A Continuous Temporal Compliance Framework for Automated Zakat Eligibility Determination in Cooperative Financial Information Systems

[1*]Sa'adatu Abdulkadir, [2]Yushau Ibrahim Ango, [3]Abdulkarim Hussaini, [4]Aminu Hamza Aminu, [5]Abdulhafiz Garba and [6]Rahilatu Mohammed

[1,3,4,5]College of Computing, Engineering and Sciences, Kaduna State University, Kaduna, Nigeria
[2,6]Department of Business Administration and Entrepreneurship, Kaduna State University, Kaduna, Nigeria

email: [1*]saa.abdul@kasu.edu.ng, [2]yushauango@gmail.com, [3]hsabdulkareem@gmail.com, [4]ahaminu@gmail.com, [5]ahafizx5@gmail.com, [6]rahmulim@gmail.com

**Corresponding author*

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Abstract - *Continuous compliance requirements challenge financial information systems when eligibility depends on maintaining specified conditions over uninterrupted temporal intervals. Under the continuous-possession interpretation adopted in this study, Zakat al-Mal eligibility requires a qualifying balance to remain at or above the applicable nisab threshold for a complete lunar year (*haul*). This study proposes a continuous temporal compliance framework that reconstructs cooperative-account-based eligibility from longitudinal transaction records using haul initiation, interruption-aware reset logic, historical nisab parameterisation, and gold–silver classification. The framework was implemented and evaluated using anonymised records from the KASU Majlis Cooperative Society in Nigeria covering January 2018 to February 2026. Analysis of 214 member accounts identified 37 completed haul intervals and 92 interruption events, showing that threshold attainment did not necessarily result in haul completion and that periodic balance assessment may overlook interruptions within an active cycle. The study contributes to algorithmic governance by applying temporal-state monitoring to Zakat eligibility reconstruction and demonstrates how cooperative financial information systems can support traceable monitoring of duration-dependent obligations. The framework analyses only financial information recorded within the cooperative system and does not constitute a complete determination of a member's overall personal Zakat liability.*

Keywords: Continuous compliance modelling, temporal state monitoring, algorithmic governance, cooperative financial information systems, zakat eligibility computation, ICT4D.

1 Introduction

Continuous compliance requirements present a distinctive challenge for financial information systems, particularly when eligibility depends on maintaining specified conditions over uninterrupted temporal intervals. Unlike event-based or snapshot-driven decision models, duration-dependent obligations require persistent state monitoring and interruption-aware recalculation mechanisms. Designing computational frameworks capable of supporting such temporally constrained rules remains underexplored within institutional financial systems.

Zakat al-Mal provides a relevant example of this problem. Under the continuous-possession interpretation adopted in this study, Zakat becomes obligatory when wealth equals or exceeds the prescribed nisab threshold and remains continuously above that threshold for a complete lunar year, known as haul. A decline below the applicable threshold before completion terminates the active cycle. Within digitally managed cooperative savings institutions, where balances fluctuate through deposits, withdrawals, loans, and other transactions, manual reconstruction of haul continuity can be difficult.

Staff cooperative societies provide structured mechanisms for collective savings and welfare support. However, Zakat assessment within such environments may rely on periodic estimation or voluntary declaration, potentially limiting consistency and traceability, despite evidence that trust, governance quality, and institutional

accountability influence Zakat compliance behaviour (Bin-Nashwan et al., 2020a; Sawmar & Mohammed, 2021). Although digital Zakat systems have improved payment collection, reporting, and transparency (Alshater et al., 2022; Hadi et al., 2023), the reviewed literature provides limited evidence of systems that reconstruct haul progression directly from longitudinal institutional transaction records.

Algorithmic governance offers a basis for translating institutional rules into executable computational logic (Kitchin, 2016; Yeung, 2017). Within cooperative financial systems, rule-based mechanisms have been applied to lending eligibility (Abdulkadir, 2026) and time-weighted dividend allocation (Abdulkadir et al., 2026). These applications demonstrate the feasibility of embedding financial rules within operational systems, but they primarily address discrete decisions or bounded accounting periods rather than conditions requiring uninterrupted temporal continuity.

Despite advances in digital Zakat administration and policy-driven system design, limited research has examined how uninterrupted haul progression and historically varying nisab thresholds can be computationally reconstructed from cooperative transaction histories. Existing platforms commonly focus on declaration, payment, collection, and reporting rather than interruption detection, time-sensitive threshold application, and retrospective reconstruction of eligibility cycles.

The study therefore investigates the following research questions:

RQ1: How can uninterrupted haul, defined in this study as 354-day ownership continuity, be computationally modelled as a continuous temporal-state condition using cooperative transaction histories?

RQ2: How does the incorporation of historical nisab variation influence reconstructed eligibility outcomes across multiple financial periods?

RQ3: Can cooperative-account-based Zakat eligibility states be reconstructed algorithmically from longitudinal transaction records without requiring members to re-enter transactions already recorded within the cooperative information system?

To answer these questions, the study proposes a continuous temporal compliance framework incorporating uninterrupted haul tracking, interruption-aware reset logic, historical nisab parameterisation, and dual gold–silver classification. The framework was implemented and evaluated using transaction records from the Kaduna State University Majlis Cooperative, Investment and Credit Society Ltd., Nigeria, covering January 2018 to February 2026. Because the framework analyses only financial information recorded within the cooperative database, its outputs represent cooperative-account-based eligibility rather than a complete determination of a member's overall personal Zakat liability.

The study makes four contributions. First, it demonstrates the implementation of continuous temporal compliance modelling for cooperative-account-based Zakat eligibility reconstruction. Second, it formalises interruption-aware progression as a computational mechanism for obligations dependent on uninterrupted continuity. Third, it integrates historically contextualised thresholds into the reconstruction process. Fourth, it evaluates the framework using eight years of longitudinal operational transaction records. More broadly, the study illustrates how cooperative financial information systems can extend beyond transaction recording to support the monitoring and administration of temporally constrained financial obligations.

2 Related work

The digitalisation of Zakat administration has expanded the use of web-based and mobile systems for contribution collection, payroll deductions, beneficiary administration, transaction reporting and institutional accountability. Existing studies have particularly examined the relationships among technology adoption, transparency, trust, governance and Zakat compliance behaviour (Bin-Nashwan et al., 2020a; Bin-Nashwan et al., 2020b; Bin-Nashwan et al., 2021; Sawmar & Mohammed, 2021; Hadi et al., 2023). Reviews of Islamic financial technology similarly show that digital platforms can improve access to financial services and strengthen the administrative infrastructure through which Islamic financial activities are conducted (Alshater et al., 2022; Meerangani et al., 2022). This literature establishes the administrative and governance relevance of digital Zakat systems, but it does not by itself demonstrate that eligibility is computed from complete longitudinal records of an individual's wealth.

Within the systems considered in the reviewed literature, Zakat platforms are generally oriented towards payment, declaration, reporting or distribution after the relevant financial information has been supplied by the user or institution. Eligibility and the amount payable are therefore commonly treated as inputs to the digital process rather than outputs reconstructed from transaction histories. Such systems may support efficient collection and accountability while still depending on periodic calculations, financial summaries or self-declared asset information. Consequently, the literature reviewed here provides limited evidence of systems that reconstruct an uninterrupted haul from chronologically ordered institutional transactions.

Algorithmic governance provides a useful conceptual basis for addressing this limitation. It concerns the representation of policies, rules and institutional requirements in forms that can be executed consistently by information systems (Kitchin, 2016; Yeung, 2017). In cooperative financial systems, rule-based mechanisms have been used to evaluate lending conditions and calculate time-weighted dividend entitlements from operational records (Abdulkadir, 2026; Abdulkadir et al., 2026). These implementations demonstrate that institutional rules can be translated into deterministic procedures and applied to transaction data. However, lending decisions are normally evaluated at an application event, while dividends are commonly calculated within a defined accounting period. Neither necessarily requires a qualifying condition to remain satisfied throughout an uninterrupted interval.

Research on temporal and continuous compliance distinguishes periodic assessment from the ongoing evaluation of conditions that may change over time. Continuous auditing, regulatory monitoring and security-compliance research emphasise persistent state observation, traceability and the detection of violations between formal reporting points (Minkkinen et al., 2022; Angermeir et al., 2024; Waltersdorfer et al., 2024). These studies provide relevant mechanisms for representing time-dependent conditions, but their principal applications concern auditing, cybersecurity, artificial-intelligence governance and regulatory control. They do not directly establish a method for reconstructing Zakat haul progression from cooperative savings records.

The cooperative information-system context nevertheless provides an appropriate environment in which to investigate such a mechanism. Digitised transaction records can provide dated information about deposits, withdrawals, dividend allocations and other account events, allowing the balance held within the institution to be reconstructed over time. This information can support account-level temporal analysis more reliably than isolated annual balances. However, institutional records represent only the financial position visible within the cooperative and may not contain a member's external assets, liabilities or other zakatable wealth. A computational framework based on these records should therefore be interpreted as an account-based eligibility reconstruction mechanism operating under a specified jurisprudential configuration, rather than as a complete determination of an individual's total Zakat liability.

The literature reviewed in this study consequently supports three elements of the proposed approach. Digital Zakat research establishes the importance of technology, transparency and institutional accountability; algorithmic-governance research provides a basis for translating selected rules into executable procedures; and continuous-compliance research provides mechanisms for tracking conditions whose validity depends on time. What remains insufficiently addressed is their combination in an institutional artefact that reconstructs cooperative-account-based haul trajectories, detects interruptions, applies time-indexed nisab parameters and records the resulting eligibility states from longitudinal transaction data.

This study addresses that specific gap by developing and evaluating a rule-based temporal framework for reconstructing Zakat eligibility from cooperative savings records. The contribution lies in the implementation and examination of interruption-aware haul tracking and historically parameterised threshold evaluation within a cooperative information system. The framework implements an explicitly selected rule configuration and is not intended to adjudicate among different jurisprudential positions or to replace the additional information and expert judgement required for complete personal Zakat assessment.

3 Theoretical foundation and methodology

3.1 Design science research positioning

This study is positioned within the Design Science Research (DSR) tradition in Information Systems, which focuses on the purposeful design, implementation, and evaluation of computational artefacts developed to address identifiable organisational and operational problems. In addition to producing a functional artefact, DSR supports the development of design knowledge that may inform related information-system applications.

The study addresses the problem of determining Zakat al-Mal eligibility within a cooperative financial environment where members' recorded balances fluctuate over time. Existing digital Zakat systems commonly support payment administration, contribution recording, reporting, and beneficiary management, while eligibility assessment may continue to depend on periodic balance inspection, manual calculation, or member-provided information. Such approaches do not readily reconstruct an eligibility condition that depends on maintaining a qualifying balance throughout an uninterrupted temporal interval.

To address this problem, the study develops and evaluates a computational framework that operationalises haul monitoring, interruption-aware reset logic, and historically contextualised nisab evaluation using longitudinal cooperative transaction records. The artefact consists of a temporal state model, a historical nisab repository, a

haul-detection algorithm, an eligibility-state management component, and reporting functions integrated within a cooperative financial information system.

The research process involved problem conceptualisation, rule specification, artefact design, implementation, demonstration, and evaluation. The contribution therefore extends beyond the implementation of a Zakat calculation function to the design of a temporal mechanism for representing obligations whose fulfilment depends on sustained conditions over time.

The framework determines eligibility from financial records available within the cooperative information system. It does not represent a complete assessment of a member's overall personal Zakat liability where relevant assets, liabilities, or financial holdings exist outside the cooperative records.

3.2 Algorithmic governance and temporal compliance

Algorithmic governance refers to the translation of institutional rules, policies, and regulatory conditions into executable computational logic capable of supporting consistent, transparent, and auditable decision processes (Kitchin, 2016; Yeung, 2017). Rule-based systems have been applied in areas such as lending eligibility, welfare administration, financial compliance, and organisational decision support.

Existing policy-driven systems commonly determine eligibility at discrete decision points, such as approval events, reporting dates, or accounting intervals. Such approaches are appropriate where a decision can be made from the conditions prevailing at a specific time. Duration-dependent obligations present a different computational problem because qualification depends on maintaining specified conditions throughout an uninterrupted temporal interval.

Zakat al-Mal provides an example of this class of temporal problem. Under the rule configuration implemented in this study, an active haul is maintained only while the member's recorded cooperative balance remains at or above the selected nisab threshold for 354 lunar days. A decline below the applicable threshold before completion terminates the active cycle, and a new cycle begins when the balance subsequently reaches or exceeds the threshold.

The framework therefore represents Zakat eligibility as a temporal computational state derived from the relationship between a member's reconstructed balance trajectory and the applicable nisab threshold. Although the framework is described as continuous monitoring, its implementation is event-driven. The eligibility state is evaluated at transaction dates, effective dates of nisab changes, and candidate haul-completion dates. Between such events, the recorded balance is treated as unchanged.

Three principles guided the design of the framework:

1. Continuous compliance principle: Obligations that depend on duration should be represented as sustained system states rather than assessed only at periodic checkpoints.
2. Interruption-aware eligibility principle: Temporal progression should include explicit reset logic whenever the governing condition is no longer satisfied.
3. Historically contextualised threshold principle: Where an applicable benchmark changes over time, historical reconstruction should use the threshold associated with the relevant evaluation period rather than applying a single current value retrospectively.

These principles inform the design of the artefact. Their contribution to broader Information Systems design knowledge is considered further in Section 4.8.

3.3 Theoretical and modelling assumptions

The study is based on several theoretical and operational assumptions.

First, consistent with DSR, knowledge about an organisational problem may be generated through the design, implementation, and evaluation of a computational artefact. The study therefore investigates Zakat eligibility determination through the construction and examination of an operational framework rather than through observation alone.

Second, the study adopts the algorithmic-governance position that selected institutional rules can be represented as explicit computational conditions. Under this position, the Zakat rules adopted for the study are translated into deterministic procedures for haul initiation, continuity monitoring, interruption detection, reset, completion, and threshold classification.

Third, the framework implements a selected continuous-possession interpretation of haul progression. Under this configuration, the recorded balance must remain at or above the applicable nisab threshold throughout the 354-

day period. A decline below the threshold terminates the active cycle. The framework does not attempt to adjudicate among different jurisprudential schools or regional interpretations. Its rules may therefore be configured differently where an institution adopts another recognised interpretation.

Fourth, the framework assumes that the transaction records used in the analysis are sufficiently complete and accurately dated to reconstruct the member's balance within the cooperative. The reliability of the resulting eligibility state depends on the accuracy and completeness of those records.

Finally, the framework analyses only financial information recorded within the cooperative system. Assets, liabilities, investments, and other forms of wealth held outside the cooperative are not represented. The output should therefore be interpreted as cooperative-account-based eligibility information generated under the configured rules.

3.4 Research design

This study adopts a Design Science Research (DSR) methodology to develop and evaluate a computational framework for automated Zakat eligibility determination within a cooperative financial information system. DSR is appropriate because the research objective is to construct and examine an artefact intended to address an identifiable institutional problem.

The research process followed three principal phases.

In the first phase, the Zakat eligibility requirements adopted for the study were analysed and translated into formal computational conditions. These conditions addressed nisab attainment, haul initiation, uninterrupted continuity, interruption detection, cycle reset, haul completion, and gold–silver classification.

In the second phase, the formal conditions were implemented as deterministic algorithms within the cooperative financial information-system environment. The implementation combined member transaction records, reconstructed running balances, historical nisab parameters, temporal-state management, and eligibility reporting.

In the third phase, the framework was evaluated using longitudinal cooperative transaction records. The evaluation examined whether the implementation followed the specified computational rules, whether reconstructed states agreed with selected manually traced transaction histories, and whether the complete historical dataset could be processed within the available computing environment.

The research design therefore links rule specification, artefact construction, implementation, demonstration, and evaluation. Comparative benchmarking against alternative Zakat software and validation across multiple institutions were outside the scope of the study.

3.5 Operational context and data source

The study was conducted using transaction records obtained from the Kaduna State University Majlis Cooperative, Investment and Credit Society Ltd., Nigeria, commonly referred to as the KASU Majlis Cooperative. The cooperative maintains digital records of member financial activities through its operational information system.

The observation period covered January 2018 to February 2026. The dataset contained 75,986 transaction records associated with 214 cooperative members. The records included dated financial events used to reconstruct changes in members' cooperative balances, including deposits, withdrawals, loan-related transactions, and dividend allocations recorded within the system.

For each member, relevant transactions were arranged in chronological order and used to reconstruct the running balance. The reconstructed balance represented the financial position recorded for the member within the cooperative at each relevant evaluation time. It did not include assets or liabilities that were not represented in the cooperative database.

The unit of temporal analysis was the individual member account. A member could experience more than one haul cycle or interruption event during the observation period. Consequently, the number of detected haul completions and interruption events represents temporal events and should be distinguished from the number of unique members associated with those events.

The records used in the study were anonymised for analysis and reporting. Direct personal identifiers were not required for reconstructing eligibility trajectories or presenting the aggregate results. Access to the operational records was granted by the cooperative for the purpose of the study.

3.6 Computational representation of zakat eligibility

For the rule configuration adopted in this study, cooperative-account-based Zakat eligibility is represented through three conditions:

1. The recorded balance must equal or exceed the applicable nisab threshold.
2. The qualifying balance must be maintained for a complete haul of 354 lunar days.
3. A decline below the applicable nisab threshold before haul completion terminates the active cycle and resets the eligibility progression.

Let:

- $B_m(t)$ represent the reconstructed cooperative account balance of member m at time t;
- N(t) represent the applicable nisab threshold at time t;
- t_s represent the start date of the active haul cycle; and
- L represent the haul duration of 354 lunar days.

A candidate haul satisfies the continuity condition where:

$$B_m(t) \geq N(t), \forall t \in [t_s, t_s + L] \quad (1)$$

Equation (1) represents eligibility progression as a sustained temporal-state condition rather than as a single balance observation.

An interruption occurs where:

$$\exists t_i \in [t_s, t_s + L] \text{ such that } B_m(t_i) < N(t_i) \quad (2)$$

When an interruption occurs at time t_i, the active haul cycle is terminated and the haul start state is cleared:

$$t_s \leftarrow \varnothing \quad (3)$$

A new cycle begins when the member's reconstructed balance subsequently equals or exceeds the applicable threshold. Under this formulation, a completed haul is recorded only when the qualifying state is maintained throughout the configured 354-day interval.

The relevant evaluation times include transaction timestamps, effective dates of changes in the applicable nisab threshold, and candidate haul-completion dates. Between these events, the member's recorded balance is treated as unchanged unless another transaction occurs.

Figure 1 illustrates the computational lifecycle comprising below-nisab status, haul initiation, haul progression, interruption and reset, and haul completion.

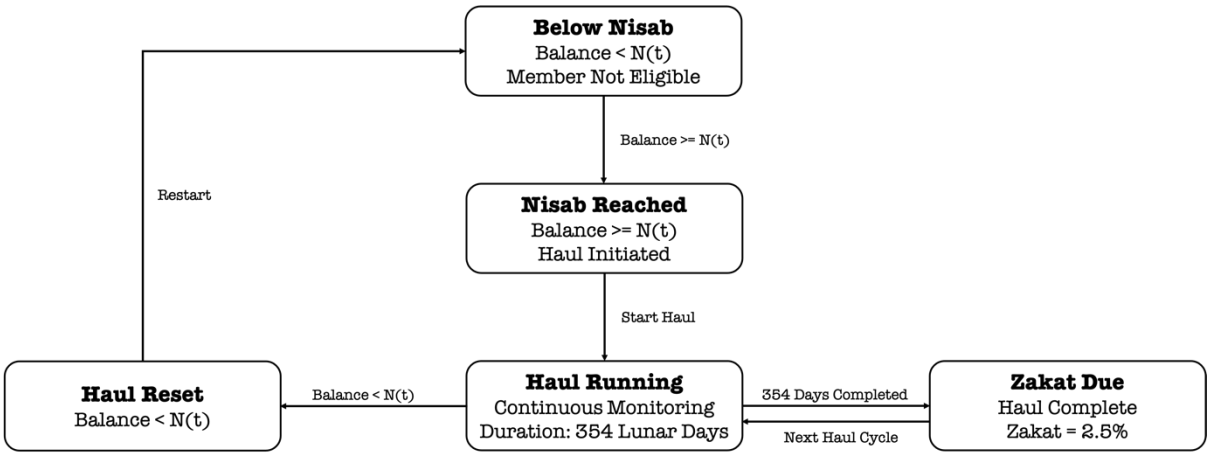

Figure 1: State-based computational lifecycle of zakat eligibility under continuous haul monitoring

3.7 Historical nisab modelling

Nisab values vary over time in response to changes in the monetary value of the relevant gold and silver benchmarks. Historical reconstruction therefore requires the threshold applicable during an earlier period to be distinguished from the threshold applicable during a later period.

A historical nisab repository was constructed to store gold and silver threshold values together with their defined validity periods. During computation, the framework retrieves the threshold associated with each relevant evaluation date.

Let $N(t)$ represent the nisab value effective at time t. The temporal engine compares the reconstructed member balance $B_m(t)$ with the threshold recorded for the same period. This prevents a single present-day nisab value from being applied uniformly to all historical balances.

Changes in the applicable nisab are treated as state-relevant events. A member's haul status may therefore be affected either by a transaction that changes the balance or by a change in the applicable threshold. Where the threshold rises above the member's recorded balance before haul completion, the model records an interruption under the rule configuration adopted in this study.

This time-sensitive parameterisation preserves the historical relationship between member balances and the nisab thresholds configured for the corresponding periods.

3.8 Continuous haul detection algorithm

The central computational task is to identify uninterrupted periods during which a member's recorded cooperative balance remains at or above the applicable nisab threshold for 354 lunar days.

The algorithm operates sequentially across the ordered transaction histories as follows:

1. Transactions are arranged chronologically.
2. The member's running cooperative balance is reconstructed.
3. The system identifies the earliest date at which the balance equals or exceeds the silver nisab threshold.
4. A candidate haul period of 354 days is initiated.
5. The balance is evaluated at transaction dates, nisab-change dates, and the candidate completion date
6. If the balance falls below the applicable threshold, the active haul is terminated and the haul start state is cleared.
7. A new candidate cycle begins when the balance subsequently equals or exceeds the threshold.
8. Where continuity is maintained for 354 lunar days, a completed haul interval is recorded.

This process represents haul progression as a temporal continuity problem rather than as a periodic balance comparison. Running balances are reconstructed from chronological credit and debit records. At every relevant evaluation time, the system compares the reconstructed balance with the nisab threshold retrieved from the historical repository.

Algorithm 1: Continuous haul detection algorithm

Input:

- T_m: ordered transaction records for member m;
- $B_m(t)$: cumulative balance of member m at time t;
- $N_{silver}(t)$: applicable silver nisab threshold at time t;
- L: haul duration of 354 lunar days.

Output:

- H: set of valid haul intervals

```
Procedure:
FOR each member m DO
     Retrieve the transaction records Tm for member m
     Sort Tm in ascending transaction-date order
     Reconstruct the running balance Bm(t)
     Set haul_start ← NULL

     FOR each relevant evaluation time t DO
          Retrieve the applicable silver nisab threshold Nsilver(t)

          IF Bm(t) < Nsilver (t) THEN
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                haul_start ← NULL
                CONTINUE
            END IF

            IF haul_start = NULL THEN
                haul_start ← t
            END IF

            IF t >= haul_start + L THEN
                Record valid haul interval (m, haul_start, haul_start + L) in H
                haul_start ← t
            END IF
        END FOR
    END FOR

    RETURN H
```

The procedure evaluates each member's balance chronologically. A candidate haul begins when the reconstructed balance reaches or exceeds the applicable silver nisab threshold. Any subsequent decline below the threshold before completion clears the active haul start date. Where the qualifying state continues for 354 lunar days, the system records a completed haul interval.

Where the member's balance remains above the threshold following a completed haul, the current evaluation time becomes the start of the next potential haul cycle. The algorithm therefore supports the identification of successive haul intervals across the observation period.

3.9 Dual nisab evaluation

Islamic jurisprudential practice recognises gold- and silver-based nisab benchmarks. In the implementation developed for this study, the silver threshold is used for haul initiation and continuity monitoring. Because the silver threshold is lower than the corresponding gold threshold, its use enables the system to retain potentially qualifying trajectories for subsequent classification.

Upon completion of a haul interval, the member's balance is evaluated against both the gold and silver thresholds applicable at the completion date.

Where:

$$B_m(t_s + L) \geq N_{gold}(t_s + L),$$

the completed interval is classified as gold-qualified.

Where:

$$N_{silver}(t_s + L) \leq B_m(t_s + L) < N_{gold}(t_s + L),$$

the completed interval is classified as silver-qualified.

Dual classification does not change the haul-continuity procedure. It is applied after a qualifying interval has been identified and records the threshold category satisfied by the member's cooperative balance at completion.

The use of the silver threshold for haul initiation represents the implementation configuration adopted in this study. The framework does not attempt to determine that this configuration is preferable to every alternative jurisprudential interpretation.

3.10 System integration

The computational framework was implemented as an analytical module operating on records stored in the cooperative transaction database. It reconstructs account-level eligibility states from the available financial history without requiring members to re-enter transactions already captured by the system.

The implementation consists of four principal components:

1. Transaction-data component: Provides dated deposits, withdrawals, loan repayments, dividend allocations, and other relevant account events.
2. Historical nisab repository: Provides the gold and silver thresholds associated with defined historical periods.

3. Continuous haul-detection engine: Reconstructs running balances, evaluates threshold conditions, detects interruptions, and records completed 354-day intervals.
4. Eligibility-state manager: Records haul start dates, completion dates, current cycle status, gold–silver classifications, and calculated cooperative-account-based obligations.

The resulting eligibility information is made available to the notification and reporting component for review by members and cooperative administrators. The framework supports traceability by linking an eligibility outcome to the corresponding transaction history, threshold period, haul start date, interruption events, and completion date.

Computation occurs without additional user intervention during each processing run. This supports consistent application of the configured rules and reduces dependence on repeated manual assessment. However, the computation applies only to information stored within the cooperative and does not remove the need to consider external assets or liabilities when determining a member's complete personal Zakat position.

The overall architecture of the continuous Zakat compliance engine is presented in Figure 2.

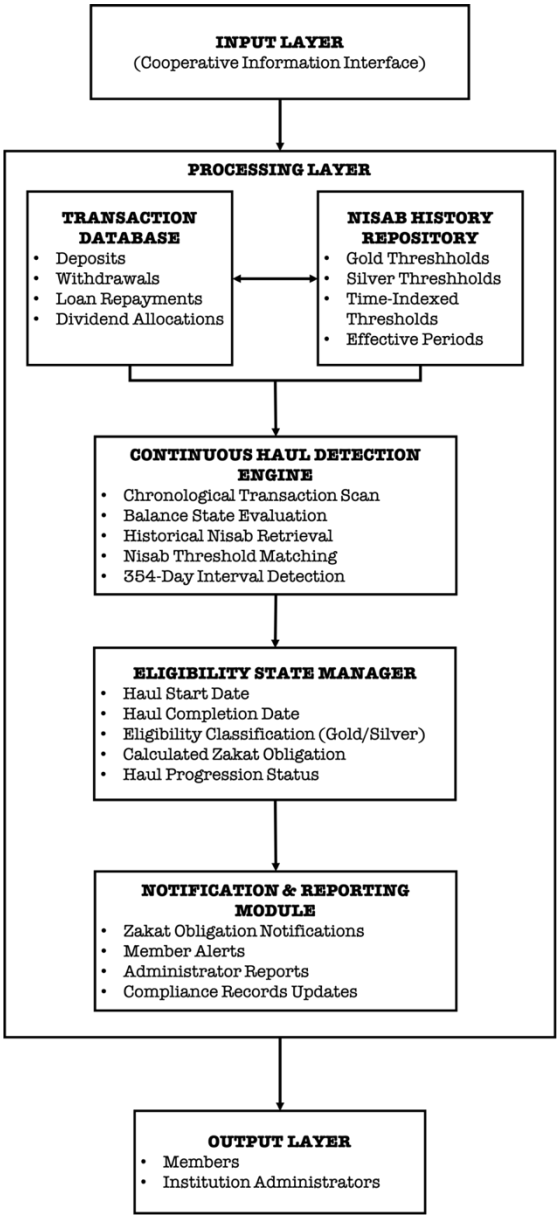

Figure 2: System architecture of the continuous zakat compliance engine

3.11 Evaluation procedure

The framework evaluation focused on three criteria: Rule conformance, historical trajectory consistency, and operational feasibility.

3.11.1 Rule conformance verification

Rule-conformance verification examined whether the implementation followed the computational conditions specified from Section 3.6 to Section 3.9. Each recorded haul completion was required to correspond to an uninterrupted 354-day interval during which the reconstructed cooperative balance remained at or above the applicable nisab threshold.

The verification also examined whether a balance decline below the applicable threshold cleared the active haul state and whether subsequent threshold attainment initiated a new candidate cycle.

This criterion evaluates correspondence between the implemented algorithm and the rule configuration adopted for the study. It is not presented as an independent resolution of differences among jurisprudential schools.

3.11.2 Historical trajectory consistency

Historical consistency was assessed by examining whether reconstructed eligibility states corresponded with the chronological sequence of member transactions and the nisab values applicable during the relevant historical periods.

A manual trace audit was conducted for five selected member trajectories. For each case, the transactions were arranged chronologically, the running balance was independently reconstructed, the applicable nisab values were identified, and the resulting haul initiation, interruption, reset, and completion events were compared with the system output.

The manual traces agreed with the corresponding algorithmic results. Because the audit involved five selected trajectories, it is interpreted as an internal implementation check rather than as a complete independent reference standard for all 214 member accounts.

3.11.3 Operational feasibility

The evaluation used transaction histories covering January 2018 to February 2026. The complete dataset contained 75,986 transaction records relating to 214 cooperative members. The implementation reconstructed member balance trajectories, identified completed haul intervals, detected interruption events, and assigned gold- or silver-based classifications where applicable.

A complete historical processing run was executed through the PHP/MySQL cooperative portal hosted locally using XAMPP. The run completed in 4.51 seconds on a 2020 MacBook Air with a 1.1 GHz quad-core Intel Core i5 processor, 8 GB LPDDR4X memory, and macOS Catalina version 10.15.7.

The reported processing time represents an implementation-level observation in the study environment. It is included to demonstrate that the complete historical dataset could be processed successfully using the available institutional computing environment. It is not presented as a hardware-independent performance benchmark or as evidence of comparative superiority over another system.

To illustrate the practical implications of temporal monitoring, the study also examined cases in which periodic balance inspection would not reveal an interruption occurring within an active haul interval. Detail explanatory comparison scenarios derived from the implemented rules are later provided in Table 2 of Section 4. They are not results of a controlled benchmark against a separate snapshot-based software application.

Comparative benchmarking against alternative computational approaches, independent jurisprudential validation, full manual verification of all member trajectories, large-scale load testing, and cross-platform performance analysis were outside the scope of the present study.

4 Results and discussion

4.1 Historical zakat eligibility reconstruction

Application of the proposed framework to cooperative transaction records spanning January 2018 to February 2026 enabled retrospective reconstruction of account-based Zakat eligibility trajectories for the members included in the dataset. Rather than relying on periodic balance inspection, the framework evaluated reconstructed balances relative to the historically applicable nisab thresholds across successive 354-day haul intervals.

The reconstruction showed that eligibility states within the cooperative environment changed in response to deposits, withdrawals, loan-related transactions, dividend allocations, and changes in the applicable nisab

threshold. Members could reach the threshold, begin a candidate haul, experience an interruption, begin another cycle, or complete a valid haul during the observation period.

Three principal states were identified:

1. Continuous haul state: The recorded balance remained at or above the applicable nisab throughout an active or completed haul interval.
2. Interrupted haul state: An active haul was terminated because the recorded balance fell below the applicable nisab before completion of the 354-day interval.
3. No observed threshold attainment: The recorded cooperative balance did not reach the applicable nisab during the observation period.

These reconstructed states address RQ1 by demonstrating how haul initiation, progression, interruption, reset, and completion can be represented as deterministic temporal-state transitions derived from chronological cooperative transaction histories.

4.2 Quantitative eligibility dynamics

Aggregate analysis was conducted across the 214 members whose transaction histories were available for the period from January 2018 to February 2026. Table 1 summarises the principal member-level and event-level outcomes produced by the reconstruction.

Table 1: Summary statistics of reconstructed zakat eligibility dynamics (2018-2026)

Metric	Description	Value
Total members analysed	Unique members with transaction histories	214
Members reaching nisab at least once	Unique members whose recorded balance reached or exceeded the applicable threshold	61
Valid haul completions detected	Completed 354-day haul intervals	37
Haul interruption events detected	Instances in which an active haul was terminated before completion	92
Members with an active uninterrupted haul state at the study end date	Unique members with an active qualifying state in February 2026	15
Members who never reached nisab	Unique members with no observed threshold attainment	153

Of the 214 members analysed, 61 (28.5%) reached or exceeded the applicable nisab at least once during the observation period. The remaining 153 (71.5%) members did not reach the applicable nisab during the period.

The temporal reconstruction detected 37 completed haul intervals and 92 interruption events. These figures are event counts rather than necessarily counts of unique members, because one member could experience more than one interruption or complete more than one haul during the eight-year observation period. They are therefore not interpreted as direct proportions of the 214 members.

The number of interruption events indicates that reaching the nisab threshold did not necessarily lead to haul completion. A member could attain the threshold and begin a candidate haul but subsequently fall below the threshold before completing the required 354-day period.

These results demonstrate the distinction between threshold attainment and sustained eligibility progression. A method based only on whether a member reached nisab at a selected assessment date would not reveal whether the qualifying balance had been maintained throughout the required interval.

The findings address RQ3 by showing that cooperative-account-based eligibility states can be reconstructed algorithmically from stored transaction records without requiring members to re-enter transactions already available within the cooperative system. The study did not, however, conduct a controlled comparison of the complete dataset against manual or member-declared Zakat assessments.

4.3 Interruption and temporal continuity analysis

A central capability of the framework is the detection of interruption events occurring during active haul intervals. The reconstructed trajectories included cases in which members reached the applicable nisab, maintained qualifying balances for part of the required period, and subsequently experienced a decline below the threshold before the 354-day haul was completed.

Under the rule configuration adopted in this study, such a decline terminates the active haul and clears the recorded haul start date. A new cycle begins only when the balance again equals or exceeds the applicable nisab.

An assessment based only on balances observed at annual or periodic checkpoints may not identify an interruption that occurred between those checkpoints. For example, a member whose balance fell below nisab during the year but recovered before a year-end assessment could appear qualified if only the year-end balance were considered.

Figure 3 provides an illustrative balance trajectory showing how temporary declines below the applicable nisab interrupt an active haul and trigger a reset under the adopted continuous-haul model.

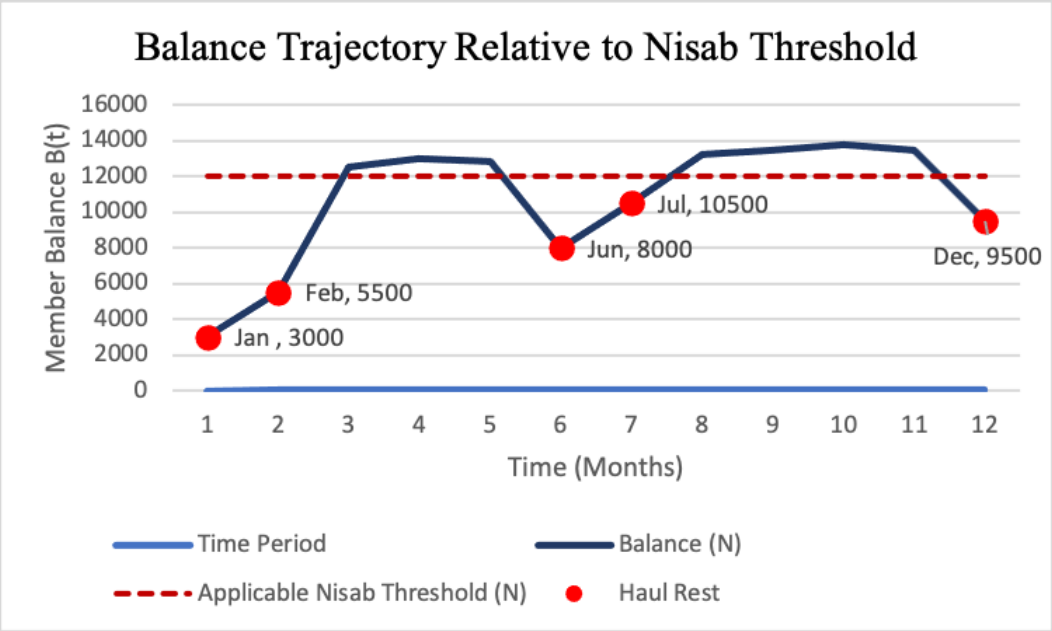

Figure 3: Illustrative balance timeline illustrating how temporary declines below the applicable nisab threshold interrupt ongoing haul progression and trigger eligibility reset events

The interruption points illustrated in Figure 3 correspond to the reset condition implemented in Algorithm 1. When the reconstructed balance falls below the applicable threshold during an active haul, the current progression is terminated and the haul start state is cleared.

Table 2 further illustrates how decisions based on isolated balance observations can differ from those generated by the adopted continuous-haul model. The scenarios are explanatory applications of the framework rules and are not results of a controlled benchmark against another software system.

Table 2: Illustrative decision differences between periodic assessment and the adopted continuous haul model

Scenario	Periodic balance assessment	Continuous-haul model	Outcome under the adopted rule configuration
Balance is above nisab at the assessment date but fell below nisab during the active haul	The interruption may not be detected where only the assessment-date balance is considered	Interruption and reset are detected	Haul not completed
Balance remains at or above nisab for 354 days	Eligibility may be inferred from selected assessment points	Complete qualifying interval is reconstructed	Haul completed

Scenario	Periodic balance assessment	Continuous-haul model	Outcome under the adopted rule configuration
Balance briefly falls below nisab before haul completion	The temporary decline may remain undetected	Interruption is detected	Active haul reset
An earlier balance satisfies the historical nisab but not a later threshold	The earlier period may be misclassified where a current threshold is applied retrospectively	The threshold applicable to the earlier period is used	Earlier period assessed using its historical threshold
Balance fluctuates but does not fall below the applicable nisab	Isolated observations cannot independently establish continuity	Qualifying state is maintained	Haul progresses or completes

The comparison demonstrates the role of interruption-aware temporal modelling in implementing the continuity condition adopted in this study. It does not establish that all periodic or manually conducted Zakat assessments necessarily produce incorrect outcomes.

4.4 Historical nisab effects

Application of time-indexed nisab values changed the threshold against which historical cooperative balances were evaluated. Rather than applying one current nisab value to transactions recorded throughout the eight-year period, the framework used the threshold configured for each relevant historical period.

Two forms of threshold-related effect were identified in the reconstructed trajectories.

First, some historical balances satisfied the nisab applicable during an earlier period even though the same balances would not have satisfied a later, higher threshold. Applying only the later threshold retrospectively would therefore alter the historical classification.

Second, changes in the applicable nisab could affect haul progression even where a member's recorded balance remained stable. Where the configured threshold rose above the member's balance before haul completion, the qualifying state was interrupted under the model adopted in this study.

These observations address RQ2 by showing that historical reconstruction depends on the relationship between the recorded balance and the nisab applicable at the corresponding time. The use of time-indexed thresholds therefore prevents a single current value from being imposed uniformly across all earlier periods.

The study did not report a separate aggregate comparison between classifications produced using historical nisab values and classifications produced using a single current threshold. The magnitude of the historical-threshold effect is therefore not expressed as a separate percentage or statistical estimate.

4.5 Dual gold-silver classification

Following completion of a valid haul interval, the framework evaluated the member's balance against the gold and silver nisab thresholds applicable at the completion date.

Completed intervals whose balances met or exceeded the gold threshold were recorded as gold-qualified. Where the completion balance met the silver threshold but remained below the gold threshold, the interval was recorded as silver-qualified.

The dual-threshold classification was applied after haul completion and did not modify the continuity, interruption, or reset logic. Its purpose was to record the threshold category satisfied by the reconstructed balance at the completion date.

This layered classification improves the traceability of the result by identifying the benchmark on which each completed interval was classified. The manuscript does not present separate aggregate counts of gold-qualified and silver-qualified intervals; consequently, no claim is made regarding the relative frequency of the two classifications.

4.6 Governance and algorithmic implications

The implementation demonstrates how cooperative transaction records can be used to support traceable account-level Zakat eligibility reconstruction. Each system output can be linked to a chronological balance trajectory, the

nisab thresholds applicable during the relevant period, detected interruption events, and the recorded haul-completion date.

This provides a more explicit basis for administrative review than a result derived only from an isolated balance or an undocumented manual calculation. It also supports consistent application of the configured rules because the same temporal conditions are applied across the member records processed by the framework.

The results should nevertheless be interpreted within the scope of the available data. The framework evaluates financial balances recorded within the cooperative system and does not incorporate external assets, personal liabilities, business holdings, or other zakatable wealth that may affect a member's complete personal Zakat position.

The framework therefore functions as a compliance-support and account-level eligibility-reconstruction mechanism rather than as a replacement for all member disclosure or expert jurisprudential assessment.

The study did not directly measure user perceptions of transparency, trust, explanatory adequacy, or administrative efficiency. Accordingly, these are treated as potential benefits of the traceable architecture rather than as empirically established behavioural outcomes.

More broadly, the implementation illustrates how cooperative financial information systems may extend beyond transaction recording to support the monitoring and administration of temporally constrained obligations.

4.7 Comparative and theoretical implications

Compared with previously implemented cooperative information-system modules for lending eligibility (Abdulkadir, 2026) and time-weighted dividend allocation (Abdulkadir et al., 2026), the proposed Zakat framework introduces a different form of temporal dependency.

Lending eligibility is commonly evaluated at an application or approval event, while dividend allocation is calculated within a defined accounting period. In contrast, the Zakat model adopted in this study requires the system to maintain an active temporal state, evaluate interruptions, apply historically varying thresholds, and reset progression when the qualifying condition is no longer satisfied.

This distinction extends event-based algorithmic decision models by demonstrating how an institutional information system can represent compliance as a condition that develops over time. The resulting output depends not only on the balance observed at one date but also on whether the qualifying condition remained satisfied throughout the required interval.

The framework also demonstrates that selected jurisprudential rules can be operationalised as explicit computational conditions while retaining the rule configuration and data assumptions on which the output is based. It does not establish that every jurisprudential interpretation can be represented by the same algorithm.

Although developed for cooperative-account-based Zakat eligibility, the underlying temporal model may inform other systems in which progression depends on maintaining a specified condition for a defined duration. Its applicability to areas such as welfare eligibility, certification validity, insurance qualification, or regulatory compliance was not empirically evaluated in the present study.

4.8 Design knowledge contribution

The implementation and evaluation support three design principles for representing duration-dependent obligations in institutional information systems.

1. Continuous compliance principle: Eligibility conditions that depend on duration should be represented as temporal states rather than as isolated decisions made only at reporting or assessment dates. In the proposed framework, reaching nisab initiates a candidate haul but does not itself establish completion. The qualifying state must remain active throughout the configured 354-day interval. This principle distinguishes threshold attainment from sustained temporal compliance.
2. Interruption-aware eligibility principle: Systems intended to represent duration-dependent obligations should treat interruption as an explicit computational event. In the framework, a decline below the applicable nisab terminates the active haul and clears its progression state. Eligibility progression therefore does not continue automatically after the governing condition has ceased to hold. This reset mechanism provides a reusable design pattern for systems in which continuous qualification is required.
3. Historically contextualised threshold principle: Where governing thresholds vary over time, historical reconstruction should use the parameter applicable during the period being assessed. The historical nisab repository enables the framework to compare each reconstructed balance with the threshold configured for

the corresponding date or validity period. This supports historically contextualised assessment and avoids applying a single present-day value retrospectively to all transactions.

Collectively, the principles extend the design of rule-based information systems from discrete eligibility decisions towards temporal-state monitoring. They may inform the design of related compliance-support systems, although their transferability beyond the Zakat and cooperative contexts requires further empirical evaluation.

5 Conclusion

This study developed and evaluated a continuous temporal compliance framework for reconstructing Zakat al-Mal eligibility from longitudinal transaction records within a cooperative financial information system. The framework represents haul progression as a temporal state, reconstructs members' recorded balances, applies historically contextualised nisab thresholds, detects interruptions, resets incomplete cycles, and classifies completed haul intervals using gold- and silver-based thresholds. Its application to cooperative transaction records covering January 2018 to February 2026 demonstrated that reaching nisab at a particular time does not necessarily result in haul completion, because subsequent balance or threshold changes may interrupt the qualifying state. The study therefore shows how cooperative-account-based eligibility can be reconstructed from chronological transaction histories rather than inferred solely from isolated balance observations.

From an Information Systems perspective, the framework extends rule-based decision support from point-in-time eligibility assessment towards interruption-aware temporal-state monitoring. The resulting design is traceable because each reconstructed outcome can be associated with the relevant balance trajectory, applicable nisab values, interruption events, and haul-completion date. However, the framework operates only on financial information recorded within the cooperative system and implements the particular haul and nisab configuration adopted in the study. It does not incorporate external assets or liabilities, does not represent every jurisprudential interpretation, and should not be treated as a complete determination of a member's overall personal Zakat liability.

The evaluation was limited to one cooperative institution, five manually traced trajectories, and one implementation environment. Future research should therefore examine the framework across multiple institutions and datasets, undertake broader independent verification, compare alternative computational approaches, and support configurable jurisprudential rules. Within these limitations, the study provides a practical foundation for incorporating duration-dependent eligibility monitoring into cooperative financial information systems and offers design guidance for other institutional applications in which qualification depends on maintaining specified conditions over time.

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Conflict of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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