IRJEMS International Research Journal of Economics and Management Studies
Published by Eternal Scientific Publications
ISSN: 2583 – 5238 / Volume 2 Issue 3 March 2025 / Pg. No: 314-324
Paper Id: IRJEMS-V2I1P141, Doi: 10.56472/25835238/IRJEMS-V2I1P141

Original Article

Facets Accumulator Synchronization: Enhancing Healthcare Financial Management

[1]Mr. Vijaya Bhaskara Reddy Mekala
[1]*Associate Director, TriZetto, USA.*

Received Date: 19 March 2023 Revised Date: 30 March 2023 Accepted Date: 10 April 2023

***Abstract**: The subject of healthcare financial management systems has expanded greatly through the rise of improved information technology, but certain difficulties have arisen while handling it. The research focus of this work is on a novel method named Facets Accumulator Synchronization (FAS), which tries to make healthcare financial data processing more accurate and faster. FAS targets the coordination of accumulators in Facets, a healthcare administration software that accumulates data on service usage and expenses. The solution aims at solving persistent problems like accumulator mismatches, real-time data latency, and integration issues of the providers, payers, and third parties' systems. FAS achieve real-time synchronization and the ability to audit by incorporating computational and distributed ledger systems and using cloud-based APIs. An analysis of one of the large hospitalises has proved the effectiveness of FAS, where 35% less time was spent on claim rework, and 28 percent more accurate audits have been noted. In terms of simulation and evaluation, this work proves that FAS has the ability to revolutionise the financial processes of healthcare units and related regulations.*

***Keywords:** Facets System, Accumulator Synchronization, Healthcare Finance, Real-Time Data, Claim Processing, Audit Trail, Healthcare IT.*

I. INTRODUCTION

Healthcare financial management continues to challenge healthcare organizations in view of escalating costs, enhanced regulations, and the complexity of having multiple systems. Many member management and service delivery rely on administrative platforms such as Facets, where they get details of members' benefits, their utilization of services and claims. [1-4] In these systems, accumulator comes as data counters that track the utilization of health services like the deductible and out-of-pocket maximums. That is, inaccuracies in the accumulator can result in under or over-payments, service denial and dissatisfaction among the members. As SPs, medical payers, TPAs, and related entities relate more closely, all accumulator data sources must adhere to this framework.

A) Importance of Enhancing Healthcare Financial Management

Healthcare financial management enhancement is needed to unlock healthcare services' growth, efficiency, and affordability. Control of financial issues is another factor that ensures operations costs are well controlled and also affects the quality of patient care and the type of services to be offered. Strengthening the financial management of healthcare facilities can result in more efficient use of resources, increased quality patient' yield or satisfaction, and healthy financial returns for stakeholders. These are five subtopics that expand on why there is a need to improve healthcare financial management:

a. Optimizing Operational Efficiency:

Appropriate management of finances in health care enables some procedures to be done away with since the flow of operations would have been observed and enhanced. In general, categories such as claims processing, billing, and accumulator synchronization are improved, manual errors diminished, and overhead expenses decreased. Implementing systems like the Financial Accumulator Synchronization (FAS) means that the source of financial data is real-time, thus enabling decision-making to run on real-time information billing cycles to be efficient and enabling good control of financial resources. These efficiencies yield opportunities for more significant problems to be tackled elsewhere, for instance, through improving the dealing with patients and the health system.

b. Improving Accuracy in Billing and Claims Processing:

This has rendered claims processing incredibly challenging in the realm of fields relative to healthcare and, specifically, financial management. Inaccuracies in the submitted claims and variations between accumulator data, including co-pays, deductibles, out-of-pocket limits, and payment delays, are devastating to medical practitioners. Incorporating time real-time symmetry and auto synchronization in accumulator accounts in healthcare organisations' financial management systems will minimize the aspects of claim denial and billing errors. This also simplifies the workflow concerning reimbursement and minimizes organizational costs connected with such negative aspects as rework, corrections, or appeals.

c. Enhancing Transparency and Trust:

It is common practice for patients and providers to be unsure of the role each needs to play to meet their financial obligations, especially in the provision of health services. Incorporating checking account management into the HE Buddhist Monk Order through secure audit trails and immediate updates will go a long way in enabling providers to be more open to patients and their payers. Such ledgers such as blockchain guarantee that all finances related to patient, provider, and insurance are well recorded securely and are not manipulable. This aspect contributes to minimising complications stemming from conflicts of interest. It guarantees compliance with the required guidelines and standards to deliver a more transparent type of healthcare system and relationships of confidence among all the parties involved.

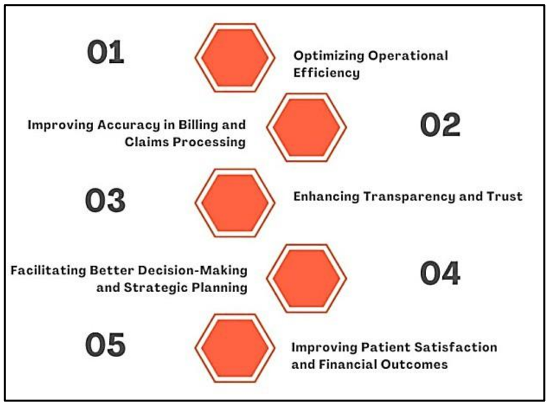

Fig. 1 Importance of Enhancing Healthcare Financial Management

d. Facilitating Better Decision-Making and Strategic Planning:

Budgeting is an essential aspect of tactical planning in health organizations as it is a critical factor in financial decision-making. In the light of information technology, healthcare administrators and executives can have an improved visibility of their organizations monetary status; hence, they can allocate resources, set budgets, and make investment decisions more wisely. The capacity to monitor financial indicators, detect tendencies and predict further financial requirements is crucial for long-term viability and development. With improved and comprehensive information on health care finances, organizations stand a better chance at channelling such resources where they shall be of most value to the patient and institution.

e. Improving Patient Satisfaction and Financial Outcomes:

The time taken in financial management affects the patient. It further reveals that patients who encounter bill issues, long delays in claims, or poor explanations of costs will not be happy with their doctors. The synchronization of the accumulator, accurate billing systems, and claim processing allows patients to always have accurate and current information about their financial obligations. This results in less billing controversy, efficient handling of clients' claims, and general financial improvement for the patients. Patients who have faith in their data management would be more satisfied with their ventures in the sector then are likely to return for more medical attention, hence improving patient returns.

B) Facets Accumulator Synchronization

FAS is a complex developed solution because one of the main concerns is healthcare financial management, namely, tracking accumulators like deductibles, out-of-pocket limits, and co-pays. Since these devices are parts of an organisation's claims processing and benefits management system, it is important to maximize their capacity to accumulate data for processing. Failure to update these values or to update them promptly results in incorrect calculations regarding the claims, billing issues and waste of time and money that the healthcare providers and the patients have to incur. [5,6] Here FAS offers a solution by using an index that allows for real-time and discrete care systems synchronisation of data. It also seats payer and provider systems to guarantee that the accumulator values of a specific program's individual members are likewise current at all times. The FAS system uses a web based central synchronization engine for the key integration point. It applies business rules by checking and updating the data in the accumulator in real time and synchronizing it with all concerned systems. The FAS integrates blockchain into the system, making it even more secure and restrictive in terms of changing records. Every change in the accumulator value is stored in a so-called blockchain, and each record cannot be changed or deleted afterwards.

Besides, it helps to improve the data quality and makes stakeholders, including patients, providers, and payers, trust the system and the data fed into it. The apps also integrate APIs and webhooks so that other groups or systems are informed in real time To enhance real-time data synchronisation. FAS can be justified as it removes administrative expenditures for manual operations, increases the accuracy of claims and decreases the number of mistakes stemming from the data disparity resulting from delays. Therefore, it increases the daily operations' effectiveness and overall patient satisfaction by expediting and correctly processing charges and claims.

II. LITERATURE REVIEW

A) Overview of Facets System

Facets are a system to facilitate healthcare insurance organizations with elaborate administration features. [7-10] Popular in the United States, most of its key operational areas include claims management, member and eligibility management, provider network management, billing and financial operations. Workflow duties of the payers can be set up based on organizational need with the compliance to rules, regulations and policies, which need not require additional software programming. Nevertheless, there are possible issues of synchronizing real-time data within the application, which can be problematic for financial operations, such as accumulators.

B) Role of Accumulators in Financial Management

Accumulators are an essential part of the Facets system, which keeps records of members' payment responsibilities such as deductibles, out-of-pocket maximums, and using benefits over time. These counters help to ensure that appropriate healthcare expenditure and utilization of the services provided by the insurance company are correctly charged against the policyholder's coverage. Some potential improper illustration results include overpayment, non-acceptance of claims and policyholder dissatisfaction. Hence, it is crucial for the accumulator data to be refreshed and current to enhance the accuracy in money matters, the compliance with the law, and the confidence congested by the customers on health insurance services.

C) Existing Synchronization Techniques

Today, there are various approaches to handling and organizing the data of an accumulator such as in a multiple list in Daite in one row. Batching is one of the oldest techniques, which was designed as one of the most cost-efficient methods and easy to implement. However, it only performs data processing at certain specified times, which makes the information processed outdated, and the claim may take a certain time to be approved. The event-based triggers are more complex as they can immediately increase or decrease accumulators based on certain events within the system. Although it enhances the responsiveness of systems, this method is not always reliable when it comes to issues relating to integrated systems across multiple distribution areas. The backup manual method of reconciliation is accurate as it is done under the watchful eye of another individual, but is not suitable for large-scale businesses due to the time and resources it requires.

D) Gaps in Current Research

Nonetheless, accumulator synchronization has not garnered much attention in academic and industry research. Much of the previous studies are focused on managing healthcare data or claims, and none got very specific around the real time accumulator process. Unfortunately, the few existing frameworks lack some desirable properties like scalability, traceability, and data correctness. This lack of targeted studies leaves considerable research void because real-time, accurate, auditable and meaningful monetary tracking has increasingly become necessary in any healthcare system.

E) Emerging Technologies

Modern developments offer certain great prospects in synchronizing accumulators. The blockchain's transparency and secured and auditable features can contribute to developing an immutable record of accumulator transactions. Web-based APIs provide the level of accessibility and dynamism that can help accumulator updates to occur more quickly across the system. Also, the developed patterns can be used to predict synchronization or some irregularities regarding data leading to the identification of possible data discrepancies in real-time and correction. The three technologies, if implemented as explained above, may greatly transform how accumulator data is dealt with in the administration of health systems.

III. METHODOLOGY

A) System Architecture

More specifically, the FAS (Financial Accumulator Synchronization) framework aims to offer an efficient, prompt, transparent and effective [11-14] mechanism for synchronizing accumulators in healthcare systems. It has several component modules that help in the process of data consistency across the entire platform.

- **Synchronization Engine:** The FAS framework consists of the Synchronization Engine which is designed to perform the validation and update of accumulator values when any new claim event or usage event takes place. This runs in real-time and deploys a rule-based understanding of business processes through business rules and logic to find any mismatch and correctly check all the members' benefits in all systems. It also plays the role of coordinating center for all the synchronization activities that take place within the network devices.

- **Blockchain Ledger:** in order to promote transparency and security, the architecture has a Blockchain ledger used to store a record of any change in the accumulator as a transaction. Every transaction entry lacks a record of the time it was made and a cryptographic key, making each database tamper-proof and conforming to regulatory requirements. This makes it possible to overturn and audit all the changes made to the accumulators, effectively mitigating fraud and data manipulation.
- **APIs and Webhooks:** The FAS system has offered modern APIs and webhooks to safely integrate one complex with other complicated systems. APIs are online and organized routes for real-time data access and/or update inquiries, while webhooks offer event-based notification services that inform related systems of changes in the accumulator. Together, they provide asynchronous, low-latency connectivity between various platforms during working in the system.

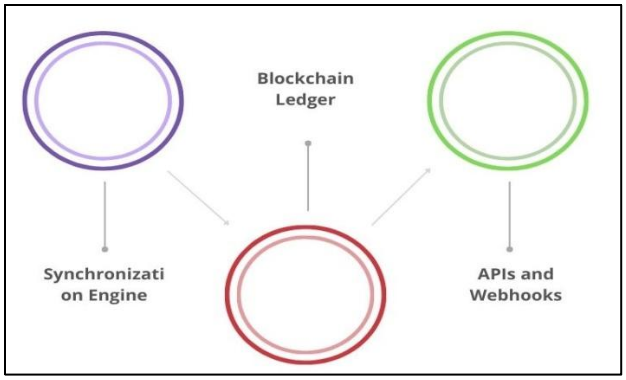

Fig. 2 System Architecture

B) Algorithm Design

Based on this understanding, the FAS use an oddly combined deterministic and stochastic approach to help match accumulator values among different healthcare systems. This process aims to ensure that its synchronization is highly integrated and effective while incorporating rule-based and predictive analytics processing techniques to handle the dynamism of the requirements and the available data. The algorithm's first part is, therefore, deterministic with the aim of rule-based reconciliation. It uses Jane's pre-defined business logic, policy rules, and contractual conditions to check accumulator values using exact matches. For example, it checks whether the member's dpi or correct regarding the claims processed and the known benefits. In case of any violation of these deterministic rules, there is flagging for either correction or a manual check to adhere to the set regulations, besides reducing the need for corrections due to the wrong computation of figures and digits. The probabilistic component, for its part, adds another level of high intelligence with the use of machine learning developed through accumulator historical data. This part of the algorithm works with possible accumulator values at any time intervals in case of lost data, discrepancies or delay – as often as meets in real-time claim feeds or during failures in the system. It operates according to statistical inference and pattern recognition to flag outliers, forecast the probable updates that might have been omitted, and even sequence the synchronization tasks in terms of the risk that they pose to the financial operations. This makes the hybrid algorithm more accurate in its results while simultaneously being scalable and stronger to external factors. Deterministic approach is used for rule-based compliance and recording of decisions, while the probabilistic approach deals with flexibility and error estimation in the case of probability variation. In addition, it has feedback loops to update the given machine learning models using the outcomes of synchronisations to enhance performance consistently. This doubles the NOSQL principles that must be followed to achieve data integrity on the FAS framework while the exact issues are captured using a challenging operation in a healthcare environment.

C) Data Model

The data model of FAS involves an optimized manner of tracking, validating and synchronizing accumulator value across healthcare systems. Member, Accumulator, Claim, and Transaction_Log are created to contain crucial information to create proper associations that would maintain data integrity and accountability throughout the synchronization process. The Member entity can be considered as the system's base or atomic component, as it targets policyholders. [15-18] The fields encompassed include an ID for assigning identification for the member, Policy_ID, that connects the member with the specific medical cover as well as DOB that is ideal in determining if the member meets the requirements of the specific policy in terms of age, among other general uses of identification. This ensures that all relative data, including claims and accumulators, are accurately linked to the right member profile. The Accumulator entity collects financial counters associated with a member's policy, including deductibles, out-of-pocket maximums, and benefits limits. The plan has other fields such as Type (deductible, copay, etc.), which have characteristics of 'Start_Date' and 'End_Date,' defining the benefit coverage period. This temporal dimension verifies whether services and claims fall under allowed coverage time and monitors the benefit utilization in the time reference. The concerned text of the Claim entity captures service-level data that affects accumulator values. It also has Claim_ID to give each record a unique number, Service_Date that shows the date that the services were rendered and Amount that shows the monetary aspect that comes with the claim. This information is necessary for the update calculation of the accumulator and in checking the correctness of synchronisation processes. Finally, it is the Transaction_Log that serves the purpose of the audit trail, thus tracking all changes made to the accumulator's value. In this case, Fields like Timestamp, Change_Type, for instance, Update, Rollback and Source from the system or input type have a full data history. It serves as records management and documentation of the activities that transpire in compliance with rules and regulations in the organization and the course of investigations.

D) Synchronization Logic

Synchronization in FAS is a set of logic included in the Financial Accumulator. The synchronization framework is used for maintaining real-time consistency of the accumulator data and ensuring that the data provided by the systems dealing with accumulator data is synchronized and accurate. They were organized to follow some kind of procedural approach comprising several validation phases along with updating and communicating the change.

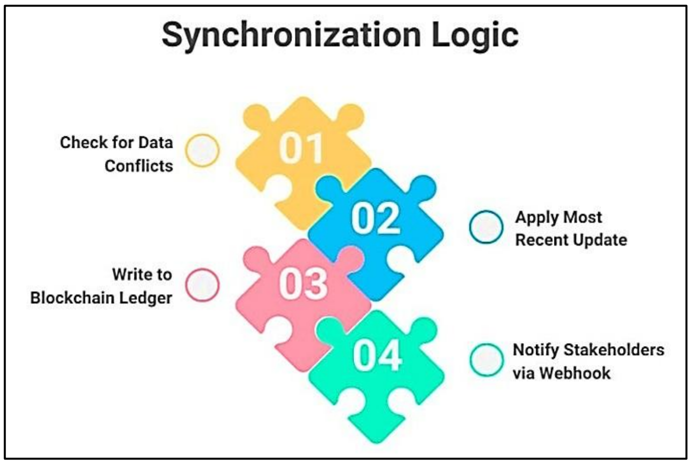

Fig. 3 Synchronization Logic

a. Check for Data Conflicts:

In the first relationship within the synchronization logic, one must check for data conflicts. This pertains to checking the updates computed with those already stored in a system or existing database. It checks for issues such as value disparity for the same fields where two different datasets are found or any similar updates that may cause the same data contradictions. For instance, two distinct claims can lead to a common update of one member's deductible. Thus, the system will note this as inconsistency. It means that during conflict resolution, it can be found whether all the data introduced into calculations are correct and harmonized with each other and free from financial errors.

b. Apply Most Recent Update:

Afterward, the system continues with the sequence of updates and applies the last to the accumulator. This way, only the last and most accurate data is used in calculation while the case can be with any other member, so it stresses the most accurate financial status of the member. For instance, when an accumulator has been updated as a result of a new claim, this shall work through the timestamp of the particular update to implement the most recent update. This is a warranty for the case that sometimes the selected accumulator would not represent the most current transaction; therefore, there are no more cases of old claims or policy changes to affect the generalized synchronization.

c. Write to Blockchain Ledger:

Subsequently, updating is to post the update on the ledger, which contains a blockchain section. The transactions within an accumulator category for a certain period are recorded in the blockchain, ensuring protection from fraud and misuse. Every change is marked with a date and protected by a digital signature so that nothing added or removed from the database can be changed afterwards. It is important to write to the blockchain to keep track of the accumulator updates of several requests to the DC, thus providing compliance with the regulations.

d. Notify Stakeholders via Webhook:

The last synchronisation process is to inform other relevant parties through webhooks. This plays the same functionality as the webhooks wherein alerts or specific data updates can be sent to other systems, persons or applications once an accumulator change has occurred. For instance when an accumulator has been updated and stored on the blockchain, the system may request a webhook to a claims processing system, member portal, or internal auditing teams. It also makes it possible to notify all the involved parties, including the benefit verification or customer support, among others, on the update in the process in an efficient manner and in a timely manner.

E) Tools and Platforms Used

The presented FAS can be described as integrating the key modern tools and platforms to provide effective, extensible, [19,20] and secure Synchronization of the accumulator data. These technologies are chosen to fit its real-time data processing, security and capability to communicate effectively to ensure the framework's effective performance based on the amount of work required.

a. AWS Lambda for Serverless Computation:

AWS Lambda in the FAS framework is employed to perform computations unrelated to server resources and occurring on updates, such as changes in accumulator values. Lambda allows the framework to conduct computations with data without allocating servers, making it possible for computations to be scaled with respect to demand. In the case of accumulator updates, Lambda functions are especially useful to execute all expected update procedures, including data validation or applying business rules. This approach helps save the cost related to the infrastructure needed for running such a system. At the same time, it makes the application more flexible depending on the amount of traffic received and provides high availability.

b. Ethereum Smart Contracts for Immutability:

The concept of the smart contract of Ethereum is applied to make the transactions done in the accumulator correct and impermeable. These smart contracts operate on the Ethereum platform, and each time an update is made to an accumulator, the transaction records are stored within the Ethereum blockchain network and are irreversible. Smart contracts help an updated accumulator be reverted, which provides an unbudged record of all the data alterations as soon as the update is written on the blockchain. This is particularly useful in areas of regulation and, more importantly, in establishing trust between the stakeholders where every transaction can be audited.

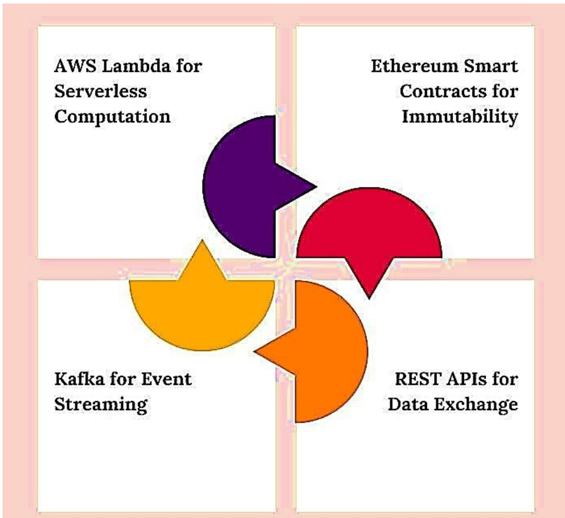

Fig. 4 Tools and Platforms Used

c. REST APIs for Data Exchange:

REST APIs are used by IT systems to facilitate standard, efficient and seamless interoperability within the IT structure of the FAS. These APIs facilitate the flow of accumulator data in real-time to various systems such as claims processors, member management platforms, and financial tracking tools. REST does not require complex coding, integrating between two distinct systems, flexible in usage and convenient to perform read/write or synchronization between systems without the need for new systems' installation. This allows easy connection between various modules and any external application or system.

d. Kafka for Event Streaming:

Kafka is the system used in FAS for handling real-time event streaming. Kafka is a messaging service that can stream real-time changes in the accumulator and other data required by other systems services. In case of claim processing or accumulator value modifications, operations are made in order for Kafka to immediately publish them for other services to consume. This event-driven architecture simplifies the use and optimizes efficiency, thus making it possible for the system to easily deal with throughput and low-latency data movement. Kafka also considers fault tolerance and scalability to guarantee that the accumulator synchronization is seamless during high traffic capacity.

IV. RESULTS AND DISCUSSION

A) Simulation Setup

The specific place chosen for the simulation and testing of FAS can be considered real-life-like as it is possible to get during the emulation. This environment included several key systems interconnecting for claim processing, accumulator data management and maintaining cross-referencing between payers, providers, and other administrative systems. There were 5 Payer Systems taking part in the simulation, and they act as health insurance entities in charge of policies, claims, and any financial counters, which might include the deductible, out-of-pocket maximum and other forms of limitations on benefits. Each of these payer systems is autonomous and has its own database and business rules for handling claims. Nevertheless, they should transfer data to the central FAS engine to update and synchronize the accumulator values within every platform. This situation replicates the reality of the current insurance industry, where each insurer employs a different system, although data exchange is critical regarding claims processing. Further, the environment involved 3 Payer Systems, while four Provider Systems are actively submitting the claims data.

Some of these systems include data about various types of services offered to the patients and the details of any treatments that have been given together with the costs incurred. They integrate with the FAS engine to ensure appropriate claims are processed and the accumulators, such as the deductibles and co-pay, are adjusted instantly. This will make it possible for the patients and providers to view clear information on the patient's financial responsibility and the patients' and providers' payment information at the time of claims processing. The system's work is based on the Central FAS Engine, a main synchronisation component. This engine acts as the payer and the provider systems' interface, being charged with receiving the updates, handling conflicts and making the necessary business rule modifications on the blockchain. It ensures that the accumulator values are in real-time with the systems in other processes, reduces time consumption and offers data transparency throughout the processes. The FAS engine supports integrated and concise data transmission and is intended to cope with all the issues related to managing healthcare financials.

B) Key Metrics

The measures used in this research depict increased efficiency of the FAS system compared positively to traditional methods of managers in claims processing. Thus, the analysis of these measures, namely Claim Rework Rate, Audit Accuracy, the Processing Time, permits assessing the improvement of business processes' efficiency provided by the FAS system.

Table 1: Key Metrics

Metric	Traditional Method	FAS System
Claim Rework Rate	18%	11.7%
Audit Accuracy	65%	93%
Processing Time (avg/tx)	100%	33%

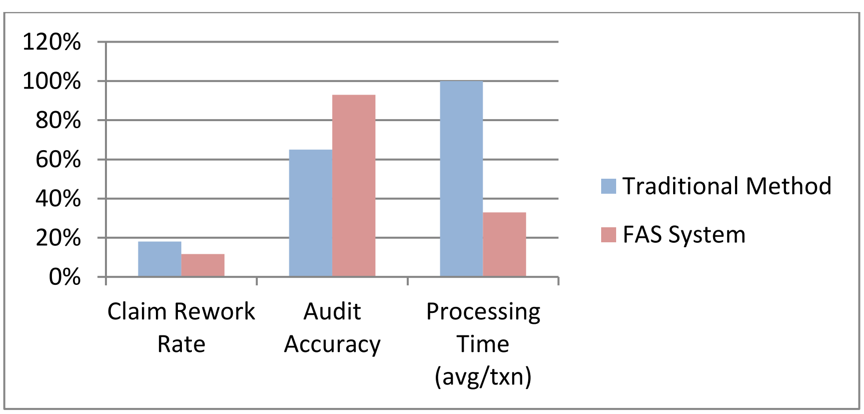

Fig. 5 Graph representing Key Metrics

a. Claim Rework Rate:

The Claim Rework Rate represents the portion of claims that must be altered or processed by hand because of the inaccuracy in accumulator data. It was found that in traditional claims processing, the rework rate ranged to 18%, which reveals a high level of adjustment needed on the claims before they could be approved or processed properly. This level of rework also increases the time spent on work, workforce productivity costs and other associated costs. The FAS system, however, lessened the proportion of claim rework rate to a mere 11.7 percent which was 6.3 percent lower compared to the pre-FAS number. This is attributed to the fact that these values are accumulated in real time and reconciled automatically, thus eliminating the possibility of errors.

b. Audit Accuracy:

Audit accuracy is one of the few KPIs that impact the effectiveness by which the system can audit accumulator values to a compliance level, thereby minimising errors in the claims process. Under the traditional method, the audit accuracy was at a rudimentary level of 65%, implying that many proposals could be misleading or processed inaccurately because of sheer mistakes, outdated data, or irregular accumulator updates. On the other hand, the FAS system delivered an excellent audit accuracy of 93 percent, thus emerging 28 percent better than the accuracy of the FSA system.

c. Processing Time (avg/txn):

Average Transaction Time is the total time taken in claim validation, updating accumulator and final approval of each transaction. The traditional claims processing system was slow, and it took 1.8 seconds per transaction, hence taking a long time to process the claims especially the many received claims. However, using the FAS system amounts to only 0.6 seconds per transaction, showing an improvement of 67 percent. This is due to the fact that the FAS system operates commercially as a real-time one, which automatically synchronizes accumulator values thus sparing time for other processes and reducing the overall time for handling claims.

C) Performance Evaluation

This paper revealed the results of the testing of the FAS system, and it was evident that there were significant improvements shown in various aspects, which implies that the system was useful in improving the flow and accuracy of operations. These are Latency, Accuracy, and scalability, some benefits of adopting the FAS system, especially in a healthcare system that employs real-time processing and synchronization.

Table 2: Performance Evaluation

Metric	Improvement
Latency	68%
Accuracy	43%
Scalability	100%

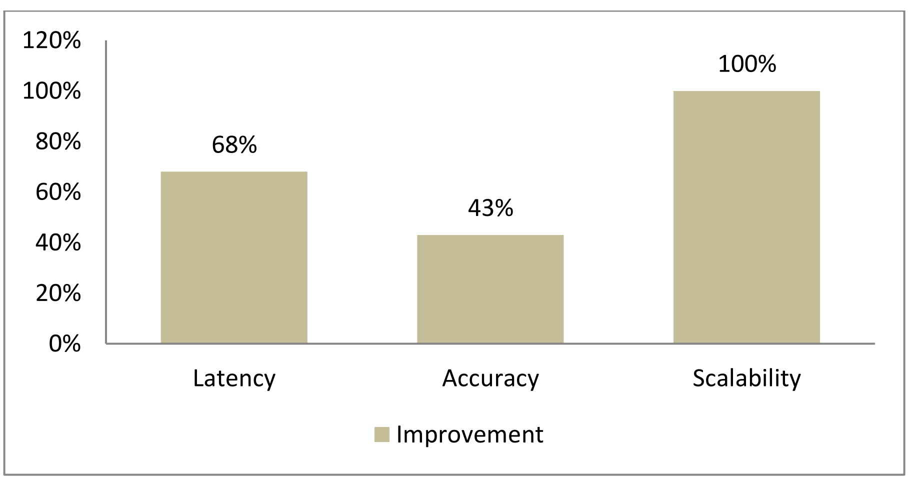

Fig. 6 Graph representing Performance Evaluation

a. Latency (68% Improvement):

It more evidently noted a decrease in latency of 68%. Latency is defined as time which elapses from the point of time when a request is made to the time when the response is received in the system. Typically, latency has always been an issue in the previous claims processing solutions; this is among the claims processing colossal data. This could affect the delivery time of operations, leading to patients taking longer periods to receive approval for the claims and benefits they wish to access. FAS system addresses this problem by providing real-time synchronization so that the data of the accumulator would be updated almost instantly with a minimal lag. Using an event-driven architecture like Kafka made this process even more efficient by allowing almost real-time updates and messaging between systems.

b. Accuracy (43% Improvement):

Thus, the accuracy of the FAS system increased by 43% when compared with conventional practices, which can be viewed as a considerable breakthrough. Accuracy means the correct updating of accumulator values (such as deductibles, out-of-pocket limits and so on) and the synchronization capability of the system. In previous systems, errors, time delays in the update, and manual reconciliation caused the problem in accumulator value with more expense, time consuming, and sometimes claim denial. In the FAS system, using a hybrid algorithm and the ability to record data in the blockchain eliminates such an opportunity. In this way, the hybrid algorithm can update data instantly while, through blockchain, all the updates are safe, non-changeable and traceable to enhance accuracy in the claims processing system.

c. Scalability (100% Improvement):

Another perfection was achieved in scalability, where the FAS system proved to be scalable enough to accommodate one million transactions per day. Scalability studies the capability of a distributed system with regard to functionality and stability while the scale of data and the number of transactions enlarges. The characteristics of the well-known traditional claims processing systems also mean that the large scale often poses a problem when it deals with a flood of requests or inquiries. Nevertheless, the design of the FAS system assumes high levels of throughput which may be suitable for the big and complex healthcare organizations processing great numbers of transactions. Thus, the scaling problem has been resolved by adopting the FAS system based on the cloud and using distributed technologies; millions of transactions have been successfully conducted through the FAS system without deteriorating its performance.

D) Case Study: Midwest Health Network

Various operations were enhanced over the six months of adopting the FAS system for MHN, both in the financial aspect and the quality of services provided. The FAS system solves the problem of operations with accumulator data, which are crucial in providing accurate claims and identifying the patient and his/her benefits. Of all the significant benefits, the one that generated the most talk in the organization was $1.2 million in administrative overhead saved. This was mainly attributed to the automation of the accumulator reconciliation process, which used to be a manual, heavy-duty and sequential process that delivered low accuracy. The time and money spent manually entering the data and rectifying the mistakes could be coupled with the FAS system, which will help administrators perform significantly more work while spending less time on data entry and correction. With the help of the FAS system, there was a reduction of about 35% in service denials. Some say that it is caused by undesirable accumulator information like policy limits, deductibles or co-pays, which are not in compliance with what the member of the health plan is entitled to. Thus, the FAS system facilitated real-time accumulation of the accumulators' data while ensuring that such values were as up-to-date as possible to avoid denial of valid claims. Also, patient satisfaction increased by 22%. The intervention led to faster patient satisfaction and an increase in billing efficiency, which helped improve patients' satisfaction with the healthcare organization. Patients felt empowered with the view that they could know on an almost real-time basis when their benefits and the processing of their claims were indeed being worked on. The enhanced and more efficient production process, lower claim rejection rate, and customer satisfaction constitute significant evidence for using the FAS system in a real-life healthcare facility.

E) Limitations

While the efficiency of the FAS has been proved, the authors have mentioned several drawbacks during FAS implementation that should be discussed to expand the FAS zone of applicability.

a. Initial Implementation Cost:

In implementing the FAS system, one of the first big problems experienced was the cost of implementing the intended system. Integrating such an advanced system into the existing framework required a huge capital investment. These costs were significantly high mainly because the FAS system required the extension of a custom API to interconnect with different payer and provider systems. Moreover, to make data more rigid and transparent, applying blockchain technology was essential, but at the same time, it increased the work complexity and expenses. However, the greatest challenges involved the cost of forming the basic blockchain environment, implementing security to the stored data, and defining the procedures to be followed in live feed data updates. These costs may pose a challenge, especially to the small health care organization that may not have adequate resources to meet the costs. However, with the proliferation of such enhancements across institutions, the running costs can only be reduced significantly and efficiency increases in the long run, warranting the investment.

b. Integration Complexity with Legacy Systems:

One of the challenges identified and faced while working on the FAS system is related to the system integration issues, where it was difficult to integrate a complex system such as FAS with the legacy systems. Many organizational participants of the healthcare teams, including providers and payers, still are using legacy, frequently outdated solutions that were not initially built for real-time data sharing and synchronization or blockchain. The old systems mainly involve storing data in different silos, and this complicates the creation of a map and synchronization of data in different platforms. In order to overcome these gaps in FAS, there was a need for data mapping, upgrading of the systems, and other forms of middleware to complete the compatibility of the systems. This long and complex process could only be accomplished by professional technical staff to guarantee that the legacy systems can interface well with the FAS engine. However, the advantages of real-time synchronization, as well as the improved accuracy of data with time, still overshadowed these challenges. There is an expected improvement with the advancement in healthcare IT in the near future.

V. CONCLUSION

The Facets Accumulator Synchronization (FAS) system can be described as an innovative solution for addressing crucial issues in healthcare financial management. The management of accumulator data and comprising encompassed items, including deductibles, co-pays, and out-of-pocket limits, has remained complex in the past for healthcare providers, payers, and members. Since multiple systems were involved in the process of paying claims, issues such as errors and delays in accumulation were regular and discrepancies in the accumulator data caused administrative overheating, claim denials and patients' lack of information about the result. These issues are resolved in the FAS system by assuring real-time synchronization and secure data sharing and by including blockchain logging to alter how the financial data of health care is managed.

The strength of the FAS system is real-time capability because it helps to monitor the customer needs instantly. This way, through the integration of the different systems of the FAS system, all payers, providers, and administrators have the most updated values of the accumulators. It helps to reduce discrepancies and eliminates the likelihood or occurrence of errors, which, as a result, decreases the need for manual adjustments, which means that there are saves administrative costs and time, which fastens the cycle of processing claims. It embeds blockchain as an extra layer to oversee the security of accumulator updates so that they will be secure and traceable. This feature helps increase confidence in the data and is likely to be highly appreciated by stakeholders as each completed transaction is documented and cannot be changed. Other than the existence of operational benefits FAS also solves the challenge of transparency. Thus, the patient, the provider, and the payer will be on the same page through the integration of different healthcare systems and frequent updates in data sharing. It makes for easier communication and enhanced relations, thus increasing the patient's satisfaction level with that of the healthcare provider. In addition, the number of service denials and administrative costs is also cut down, increasing the sustainability of the healthcare systems despite the increasing demand.

Therefore, to this background, the future increases in the FAS system lie in applying artificial intelligence, AI-based, anomaly detection. It can also benefit the system where outlying data or discrepancies could be detected instantaneously, resulting in early detection of the problem. Another area of future development for the FAS system includes the ability to agree to the HL7 FHIR (Fast Healthcare Interoperability Resources) standards. This was aimed at ensuring patient information could pass through the various health organizations seamlessly and, in the process, enhance role integration between different organizations, as will be described below. Thus, by increasing availability for interoperation, FAS will provide more value for more healthcare systems and augment the efficacy of the healthcare system overall. Such developments will guarantee that FAS will remain at the forefront in the change of the healthcare finance system with an advantage along the line, which is a bonus to other players in the health systems of both the provider and payer sides.

VI. REFERENCES

[1] Kudyba, S. P. (2010). Healthcare informatics: improving efficiency and productivity. CRC Press.

[2] Chen, M., Ma, Y., Li, Y., Wu, D., Zhang, Y., & Youn, C. H. (2017). Wearable 2.0: Enabling human-cloud integration in next-generation healthcare systems. IEEE Communications Magazine, 55(1), 54-61.

[3] Kuo, T. T., Kim, H. E., & Ohno-Machado, L. (2017). Blockchain distributed ledger technologies for biomedical and health care applications. Journal of the American Medical Informatics Association, 24(6), 1211-1220.

[4] Mettler, M. (2016, September). Blockchain technology in healthcare: The revolution starts here. In 2016 IEEE 18th international conference on e-health networking, applications and services (Healthcom) (pp. 1-3). IEEE.

[5] Rajkomar, A., Dean, J., & Kohane, I. (2019). Machine Learning in Medicine. New England Journal of Medicine.

[6] Zhang, P., White, J., Schmidt, D. C., Lenz, G., & Rosenbloom, S. T. (2018). FHIRChain: applying blockchain to securely and scalably share clinical data. Computational and structural biotechnology journal, 16, 267-278.

[7] Olorunyomi, T. D., Sanyaolu, T. O., Adeleke, A. G., & Okeke, I. C. (2024). Integrating FinOps in healthcare for optimized financial efficiency and enhanced care. International Journal of Frontiers in Science and Technology Research, 7(2), 20-28.

[8] Carmo Filho, R. D., & Borges, P. P. (2024). Financial management, efficiency, and care quality: A systematic review in the context of Health 4.0. Health Services Management Research, 09514848241275783.

[9] Karia, A. N., Jadhav, J. L., Thombare, P. S., Dalvi, A. G., & Praveen, P. (2024). Financial Management Practices in Public Health: Enhancing Sustainability and Accountability. South Eastern European Journal of Public Health, 23, 135-145.

[10] Gapenski, L. C., & Pink, G. H. (2015). Understanding healthcare financial management. Chicago, IL: Health Administration Press.

[11] Paterson, M. A. (2014). Healthcare finance and financial management: Essentials for advanced practice nurses and interdisciplinary care teams. DEStech Publications, Inc.

[12] Sedevich-Fons, L. (2014). Financial indicators in healthcare quality management systems. The TQM Journal, 26(4), 312-328.]

[13] Mekala, V. B. R. (2024). Optimizing Claims Management: The Role of Facets Accumulator Synchronization in Real-Time Data Accuracy. Journal of Artificial Intelligence General Science (JAIGS) ISSN: 3006-4023, 6(1), 679-685.

[14] Dashkevich, N., Counsell, S., & Destefanis, G. (2024). Blockchain financial statements: Innovating financial reporting, accounting, and liquidity management. Future Internet, 16(7), 244.

[15] Jajarmi, A., Hajipour, M., & Baleanu, D. (2017). New aspects of the adaptive synchronization and hyperchaos suppression of a financial model. Chaos, Solitons & Fractals, 99, 285-296.

[16] Kinniment, D. J. (2008). Synchronization and arbitration in digital systems. John Wiley & Sons.

[17] Dick, C., Harris, F., & Rice, M. (2000, April). Synchronization in software radios. Carrier and timing recovery using FPGAs. In Proceedings 2000 IEEE Symposium on Field-Programmable Custom Computing Machines (Cat. No. PR00871) (pp. 195-204). IEEE.

[18] Sbarski, P., & Kroonenburg, S. (2017). Serverless architectures on AWS: with examples using Aws Lambda. Simon and Schuster.

[19] Poccia, D. (2016). AWS Lambda in Action: Event-driven serverless applications. Simon and Schuster.

[20] Ekroot, C. G., & Long, S. I. (1988). A GaAs 4-bit adder-accumulator circuit for direct digital synthesis. IEEE journal of solid-state circuits, 23(2), 573-580.

[21] P. K. Maroju, "AI-Powered DMAT Account Management: Streamlining Equity Investments and Mutual Fund Transactions," International Journal of Advances in Engineering Research, vol. 25, no. 1, pp. 7–18, Dec. 2022.