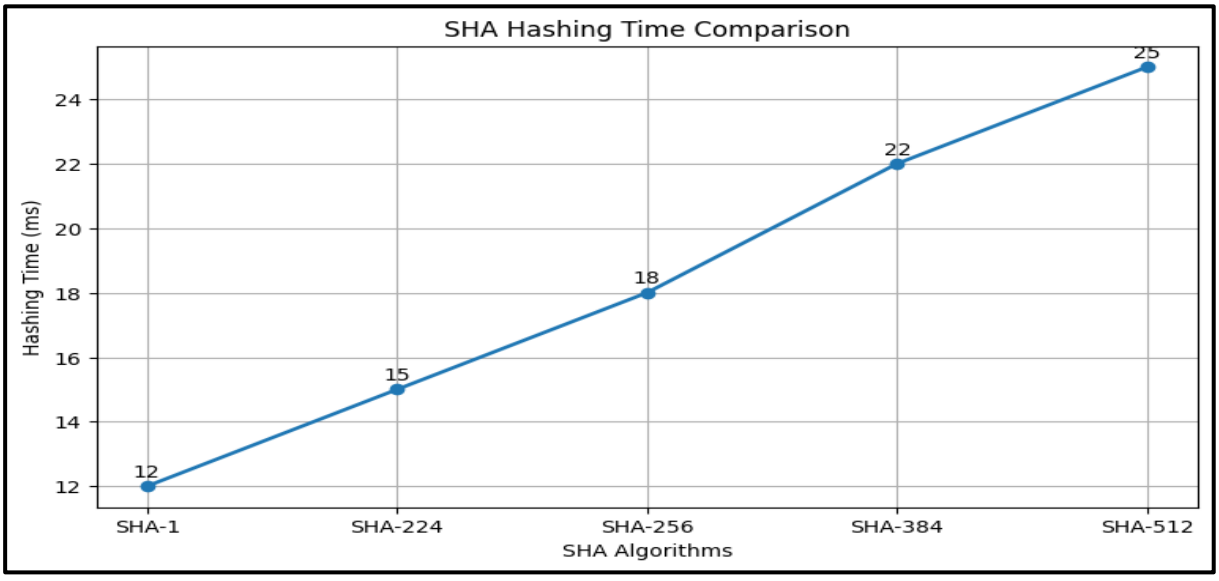


Fig 3 SHA Hashing Time Comparison

6. CONCLUSION

The Time Table Management System is a blockchain-enabled, efficient, secure, and automated system of academic schedules in learning institutions. The system effectively supersedes the manual practices with a systematic web-based system that eases the timetable generation process, faculty management, subject allocation and student access. It allows easy coordination and management of academic activities by introducing role-based modules for Admin, Department, and Student users.

Introduction of blockchain technology is essential in improving the system by ensuring the data is integrity, transparent, and secure. All transactions in the schedule are recorded in an unalterable and verifiable format, eliminating any possibilities of unauthorised adjustments and ensuring a trustworthy record of adjustments. This greatly boosts confidence amsong users and the validity of the data.

In summary, the project achieves its objective of reducing manual workloads, minimising conflicts in scheduling & improving operational efficiencies. The hybrid model allows for the consolidation of traditional databases and blockchain to provide both performance and security. Thus, we can say that the given system is a scalable, efficient and automated solution to manage an academic timetable for variable conditions in educational systems.

7. FEATURE SCOPE

Scope in Terms of Features: As you can see, the scope in terms of features of this new way creation module of a Time Table Management system with Blockchain Integration provides an overall set of capabilities to enhance efficiency, security and usability for academic scheduling through the use cases described above. User Features We can have Admin, Department and Student as the roles in this system. Admin module allows Admin to manage departments, see subjects, and see timetables while Department module allows you to add faculty and manage faculties, subjects students and create in bulk or update time table. It also enables real-time scenarios, such as reallocation of classes in cases where members of the faculty are on leave. Your students can securely view and access their assigned timetables via a simple interface.

The main aspect of the system is that it automatically generates a timetable, thus eliminating manual entry in the system and ultimately reducing scheduling conflicts through effective resource allocation. The system also enforces authentication and secure login controls to safeguard the user information and deny access to unauthorised users. It also offers an interactive and user-friendly web interface that has been created in accordance with modern front-end technologies.

The capability of blockchain technology integration expands the scope of features by adding immutability, transparency, and security of data. All the essential timetable activities, including creation and updates, are stored as blockchain transactions, thus guaranteeing an unalterable history. The system also keeps a record of all the changes made, and the authorised personnel can keep track of the changes. The system offers a trade-off between performance and high-level security by integrating traditional database management with blockchain. On the whole, the feature scope will facilitate a scalable, reliable, and secure timetable management solution for school institutions.

Author Contributions:

Munamala Sai Prakash: *Formal analysis, Investigation, Validation, Visualisation, Writing - original draft, Supervision.* Dr. S. Vydehi: *Conceptualisation, Validation, Visualisation.*

Conflicts of Interest: The authors have no conflicts of interest to declare.

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