FROM POLICY TO CODE: ALGORITHMIC ENFORCEMENT OF COOPERATIVE LENDING RULES IN UNIVERSITY COOPERATIVE SYSTEMS

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ABSTRACT

Digitisation of cooperative commodity management systems often begins with automating reservation, inventory, and transaction recording processes. However, post-deployment experience often reveals governance and policy-enforcement gaps that are not evident at the design stage. Building on a previously deployed web-based system for the KASU Majlis Cooperative Society, this study presents an algorithmic decision framework that embeds cooperative lending policy directly into system logic. The framework operationalises lending and repayment eligibility rules through cumulative obligation modelling, time-aware assessment of repayment behaviour, and automated decision enforcement. Using live operational data from the deployed system, the study demonstrates how policy-driven decision logic improves repayment discipline, reduces reliance on administrative discretion, and enhances transparency through structured, automated notifications to members. Rather than introducing new user-facing functionality, the contribution of this study lies in showing how cooperative governance policies can be translated into executable rules within an operational information system. The proposed framework offers a replicable and explainable approach for university cooperatives and similar organisations in developing contexts seeking to strengthen post-deployment policy enforcement in digital lending environments.

Keywords: Information systems, ICT4D, algorithmic governance, cooperative societies, policy enforcement

INTRODUCTION

Cooperative societies play an important role in supporting staff welfare within Nigerian universities by providing organised access to savings, credit facilities, and essential commodities. In an effort to improve efficiency, accountability, and record management, many cooperatives have begun adopting digital platforms to replace manual, paper-based operations. Existing studies indicate that such digitisation initiatives can streamline administrative workflows, improve data accuracy, and enhance service delivery, particularly within resource-constrained institutional settings.

In earlier work, Abdulkadir et al. (2024) reported the design and deployment of a web-based food commodities reservation and management system for the KASU Majlis Cooperative Society. That study demonstrated the practical feasibility of migrating from manual and spreadsheet-driven processes to an integrated digital platform that supported online commodity requests, inventory monitoring, and basic transaction recording. While the deployed system successfully met its immediate operational objectives, sustained post-deployment use exposed an important limitation: the lack of automated mechanisms for enforcing cooperative repayment policies during eligibility assessment for new commodity requests.

In routine cooperative operations, members often accumulate overlapping financial obligations across successive collection cycles. Repayments, which are commonly effected through salary deductions, may occur partially or with delays. The original system evaluated eligibility largely through isolated transaction checks and administrative judgment, an approach that proved inadequate for managing cumulative obligations and time-dependent repayment expectations. This limitation led to operational inconsistencies, including instances where compliant members were restricted or where financial risk was insufficiently controlled.

This study addresses the identified limitation by introducing a post-deployment enhancement centred on algorithmic eligibility and capacity checking. Rather than modifying user interfaces or core system architecture, the focus is on embedding cooperative lending policies directly into system logic. This is achieved through cumulative obligation modelling, temporal assessment of repayment behaviour, and automated enforcement of minimum payment thresholds. These enhancements reposition the system from a transactional record-keeping tool to a governance-aware decision support framework capable of applying policy rules consistently and transparently.

By illustrating how cooperative lending policies can be translated into executable decision logic within an operational system, the study contributes to applied discussions on algorithmic governance in resource-constrained financial environments.

Beyond operational efficiency, the digitisation of cooperative systems in developing institutional contexts raises broader questions of governance, accountability, and institutional capacity. Within the field of Information and Communication Technologies for Development (ICT4D), digital systems are increasingly viewed not merely as tools for automation, but as mechanisms for embedding rules, improving transparency, and strengthening organisational decision-making in resource-constrained environments (Sturn, 2024; Zheng et al., 2018). From this perspective, the challenge faced by many digitised cooperatives is not the absence of technology, but the absence of policy-aware logic that ensures consistent and fair enforcement of institutional rules once systems are deployed. This study therefore aligns with ICT4D concerns by examining how cooperative lending policies can be translated into executable system logic that supports accountable governance during sustained real-world use.

LITERATURE REVIEW

This literature review surveys research on digitising cooperative financial services, the shift toward governance-aware systems, and the specific challenges of policy enforcement and temporal logic

that inform the present study.

Digitisation of cooperative financial services in resource-constrained settings

Cooperative societies continue to play an important role in savings mobilisation, access to credit, and welfare support, particularly in developing economies where access to formal financial services remains limited. Within Nigerian universities, cooperatives often operate as semi-formal financial institutions that support staff through loan schemes, food commodity provisioning, and collective procurement arrangements. Despite their importance, many of these cooperatives still depend on manual record-keeping or fragmented spreadsheet-based systems, which frequently result in delays, data inconsistencies, and accountability challenges.

Existing empirical studies indicate that the introduction of information technology into cooperative operations can improve record accuracy, processing speed, and administrative coordination. For example, Elee (2021) reported that digitisation enhances service delivery in Nigerian cooperative societies by reducing human error and improving access to member records. Similarly, et al. (2024) stated that the use of digital tools can strengthen transparency and trust among cooperative members, although adoption is often constrained by infrastructural limitations and organisational readiness.

From a broader organisational perspective, digital transformation in small and medium-scale institutions is typically incremental and shaped by factors such as affordability, availability of technical skills, and governance capacity. Policy-oriented analyses emphasise that while digitisation can reduce operational costs and improve efficiency, systems that focus solely on automating transactions may introduce new risks if institutional rules are not adequately embedded (OECD, 2021). These risks include weak enforcement of internal policies and inconsistent decision-making outcomes.

Within the literature on cooperative management systems, much attention has been given to the development of web-based or mobile applications that digitise loan applications, transaction recording, and member services. Several applied studies have implemented such systems using widely accessible technologies such as PHP and MySQL. For example, Rilwan et al. (2022) described a custom web-based cooperative loan management system built on a PHP–MySQL architecture, while Maliwa and Simatela (2025) reported a similar approach in the development of a cooperative information management system. Although these implementations successfully replace manual workflows, repayment compliance is often treated as an administrative responsibility rather than as a constraint enforced directly by system logic.

From digitisation to governance-aware information systems: Embedding policy in decision logic

A persistent challenge in many digitised cooperative systems is the continued dependence on manual discretion when enforcing lending and repayment policies. Systems that focus primarily on recording transactions often leave administrators responsible for interpreting balances, assessing repayment behaviour, and determining eligibility for new requests. This reliance on human judgement can lead to inconsistent decisions, member disputes, and the gradual accumulation of unpaid obligations.

Within information systems research, organisational policy is increasingly conceptualised as a set of explicit business rules that define acceptable system behaviour. Vavpotič et al. (2022) noted that making such rules explicit supported system reliability, traceability, and long-term maintainability. From this perspective, governance is embedded within system design rather than treated as a separate administrative activity.

This perspective is consistent with emerging work on policy-as-code, where organisational policies are translated into machine-executable logic to support consistent enforcement (Mubarkoot et al., 2022; Vakhula et al., 2025). Although much of this literature originates in security and compliance domains, the underlying principle of operationalising rules through deterministic logic is equally relevant to cooperative lending environments.

In cooperative and welfare provisioning systems, policy-driven decision logic is particularly useful because it reduces ambiguity in eligibility assessment and supports procedural fairness. Even without the use of advanced artificial intelligence techniques, rule-based decision support systems are widely regarded as appropriate for financial decisions that demand transparency, consistency, and auditability (Sachan et al., 2019).

Financial eligibility, affordability checks, and explainability

Eligibility assessment in lending and credit systems is commonly shaped by a combination of repayment capacity, outstanding obligations, and policy-defined thresholds. Within cooperative settings, this assessment is often implemented through affordability checks based on salaries of members and their existing deductions, alongside requirements for minimum repayment progress before further borrowing is allowed. Transparent and clearly articulated decision criteria are therefore essential, particularly in institutional environments where members expect decisions to be fair, consistent, and accountable (Kostopoulos et al., 2024).

Recent work on algorithmic decision-making in credit and microfinance systems reinforces the importance of explainability and alignment with organisational values. Garcia et al. (2023) observed that decision processes perceived as opaque may undermine trust and reinforce perceptions of unfairness, even when outcomes are technically correct. In a similar vein, Koefer et al. (2023) noted that fairness in financial decision systems depends not only on the decisions reached, but also on the extent to which those decisions can be clearly explained and justified to affected members.

Although some organisations have adopted AI-enabled credit scoring approaches (Li et al., 2024), many cooperative societies operate under conditions where data limitations, modest transaction volumes, and regulatory or institutional constraints limit the feasibility of such models. In these contexts, rule-based systems grounded in explicit policy logic remain a practical and appropriate choice. Their deterministic and explainable nature allows cooperatives to automate eligibility decisions while retaining accountability and alignment with established governance practices.

Temporal repayment policies and cumulative obligation assessment

An important yet often overlooked aspect of cooperative information systems concerns the temporal nature of repayment policies. In practice, many cooperatives distinguish informally between short-term arrears, partial compliance and persistent default. However, these distinctions are seldom encoded explicitly within system logic. As a result, eligibility assessments frequently

rely on current balances or the most recent transaction, with limited consideration of cumulative exposure or repayment behaviour over time.

Research on business rules highlights the role of temporal constraints, such as the time elapsed since an obligation was incurred, in supporting effective policy enforcement (Vavpotič et al., 2022). In financial systems, time-aware logic allows policies to be applied progressively. For example, systems may permit partial repayment during an initial period but require full settlement once outstanding obligations persist beyond an acceptable timeframe. Where such logic is absent, compliant members may be treated unfairly, while longer-term financial risk remains insufficiently controlled.

This challenge is further intensified by the lack of cumulative obligation modelling. When transactions are evaluated in isolation, an overall financial exposure of a member can be misrepresented, particularly in cases where unpaid balances are carried forward across multiple repayment cycles. Addressing this limitation requires eligibility models that reconstruct total obligation by combining outstanding balances with payments already made, rather than relying solely on the most recent debit or credit record.

Notifications, auditability, and operational transparency

Beyond determining eligibility, cooperative information systems are more effective when members receive timely and specific explanations for approval or restriction decisions. Clear communication helps to reduce disputes and supports trust in automated processes, particularly where financial decisions affect member welfare. The *World Development Report 2021* highlights that the value derived from data-driven systems depends on trust, credible rules, and institutional accountability, principles that are directly relevant to cooperative information systems (World Bank, 2021).

Consistent with this perspective, existing studies support system designs that integrate rule-based decision enforcement with clear and traceable notification mechanisms. Such designs ensure that automated outcomes are not only applied consistently but can also be justified and reviewed when necessary. This is especially important in institutional environments where decisions may be questioned by members or require administrative explanation.

Despite these advances, there remains limited empirical evidence on how cooperative financial policies are translated into executable decision logic within operational systems. In particular, policies involving cumulative obligations and time-dependent repayment conditions are rarely documented beyond conceptual discussion. Much of the existing literature emphasises initial system deployment, with comparatively little attention given to post-deployment governance refinement and operational transparency.

ICT4D, Digital Governance and Institutional Capacity

Contemporary ICT4D research has increasingly been shifted away from narrow concerns with technology access or mere automation towards examining how digital systems reshape institutional practices, governance structures, and decision-making processes in developing environments (Sturn, 2024). Walsham (2017) argued that ICT4D outcomes should be assessed in terms of how technologies support organisational accountability, transparency, and the capacity of institutions to enact their own rules consistently. Similarly, Zheng et al. (2018) conceptualised ICT4D as a process through which information systems are embedded within social and organisational structures, influencing how policies are operationalised rather than merely recorded.

This perspective is particularly relevant for cooperative societies, which often operate as semi-formal financial institutions with clearly defined but informally enforced lending rules. While digitisation can improve record-keeping and transaction speed, ICT4D research highlights the risk that systems which fail to embed institutional policy logic may reproduce or even amplify governance weaknesses. The present study responds to this concern by demonstrating how cooperative lending policies can be encoded as executable decision rules within an operational system, thereby strengthening post-deployment governance rather than relying on discretionary administrative judgement.

Relation to Previous Work

This study builds directly on the work of Abdulkadir et al. (2024), which reported the design and initial deployment of an integrated food commodities reservation and management system for the KASU Majlis Cooperative Society. The study focused on replacing manual and spreadsheet-based processes with a centralised web platform supporting online commodity requests, inventory tracking, reservation handling, and basic transaction recording. Its main contribution lay in demonstrating the practical feasibility and operational benefits of digitising cooperative commodity provisioning within a resource-constrained university environment. Experience from sustained post-deployment use, however, revealed a governance-related limitation that was not the primary focus of the earlier work. In the initial system, eligibility to submit new commodity requests was determined largely through transaction-level checks and administrative judgement. The system did not implement automated mechanisms for enforcing cooperative repayment and eligibility policies based on cumulative obligations, partial repayments spanning multiple cycles, or time-dependent repayment conditions. As system usage expanded, these limitations increased the risk of inconsistent outcomes, including cases where members who had met minimum repayment expectations were restricted, while cumulative exposure was insufficiently controlled in others.

The present study extends the earlier work by addressing this limitation through a targeted post-deployment enhancement centred on policy-driven decision logic. Rather than revisiting interface design, database architecture, or the core reservation workflow, the focus is placed on translating cooperative lending and repayment rules into executable system logic that operates autonomously at the point of request. The enhancement introduces cumulative obligation modelling that integrates carried-forward balances with newly incurred costs, time-aware repayment logic that distinguishes between short-term arrears and longer-standing obligations, and structured outcomes supported by automated notifications to members. These additions shift the system beyond transaction recording towards a governance-aware decision support role, enabling more consistent and transparent application of cooperative policy.

Taken together, the two studies present a coherent progression in cooperative digitisation. The earlier work established a functional digital foundation for commodity reservation and record management, while the present study demonstrates how embedded decision logic can strengthen operational governance, reduce reliance on discretionary judgement, and support fairer outcomes during sustained real-world use.

Table 1 shows the conceptual comparison between the initial Food

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Commodities Reservation System reported in Abdulkadir et al. (2024) and the post-deployment, policy-driven eligibility and capacity-checking framework introduced in the present study.

Table 1: Conceptual Contrast between Abdulkadir et al. (2024) and the Present Study

Dimension	Abdulkadir et al. (2024)	Present Study
Primary Focus	Digitization of food commodity reservation and inventory processes	Algorithmic enforcement of cooperative financial policy
System Maturity Stage	Initial deployment	Post-deployment operational refinement
Repayment Handling	Basic recording of payments	Cumulative obligation modelling across multiple transactions
Eligibility Decision Basis	Transaction-level checks and administrative oversight	Automated rule-based decision logic
Temporal Awareness	Limited (current transaction focused)	Time-aware logic (months since collection vs repayment progress)
Financial Risk Control	Implicit	Explicit capacity and affordability assessment
Outstanding Balance Logic	Isolated per transaction	Aggregated cumulative balance
Policy Enforcement	Manual and discretionary	Embedded, automated, and consistent
Member Communication	Basic notifications	Automated, personalized, transparent financial explanations
Governance Role of System	Record-keeping tool	Policy-aware decision support system
Research Contribution	Proof-of-concept system deployment	Algorithmic codification of cooperative lending policy

MATERIALS AND METHODS
Study Context and System Setting
This study was carried out within the operational setting of the KASU Majlis Cooperative Society, a university-based cooperative that provides staff members with access to food commodities through structured collection and repayment arrangements. The cooperative operates a web-based Food Commodities Reservation and Management System that was previously designed and deployed by Abdulkadir et al. (2024) to support its routine activities. The system enables members to submit commodity requests online and supports inventory tracking, transaction recording, and repayment monitoring. However, sustained use of the system in a real operational environment revealed practical challenges related to the enforcement of cooperative lending and repayment policies. These challenges were particularly evident in cases where members accumulated overlapping obligations and made partial repayments across different collection cycles.

This study therefore focuses on the post-deployment enhancement of the existing system through the introduction of an algorithmic eligibility and capacity-checking framework. The enhancement was implemented directly within the live production system and evaluated using actual cooperative transaction data generated during routine operations.

Data Sources and Inputs
The decision framework relies exclusively on data already captured and maintained within the cooperative information system. No external datasets were introduced for the purpose of this study. All eligibility and capacity assessments are therefore grounded in routine operational records generated through everyday system use.

1. Member Records: Member information is stored in the staff table. These records include the staff personnel number, staff name and contact details such as email address, and the current outstanding balance for food commodities. In addition, salary information and records of existing deductions are also maintained. Collectively, these data provide the baseline profile required for evaluating repayment status and financial exposure.
2. Transaction History: Transaction-level data are stored in the commodity transactions table. This table records commodity collections, identified by debit entries associated with food item purchases, as well as repayments recorded as credit entries linked to payment transactions. Each transaction is time-stamped using the transaction date field. These records are used to identify the most recent commodity collection, the most recent repayment, and patterns of cumulative repayment behaviour over time, which are central to the operation of the eligibility logic.
3. Salary and Deduction Information: For cases where financial capacity assessment is required, the system retrieves net salary values alongside existing cooperative deductions. These may include loan repayments, savings contributions, or obligations arising from other commodity streams. This information supports an affordability assessment that determines whether a member can reasonably absorb additional financial commitments without breaching cooperative policy.

Decision Framework Overview
The enhanced system incorporates a dedicated decision-logic layer that evaluates a member's eligibility to submit a new food commodity request before the request is formally accepted. This layer operates between the retrieval of transaction records and the final confirmation of a request, ensuring that policy compliance is assessed at the point of action.

Eligibility decisions are based on the combined evaluation of four interrelated dimensions. These include the member's cumulative financial obligation, the temporal status of repayment, compliance with minimum repayment thresholds defined by the policy of the cooperative, and the member's financial capacity to absorb additional obligations.

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Based on this evaluation, the decision layer produces one of three explicit outcomes. A request may be approved, deferred pending partial settlement, or blocked until full repayment is completed. Each outcome is linked to a clearly defined policy rationale and, where applicable, triggers an automated notification that explains the basis of the decision to the member.

Specifically, the system returns one of the following outcomes:

- **ALLOW**, indicating that the member may proceed with a new request
- **REQUIRE HALF PAYMENT**, indicating that the member must meet a minimum repayment threshold before proceeding
- **REQUIRE FULL PAYMENT**, indicating that all outstanding obligations must be settled before a new request can be considered

Table 2 presents the policy-driven eligibility rules implemented within the enhanced cooperative commodity management system. Eligibility outcomes are determined through the combined consideration of elapsed time since the last commodity collection, recent repayment activity, and the member's cumulative outstanding obligation.

The decision logic applies progressive repayment discipline by tightening requirements as obligations persist over time. At the same time, it preserves fairness by allowing members who demonstrate timely and sufficient repayment behaviour to proceed without unnecessary restriction.

Table 2. Policy-Driven Eligibility Decision Rules for Food Commodity Requests

Months Since Last Collection (MC)	Months Since Expected First Payment (MP)	Repayment Status (Cumulative)	System Decision	Policy Rationale
0	0 (payment due current month)	Any	ALLOW	Fresh collection; repayment process has not yet matured
1	0 (payment due last month)	Paid ≥ 50% of total obligation	ALLOW	Minimum repayment commitment satisfied
1	0 (payment due last month)	Paid < 50% of total obligation	REQUIRE HALF PAYMENT	Partial repayment insufficient or Repayment has not commenced
2	1 (payment due two months ago)	Paid ≥ 50% of total obligation	ALLOW	Early repayment satisfies minimum threshold
2	1 (payment due two	Paid < 50% of total obligation	REQUIRE HALF PAYMENT	Repayment inadequate after two

Months Since Last Collection (MC)	Months Since Expected First Payment (MP)	Repayment Status (Cumulative)	System Decision	Policy Rationale
	months ago)			months
2	≥2 (payment overdue)	Paid ≥ 50% of total obligation	ALLOW	Sustained repayment behaviour
2	≥2 (payment overdue)	Paid < 50% of total obligation	REQUIRE HALF PAYMENT	Outstanding obligation remains significant
>2	Any	Any	REQUIRE FULL PAYMENT	Chronic default; leniency withdrawn

Figure 1 presents a decision-flow diagram that illustrates the eligibility logic applied when approving new food commodity requests, based on cumulative obligation, repayment status, and time elapsed since the last collection.
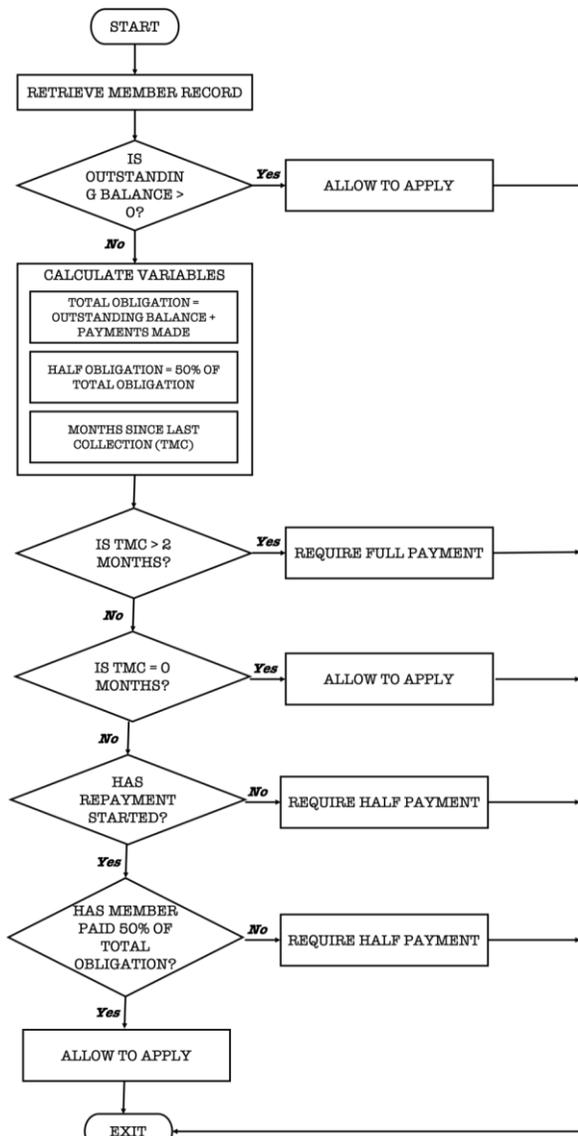
Figure 1: Policy-driven eligibility decision flow for food commodity requests

Computer Variables and Definitions
The system computes a set of computed variables from existing transaction records to support consistent, policy-aligned decision-making. These variables provide a structured representation of a member's repayment position and are used to support automated eligibility assessment.

The **outstanding balance (foodBal)** represents the current unpaid amount for food commodities. This value reflects the member's remaining liability at the time of evaluation. The **last collection amount (lastDebit)** records the value of the most recent commodity collection, while the **last payment amount (lastCredit)** captures the amount of the most recent repayment made by the member.

Temporal aspects of repayment are represented using two time-based variables. **Months since last collection (MC)** is calculated as the number of calendar months between the current date and the date of the most recent commodity collection. Similarly, **months since expected first payment (MP)** measures the number of calendar months since the scheduled first installment was due. It tracks whether repayment began on schedule (MP = 0), was delayed by one month (MP = 1), or is significantly overdue (MP $\geq$ 2). This metric is used to support escalation logic where required, particularly for assessing compliance with the standard repayment timeline.

To reflect a member's true financial exposure, the system computes the **total obligation (totalObligation).** This value is defined as the sum of the current outstanding balance and the payments already made during the active obligation cycle. By reconstructing the full obligation in this way, the system avoids reliance on isolated transaction values and supports a more accurate assessment of repayment status.

Based on the total obligation, a **half-payment threshold (halfThreshold)** is calculated as one half of the total obligation. This threshold is used to evaluate minimum repayment compliance within defined time windows. The formulation avoids transaction-centric bias and ensures that members with carried-forward balances are assessed fairly and consistently.

Eligibility Evaluation Pseudocode
The eligibility algorithm applies cooperative repayment rules through a combination of time-aware evaluation and cumulative obligation modelling. Rather than relying on isolated transaction checks, the algorithm assesses a member's repayment position in relation to elapsed time since the most recent commodity collection and the extent of repayment made. This approach enables the system to enforce repayment discipline consistently while accounting for partial compliance within acceptable policy windows.

The eligibility evaluation logic is implemented as follows:

```
FUNCTION EvaluateEligibility(staffNum, today):

    member ← GetMember(staffNum)
    foodBal ← member.outstandingFoodBalance

    IF foodBal ≤ 0:
        RETURN ALLOW

    lastCollection ← GetLastDebitTransaction(staffNum)

    MC ← MonthsBetween(today, lastCollection.date)

    Payments ← GetAllCreditTransactionsSince(staffNum,
lastCollection.date)
    paidSoFar ← SUM(payments.amount)

    totalObligation ← foodBal + paidSoFar
    halfThreshold ← totalObligation / 2

    IF MC > 2:
        RETURN REQUIRE_FULL

    IF MC == 0:
        RETURN ALLOW

    IF MC IN {1, 2}:
        IF paidSoFar ≥ halfThreshold:
            RETURN ALLOW
        ELSE:
            RETURN REQUIRE_HALF

END FUNCTION
```

The decision logic implements a graduated enforcement strategy. Members with recent collections are allowed to proceed, recognising the lag inherent in salary-based repayment processes. As time progresses, minimum repayment thresholds are applied to distinguish between compliant and non-compliant behaviour. Full settlement is required only where obligations persist beyond the defined repayment window.

Financial Capacity and Affordability Assessment
In addition to repayment eligibility, the system also assesses whether a member has sufficient financial capacity to take on an additional obligation without undermining the financial sustainability of the cooperative. This assessment focuses on affordability rather than risk prediction and is grounded in existing salary and deduction records already maintained by the cooperative.

The capacity check is applied only after repayment eligibility conditions have been satisfied. Its purpose is to ensure that new commodity requests remain consistent with cooperative affordability rules and do not impose repayment burdens that exceed a member's disposable income.

The capacity evaluation logic is implemented as follows:

```
FUNCTION EvaluateCapacity(staffNum, requestedAmount):

    salaryProfile ← GetSalaryProfile(staffNum)
    netSalary ← salaryProfile.netSalary

    deductions ← GetActiveMonthlyDeductions(staffNum)
    totalDeductions ← SUM(deductions)

    disposableIncome ← netSalary – totalDeductions

    maxRepayment ← disposableIncome × (1/2)
    proposedRepayment ← ComputeExpectedRepayment(requestedAmount)

    IF disposableIncome ≤ 0:
        RETURN DENY

    IF proposedRepayment ≤ maxRepayment:
        RETURN APPROVE
    ELSE:
        RETURN DENY
END FUNCTION
```

This rule-based capacity assessment ensures that eligibility decisions remain transparent and consistent with cooperative affordability policies. By relying on clearly defined thresholds derived from salary and existing deductions, the approach supports explainable decision-making and avoids discretionary judgement, which is particularly important in resource-constrained institutional settings.

Workflow Integration and Notification Mechanism
During system operation, the commodity request workflow follows a structured sequence. First, the system retrieves the relevant member profile and transaction history. Eligibility is then evaluated using the repayment policy logic embedded in the decision layer.
Where the outcome is ALLOW, the workflow proceeds to the financial capacity assessment. If the outcome is REQUIRE HALF or REQUIRE FULL, the request is halted and the member is notified accordingly. Requests that pass the eligibility stage but fail the capacity assessment are declined with a structured financial explanation.
Notifications are generated automatically and are designed to support transparency and clarity. Each notification includes a summary of the outstanding balance, the required payment threshold, and the specific reason for the decision. Clear guidance is also provided on the actions required for the member to restore eligibility.
By integrating decision logic and notification within the request workflow, the system ensures that eligibility outcomes are not only automated but also transparent, traceable, and auditable within the cooperative's operational context.

Evaluation Approach
The enhanced framework was assessed through close observation of its behaviour within the live system during routine cooperative operations. Evaluation focused on how eligibility decisions were produced under real operational conditions rather than through controlled experimentation.
A representative worked example, drawn from actual transaction records, was used to examine whether the eligibility logic operated correctly and in a manner consistent with cooperative repayment policy. Particular attention was given to situations involving partial repayments and overlapping financial obligations, as these cases had previously resulted in inconsistent or ambiguous decision outcomes.

RESULTS
This section presents the outcomes observed following the integration of the policy-driven eligibility and capacity-checking framework into the operational food commodities management system of the KASU Majlis Cooperative Society. The findings are drawn from observed system behaviour during routine use, administrative experience, and representative operational cases recorded after deployment. Together, these sources provide a practical account of how the enhanced decision logic performed within the live cooperative environment.

Enforcement of Repayment Eligibility Policies
Following the deployment of the enhanced decision-logic framework, eligibility for new food commodity requests was determined using a combination of cumulative outstanding balances, time elapsed since the last collection, and evidence of repayment progress. This marked a departure from the earlier transaction-centred approach, which assessed eligibility largely on the basis of the most recent debit or the mere presence of a remaining balance.
In operational terms, the system generated three clearly defined outcomes, namely ALLOW, REQUIRE HALF PAYMENT, and REQUIRE FULL PAYMENT, each derived from predefined cooperative policy rules. These outcomes were applied consistently across all members, thereby reducing dependence on manual verification and discretionary judgement by cooperative administrators. Requests linked to balances that had remained unsettled for more than two months were automatically restricted until full repayment was completed. By contrast, members within the initial repayment period were assessed against minimum repayment thresholds rather than being categorically blocked.
Administrative review of system behaviour indicated that the

resulting eligibility decisions were broadly aligned with the repayment policy intentions of the cooperative. This alignment was particularly evident in cases involving overlapping obligations and partial repayments, where the enhanced logic produced outcomes that were perceived as more consistent and equitable than those generated under the previous transaction-focused approach.

Resolution of Transaction-Centric Eligibility Errors
A significant outcome of the enhanced framework was the reduction of incorrect eligibility decisions that had arisen from transaction-level repayment checks. Under the earlier system, members with outstanding balances were often prevented from submitting new requests, even when they had met cooperative repayment expectations through partial payments.

The revised logic addressed this limitation by reconstructing the total balance for each repayment cycle. This total was defined as the combined value of the remaining outstanding balance and payments already made. Using this approach, the system was better able to differentiate between members who were genuinely non-compliant and those who had demonstrated acceptable repayment behaviour. This adjustment directly responded to a recurring operational concern raised by administrators during the initial deployment period.

As a result, members who had satisfied minimum repayment thresholds were no longer incorrectly classified as ineligible. At the same time, members with inadequate repayment progress continued to be appropriately restricted, thereby improving both fairness and consistency in eligibility decisions.

Worked Example: Application of Eligibility Decision Logic
This section illustrates how the enhanced eligibility framework operates in practice by drawing on a representative case observed during post-deployment system use.

In month A, a cooperative member had an outstanding food commodity balance of ₦24,750 from earlier requests. During the same month, the member collected additional food commodities valued at ₦64,900. This resulted in a cumulative financial obligation of ₦89,650. Within month A, the member made a repayment of ₦44,825 through salary deduction, representing exactly half of the total obligation.

When the member attempted to submit a new food commodity request in month B, the system calculated that one month had elapsed since the most recent collection. As an outstanding balance remained, eligibility was assessed using cumulative obligation modelling and time-aware repayment rules. The system recognised that repayment had commenced and confirmed that the amount paid met the minimum half-payment requirement applicable within the one to two month repayment window.

On the basis of these conditions, the system approved the new request. This decision aligned with the repayment policy of the cooperative and reflected the member's demonstrated compliance. Under the earlier transaction-centric logic, the same request would have been incorrectly rejected solely due to the presence of a remaining balance, despite adequate repayment progress.

Transparency and Automated Member Communication
When eligibility conditions were not satisfied, the system automatically generated personalised notifications that explained the basis for each decision. These messages explicitly referenced outstanding balances, the time elapsed since the last commodity collection, and the applicable payment thresholds. Providing this

level of detail improved transparency by offering members clear and actionable information, rather than relying on brief or generic rejection notices.

From an operational perspective, administrators observed a reduction in follow-up enquiries from members regarding eligibility outcomes. The system-generated explanations clarified the reasons for restriction and the steps required to regain eligibility. This experience indicates that embedding decision rationale directly within automated communication can improve member understanding while also reducing routine administrative workload.

Observed Operational Outcomes
Post-deployment observations indicate that the enhanced eligibility and capacity-checking framework supported more consistent operational behaviour within the cooperative system. Eligibility decisions were applied uniformly through automated, rule-based logic, which reduced reliance on ad hoc administrative judgement when assessing repayment compliance.

The system also reduced cases where members who had met repayment expectations were incorrectly denied access to new requests. Decisions showed closer alignment with the governance principles of the cooperative, particularly in how cumulative obligations and repayment progress were interpreted.

In addition, communication with members became more transparent. Eligibility outcomes were accompanied by clearer explanations of the underlying financial conditions, which improved understanding of decisions and reduced ambiguity.

Taken together, these observations suggest that encoding cooperative lending policy as executable decision logic can enhance both the reliability and perceived fairness of digitised cooperative systems in routine operational use.

DISCUSSION
From Transaction-Centric Automation to Policy-Aware Decision-Making
The findings of this study indicate that digitising cooperative operations, on its own, is not sufficient to ensure effective financial governance once a system enters sustained operational use. Although the earlier system reported in Abdulkadir et al. (2024) successfully automated commodity reservation and repayment recording, experience from post-deployment use showed clear limitations. In practice, transaction-level checks did not reflect how cooperative lending actually unfolds, as members often carry balances forward across months, make partial repayments, and depend on salary deductions that may be delayed.

The enhanced decision framework presented in this study responds to these challenges by moving eligibility assessment away from isolated transaction checks towards a policy-aware, cumulative evaluation approach. By modelling cumulative obligations, the system reconstructs a more accurate picture of a member's financial exposure and applies eligibility decisions in line with cooperative repayment rules. As a result, automation extends beyond record-keeping to include the consistent enforcement of institutional policies that were previously managed through administrative judgement.

Effectiveness of Cumulative Obligation Modelling
One important outcome of the enhanced framework is the correction of eligibility errors that arose from fragmented repayment assessment. Under the original logic, members with outstanding balances were sometimes classified as non-compliant, even when

they had satisfied minimum repayment expectations across combined obligations. This limitation stemmed from evaluating repayments at the level of individual transactions rather than considering the member's overall financial position.

The cumulative obligation model addresses this issue by consolidating unpaid balances and prior repayments into a single, coherent representation of financial exposure. This approach allows eligibility decisions to reflect actual repayment behaviour rather than isolated balance snapshots.

The worked example included in this study illustrates the practical value of this adjustment. A member who had repaid exactly half of the total cumulative obligation was correctly recognised as eligible to submit a new request under the enhanced logic, whereas transaction-level checks would have led to an inconsistent outcome. This demonstrates that cumulative modelling supports more accurate and equitable decision-making, particularly in cooperative settings where obligations accumulate gradually over time rather than arising as discrete, independent transactions.

Temporal Enforcement and Repayment Discipline

The incorporation of time-aware rules strengthens policy enforcement by recognising that repayment obligations change as time progresses. Instead of applying a single rule to all outstanding balances, the system distinguishes between short-term, medium-term, and long-term arrears based on the number of months elapsed since the last commodity collection. This enables the cooperative to apply graduated responses, allowing flexibility during early repayment periods while enforcing stricter conditions where obligations remain unresolved over longer durations.

This temporal structure reflects established cooperative practices, in which initial leniency is commonly granted but reduced as arrears persist. By embedding these expectations directly into system logic, the framework supports consistent application of repayment policy across all members. This approach reduces ambiguity in eligibility decisions and limits the scope for disagreement. The use of rule-based logic also preserves explainability, ensuring that decisions can be clearly justified without dependence on opaque or difficult-to-interpret scoring methods

Governance, Fairness, and Reduction of Administrative Discretion

From a governance perspective, the automated enforcement of eligibility rules reduces reliance on discretionary decision-making in a practical and meaningful way. In manual or semi-automated arrangements, administrators are often required to assess repayment status individually, which can introduce inconsistency, perceptions of bias, and avoidable delays. The enhanced framework addresses these challenges by applying clearly defined rules consistently at the point of request, rather than depending on ad hoc judgement.

This consistency strengthens both fairness and accountability within the cooperative. All members are assessed using the same criteria, and eligibility outcomes are based on transparent computations rather than subjective interpretation. In addition, personalised notifications that explain approval or restriction decisions make the reasoning behind system actions visible to members. As a result, the system operates not only as an administrative support tool, but also as an embedded mechanism for enforcing cooperative governance in a clear and accountable manner.

Practical Implications and Replicability

Although the framework was developed within the specific setting of the KASU Majlis Cooperative, the underlying design principles have wider relevance. Many cooperatives and member-based financial organisations operate under comparable conditions, such as limited technical and financial resources, dependence on salary-based repayment mechanisms, and the need to apply lending rules in a manner that is both transparent and enforceable. In this context, the rule-based eligibility and capacity-checking logic presented in this study provides a low-cost and explainable alternative to more complex credit-scoring methods that may be difficult to implement or sustain in resource-constrained environments. From an ICT4D standpoint, the contribution of this study lies in demonstrating how institutional policy can be operationalised through system logic to support accountable governance in a resource-constrained setting. Rather than introducing complex predictive models, the system relies on transparent, rule-based decision logic aligned with cooperative norms and administrative realities. This approach is consistent with ICT4D arguments that emphasise appropriateness, explainability, and institutional fit over technological sophistication (Walsham, 2017; Zheng et al., 2018). By embedding lending rules directly into system behaviour, the framework illustrates how digital systems can strengthen institutional capacity and fairness during sustained operational use.

By tracing how the system evolved in response to concrete operational challenges, the study offers practical insight into post-deployment system refinement in cooperative settings. The findings indicate that translating organisational policy into executable system logic is an important step in progressing beyond basic process automation towards more robust and self-enforcing financial information systems.

CONCLUSION

The Integrated Food Commodities Management System for the KASU Majlis Cooperative Society was implemented to digitize commodity reservation, inventory management, and basic transaction recording, addressing the limitations of the prior manual approach. Post-deployment evaluation revealed that, while the system successfully automated routine operations, operational challenges arose in enforcing cooperative lending and repayment policies, including assessing eligibility, handling partial repayments, tracking cumulative obligations, and managing time-dependent repayment rules.

To address these challenges, a policy-driven eligibility and capacity-checking framework was embedded within the system, enabling automated enforcement of cooperative financial rules. This enhancement introduced cumulative obligation modeling, time-aware assessment of repayment behaviour, and affordability checks based on salary and existing deductions, allowing eligibility decisions to reflect a comprehensive view of each member's financial exposure. The implementation improved consistency, fairness, and transparency, reducing reliance on administrative discretion and preventing incorrect exclusion of compliant members.

The system now provides cooperative staff with a governance-aware decision support tool, ensuring that institutional policies are systematically enforced within daily operations. While it successfully improves operational efficiency and transparency, future enhancements could optimize decision-making and strengthen member welfare.

Based on these findings, the following recommendations are proposed:

1. Extension Across Cooperative Services: While the current framework enforces cooperative financial rules only for food commodities, the same principles can be applied to other facilities offered to members, such as building materials, vehicles, land or electronics. Extending the framework across these services would enhance fairness, transparency, and operational efficiency throughout the cooperative.

2. Adaptation Across Cooperative Contexts: The decision framework can be adapted to other cooperative domains, including housing, transport, and agricultural input cooperatives. Adaptation should involve configuring repayment thresholds, time windows, and affordability rules to reflect the specific policies and operating conditions of each cooperative.

3. Incorporation of Predictive Risk Indicators: Future enhancements could incorporate predictive indicators, such as repayment consistency over time, to complement the current deterministic, rule-based logic. This would strengthen early identification of potential defaults while preserving transparency and interpretability.

4. Governance and Ethical Review Mechanisms: As eligibility decisions become increasingly automated, cooperatives should establish periodic oversight mechanisms to review decision outcomes. Regular monitoring would help ensure that automated enforcement aligns with cooperative values and remains attentive to member welfare.

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