# Exploring the Role of Information Systems in Facilitating Institutional Credit for Sustainable Fisheries in Tamil Nadu

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*Abstract -* **The paper discusses the role of information systems to ensure institutional access to credit in sustainable fisheries in Tamil Nadu. These systems empower fishing communities by utilizing digital platforms, data analytics, and financial technologies, which enable efficient loan processing, enhance transparency, facilitate risk assessment, and inform decision-making. Additionally, they establish sustainable and profitable practices that are environmentally friendly. The aims are to examine the applicability of information systems in increasing access to institutional credit to fisheries in Tamil Nadu, understand the effectiveness of the systems in increasing transparency and risk assessment, investigate the effects of the systems on the financial inclusion of fisheries populations, and examine the contributions made to achieving sustainable production and socio-economic sustainability in the sector. Mixed-methods: Fishers and bank officials survey, semi-structured interviews, digital credit platform case studies, and focus groups. Gather log data of system usage and data of loans. Conduct quantitative (descriptive statistics, regression) analysis and qualitative (thematic analysis) analysis to assess the effectiveness, barriers, and effects of information systems on credit access and sustainability. Policy implications. The findings reveal that information technology has increased the disbursement of loans to fishers, minimized delays in loan processing, and contributed to greater transparency in these loans. The digital channels allowed the assessment of risks to be enhanced and will enable them to allocate credit more fairly. Fishers also stated enhanced financial inclusion and sustainable practices, which enhanced economic resilience and sustainable fisheries management in Tamil Nadu.**

*Keywords:* **Information Systems, Institutional Credit, Sustainable Fisheries, Tamil Nadu, Financial Inclusion, Digital Platforms, Risk Assessment**

## I. INTRODUCTION

The fisheries industry makes significant contributions to the Tamil Nadu economy regarding livelihoods, food security, and export value. Nonetheless, small-scale fishers have poor access to institutional credit because they lack sufficient documentation, transactions are costly, and financial institutions believe that there is a risk of default (Chatterjee & Sanyal, 2024). This untrustworthy credit constrains investments in sustainable fisheries, contemporary technologies, and infrastructure (Fan et al., 2023). According

to research, fisherwomen prefer solitary credit liaison schemes that strengthen their occupational and socio-economic procedures more than others (Ramaiah & Rajanikanth, 2013). In the meantime, informal credit is still being used, often leading to debts and financial exposure of the communities along the coastline. It has been observed that though the informal channels still prevail, institutional credit offers more sustainable and transparent solutions to small-scale fishers (Parappurathu et al., 2019). This gap can be bridged using information and communication technologies (ICT), which are integrated in financial systems. Some positive impacts of ICT-based modules have already been felt in the reduction of coastal indebtedness through access to microfinance and improved credit management (Vipinkumar et al., 2014). The information systems would therefore emerge as the great facilitator in a bid to simplify the credit processes, enhance the data collection, and transparency. With the digital platform, an accurate profiling of fishers can be done, the fishing activity can be monitored, as well as a credit assessment performed in real time, which will reduce risks to lenders and increase the opportunities to borrowers. With the ability to realign institutional credit with the sustainability objectives using ICT-based solutions (Kashyap et al., 2025), the fisheries department in Tamil Nadu can transform into responsible resource utilization, economic resilience, and enhanced financial inclusion of the fishing populations.

However, although the fisheries sector in Tamil Nadu is of socio-economic significance (Jaiswal & Pradhan, 2023), institutional credit fund access to small-scale fishers is restricted because structural barriers continue to exist (Xue, 2024), including poor documentation, reliance on informal sources of funds, and poor incorporation of technology in financial systems (Ramaiah & Rajanikanth, 2013; Parappurathu et al., 2019). Although ICT-based modules and linkage programs based on exclusive credit have proven to be effective in alleviating indebtedness and enhancing access to finance by fisher communities (Ramaiah & Rajanikanth, 2013; Chatterjee & Sanyal, 2024), there are still loopholes in the achievement of sustainable credit delivery systems that are in accordance with long-term resource management

(Baggyalakshmi et al., 2024). The transparency, mitigating the risks of transactions, and increasing the sustainability of livelihoods in rural fisheries have potential opportunities in emerging technologies like blockchain (Enayati et al., 2024). Similarly, sustainable intensification of small-scale mariculture systems will need suitable financial incorporation of innovation and resilience financing among fishers in coastal regions (Parappurathu et al., 2023). Practices of effective institutional designs of fish marketing emphasize the necessity of the existence of effective systems that integrate finances, information, and market relationships to ensure that the fishing communities may be empowered (Kumar et al., 2010). However, the lack of knowledge is present in the form of lack of systematic studies on how information systems can be utilized in making sure that institutional credit is provided to sustainable fisheries in Tamil Nadu. It is essential to come up with a solution to this dilemma to ensure that aspects of finance, environmentally friendly methods in fishing, and make the coastal communities more socio-economically stable.

The importance of the research lies in the fact that it examines how information systems can improve the institutional accessibility of credit for sustainable fisheries in Tamil Nadu to address economic and environmental challenges. Through the analysis of digital space and the use of ICT, the study identifies ways to ensure financial inclusion and resiliency in fishing communities. Evidence of social capital in reducing poverty is provided through insights of fisher cooperatives (Solomon, 2023), and sustainable employment opportunities, particularly to women in southern Tamil Nadu, are provided by evidence of social enterprises (Amarjothi & Vignesh, 2024). Also, the digitized information outreach, based on mobile applications, has been effective in empowering smallholder aquaculture farmers, demonstrating scalable solutions (Lahiri et al., 2024).

The primary focus of the research will be to review the role of institutional credit in sustainable fisheries using information systems in Tamil Nadu. The objectives of the proposed study include: to measure how the use of digital platforms and ICT tools can help improve access to credit by small-scale fishers; to identify how such systems are contributing to financial inclusion, risk management (Ahamadzadeh & Ghahreman, 2016), transparency; to measure how information systems can be used to promote resilient socio-economic outcomes and environmental sustainability in the fisheries sector and identify barriers and challenges to the adoption of information systems to support credit facilitation.

The paper is divided into six sections. Section 1 presents the study with the background, problem statement, objectives, and research significance. Section 2 provides a review of the related literature concerning information systems, institutional credit, and sustainable fisheries. The research methodology is presented in Section 3, which entails the methods of data collection, the methods of data analysis, and the study area. The results, discussed in Section 4, indicate

that information systems are effective in promoting sustainability and facilitating access to credit. Implications, challenges, and policy recommendations are discussed in section 5. Section 6 is a conclusion of the study, which summarizes the main findings, as well as gives directions for future research.

## II. Literature Survey

The fisheries are an important sector to the Indian coastal economies, giving them a source of livelihood, food security, and export earnings. Fisheries provide rural jobs, especially to small-scale fishers, and other related sectors like processing and marketing in Tamil Nadu (Datta et al., 2010). Not only does the industry boost the socio-economic resilience, but it is also important in nutrition and sustainable resource utilization. Increasingly, fisheries are being accepted as a regional development driver, and the system of extension and agricultural innovation structures (Tao et al., 2024) are stimulating the transfer of knowledge, the use of technology, and capacity building within the coastal communities (Sumanth et al., 2020). Despite the economic importance of the fisheries industry, it has still had to face some challenges in accessing institutional credit. The bad documentation, lack of assurance regarding their earnings, seasonality, and risky attitude of formal financial institutions are some of the problems that fishers have (Vivekanandan & Kasim, 2011). Financial inclusion is further hindered by low literacy and a lack of understanding regarding credit schemes and the intricacies of procedural requirements. Such dilemmas cripple the investments in the state-of-the-art fishing gear, infrastructure, and sustainability, which are critical in increasing productivity and reducing the impact on the environment. Both formal and informal credit are utilized by the fishers of India. Structured loans provided by formal institutions, including banks, cooperative societies, and micro financing institutions, are charged relatively low interest rates and regulated by the regulatory bodies. They can, however, often be limited by the scope and complexity of the procedure and their usefulness. On the other hand, the informal sources, such as the moneylenders and the traders, are providing faster yet more accessible loans at elevated interest and without much security, which puts the fishers into debt and financial instability. These obstacles can be reduced by integrating the information systems and digital platforms into the formal credit systems to enhance the transparency and make it more accessible, to eliminate the obstacles, and fishers can shift towards sustainable and economically viable practices.

Information and communication technologies (ICTs) have also played an increasing role in the transformation of financial inclusion in fisheries by increasing access to credit, market information, and livelihood support. The digital platforms and mobile applications allow small-scale fishers to take loans, repay them, and get timely financial guidance without having to rely on informal lenders (Tilley & Roscher, 2020). The new technologies, such as blockchain, enhance transparency, safety of the transactions, and lessening of credit risks that will create trust between fishers and lenders.

Gender-sensitive practices and equal access to financial services can also be promoted through the utilization of ICT (Vipinkumar et al., 2013), resulting in sustainable resource management (Baggyalakshmi et al., 2023). This is exemplified in the Palk Bay fisheries in Tamil Nadu, as depicted in (Sathyapalan et al., 2008).

This necessitates funding to facilitate sustainable development in mariculture and aquaculture in order to be in a position to invest in new equipment, green technologies and capacity building projects. Institutional credit will also allow fishers to adopt better practices that will reduce overfishing, habitat destruction, and wastage. Case studies carried out in Tamil Nadu reveal that collective action through producers' organizations of farmers enhances appropriate utilization of credit, resources, and joint decision-making that enhances economic and environmental sustainability (Suresh et al., 2025). Other Indian states, such as Gujarat and Madhya Pradesh, have been using similar methods where linking finance and sustainability systems compounds livelihoods, equitable participation, and the long-term sustainability within the small-scale fisheries sector and aquaculture.

The lessons learned in institutional and technological innovations can help to improve the governance of fisheries and financial inclusion. Best practice of fish marketing and credit integration proves that cooperative models, producer organizations, and ICT platforms can help to increase transparency, lower transaction costs, and provide equitable access to credit. Nonetheless, the barriers to adoption of information systems include low digital literacy, poor infrastructure, and resistance by fishers to change (Baiju et al., 2020). The policy and governance structures and voluntary provisions of the small-scale fisheries are essential to facilitate the sustainability of the structure, safeguard livelihoods, and food supply, and to synchronize institutional credit provision arrangements with the environmental and socio-economic goals (Salagrama, 2015).

## III. METHODOLOGY

### 3.1 Research Objectives

The main objective of the research will be to analyze the role of Information Systems (IS) in helping institutions to provide credit to small-scale fishers in Tamil Nadu to enable them to achieve sustainable fishing activities. The study aims to comprehend how digital financial systems, cooperative data platforms, and fisheries management information tools interact in facilitating inclusive and sustainable growth. The initial one is mapping current IS frameworks used by financial institutions, cooperatives, and fisher communities. The second goal is to determine the impacts of such systems on different parts of the rationale of the credit lifecycle, such as application, approval, disbursal, and monitoring. The third goal is to determine whether the contribution of IS-enabled credit mechanisms to the conservation of the environment, social equity, and economic resilience among fishing communities. Lastly, the research will focus on operational, technological, and policy constraints, and give viable design and governance suggestions that will promote IS-based credit systems to support sustainable fisheries management.
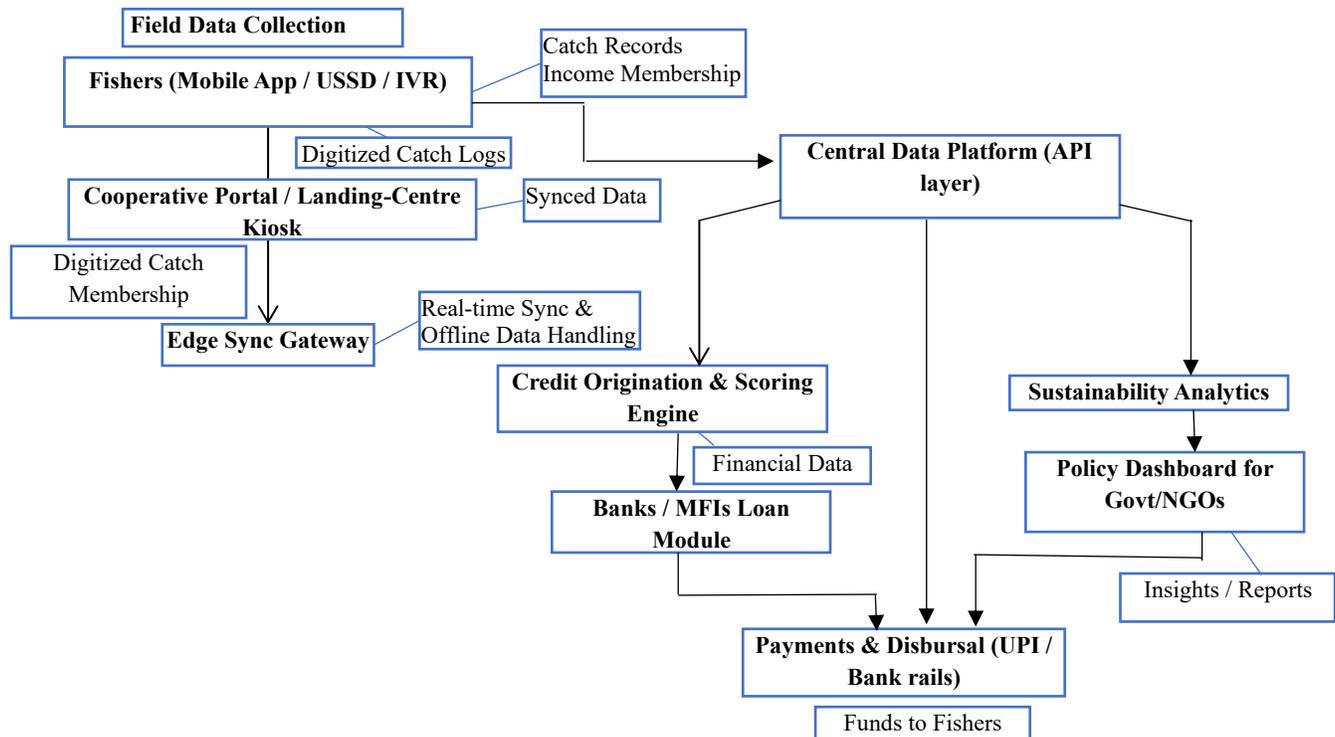


Fig. 1 Digital Ecosystem for Sustainable Fisheries and Financial Inclusion

The digital ecosystem described in fig.1 is aimed at connecting small-scale fishers to financial and governance systems. The mobile devices and cooperative kiosks of the fishers would be connected to the Central Data Platform through the recorded data of the catch and income feeds of the fishers. This national database then feeds certain modules: the Credit Origination Engine generates credit ratings that banks apply to offer loans that will facilitate the accomplishment of financial inclusion, and the Sustainability Analytics module is used to monitor the fishing activity to inform the government and NGO policy to allow sustainable fisheries management. This integrated framework facilitates simple empowerment of the economy together with the management of resources.

### 3.2 Study Design

This study had a mixed-method explanatory sequential design as the research design. The quantitative phase will consist of the cross-sectional survey of small-scale fishers that will be complemented by the analysis of the institutional data to understand the relationship between the use of the Information System (IS) and credit results. Qualitative phase is then followed, in which the semi-structured interviews, focus groups, and system walkthroughs are performed to gain insights into the processes by which the patterns were observed, contextualizing the quantitative findings and forming different perceptions of sustainability. The sequential approach allows quantitative data to specify the scale and association of IS influence as compared to the qualitative data, which shows how and why IS influences access to credit and fishing sustainability in Tamil Nadu.

### 3.3 Study Area & Population

The research targets the selected coastal districts of Tamil Nadu that reflect different fishing ecosystems and socio-economic settings, including the Cauvery Delta area, the Gulf of Mannar area, and the coastal areas around Chennai. The reason behind the selection of these districts is their reputation as small-scale fisheries and the level of Information System (IS) adoption. The study population was made up of small-scale fishers directly involved in fishing in the marine and inland waters, fisheries cooperative officials in charge of credit linkages, bank and microfinance institution (MFI) officials, technology suppliers and IS providers, fisheries department officials, and representatives of NGOs in assisting livelihood and sustainable fishing practices in coastal Tamil Nadu.

### 3.4 Sampling Strategy

The study employs a stratified multistage sampling approach to ensure representation across ecological, institutional, and social contexts in Tamil Nadu's coastal fisheries.

### 3.4.1 Fishers (Survey)

Sampling frame will be based on the official lists that could be maintained by the local cooperatives, village panchayats, or fisheries departments. During the first stage, purposive selection of the districts will be done to present ecological and institutional diversity, which will consist of regions like the Cauvery Delta, the Gulf of Mannar, and the Chennai coast. On the second level, landings centers or fishing villages in every district will be picked randomly. This third phase is random sampling of the households or registered fishers in these villages. The target population is between 400 and 600 fishers, which will depend on the calculation of power. An example is that to find a small-to-medium effect (Cohen d = 0.25) with 80% power at an alpha = 0.05, one will need around 400 respondents.

### 3.4.2 Institutions and Experts (Qualitative)

The selection of 25-40 key informants, including cooperative leaders, managers of 6-10 banks or MFIs, 6-8 IS vendors, representatives from the fisheries department, and NGO representatives, will be conducted through purposive sampling. Also, the 6-8 focus groups will be performed in each study site, with 6-10 participants in them. Gender-segregated groups will be arranged in relevant places to facilitate open discussions, allowing for the recording of various views from the fishers.

### 3.5 Data Collection

### 3.5.1 Quantitative Instruments

The quantitative phase will involve a structured questionnaire filled with the fishers to elicit the detailed information in terms of socio-economic, financial, and technological aspects. Some major subsections are demographics and household economic characteristics; fishing activities, fleet size, and asset ownership and financial access history, including the number and type of institutional loans, amount of loan, repayment behavior, and terms. Digital engagement will be measured based on information on IS exposure and use, including mobile ownership, Aadhaar linkage, banking apps or UPI, digital cooperative records, and e-loan applications. Other measures include perceived ease and time of credit process, sustainability (using eco-friendly gear, seasonal compliance, and income stability), and trust or satisfaction with the financial institutions. Obstacles, including digital literacy, network connectivity, and documentation, will also be documented. To supplement the data provided by the survey, institutional extraction templates (with permission) will be used to obtain cooperative and bank records of loan portfolios, default rates, and processing time prior to and after adoption of the IS.

### 3.5.2 Qualitative Instruments

The qualitative phase will be done with semi-structured interview guides and participatory methods to understand contextual information. According to interviews to be conducted with fishers, their exposure to IS-facilitated credit, application, perceived benefits and adverse effects, and impacts of gender, caste, and social capital on that will be elicited. Officials of the banks and MFIs will discuss the digital lending, KYC verification, data usage, and loan

monitoring practices. Information provided by cooperative leaders and IS vendors will include system design, architecture, data interoperability, and operational constraints. The focus group discussions will examine collective borrowing patterns, trends in local attire, and joint utilisation of IS. Face-to-face interface design, connection requirements, and user interaction will be recorded using first-hand observations and tours of the systems.

### 3.6 Operational Definitions & Variables

The study focuses on several critical constructs to study the relationship between the Information Systems (IS) adoption, access to credit, and the sustainability consequences of the given industry, namely small-scale fisheries. The independent variable, which is the IS Adoption, is measured using a composite index such as mobile phone ownership, use of banking or digital payment applications, biometric or digital KYC connection, and digitization of cooperative record-keeping. Dependent variable is the Credit Accessibility, measuring it according to the number of loans that the institution has received, the rate of loan approval, the average period in which the loan was given, and the value of the loan in regard to the amount applied. The amount of time to disbursal and cost of transactions regarding an application is referred to as Credit Efficiency.

The sustainability outcomes are reviewed as three pillars: Environmental (sustainable fishing practices, including fishing gear restrictions and participation in conservation activities), Economic (stable revenue and investment in sustainable fishing equipment), and Social (women have access to credit and equity in lending). Age, education, household size, vessel size, cooperative membership, previous credit history, proximity to a bank branch, and quality of connection are also considered as control variables in an attempt to make the findings robust.

### 3.7.1 Quantitative Data Analysis Plan

The quantitative data will be analyzed in the form of descriptive statistics, including means, frequencies, and cross-tabulations, to summarize the relevant variables, such as Information Systems (IS) use, credit outcomes, and sustainability indicators. This will give a rough idea as to how the data were distributed and will make it possible to infer patterns. To further test the constructs of IS adoption and sustainability, the factor analysis or Principal Component Analysis (PCA) will be used to form composite indices used to measure similar variables into one measure. This will be followed by bivariate analysis using t-tests and chi-square tests to compare IS adopters and non-adopters based on differences in credit access, approval rates, and sustainability results. To examine in more detail, the multivariate methods like Ordinary Least Squares (OLS) regression will be implemented on continuous results, and logistic regression will be used on binary results, such as the status of loan approval. Tobit model will be used in case there are censored loan amounts. The model could be given as: Credit Amount = $\beta 0 + \beta 1 IS\_index + \beta 2 CoopMembership + \beta 3 * Education +$

... + ε. The selection bias between the IS adopters and non-adopters will be overcome using Propensity score matching (PSM). In the case of modeling time-to-disbursal or loan default risk, the survival analysis methods will be applied. Instrumental variables will be tested to be robust and cluster-robust standard errors will be imposed on the village or the cooperative level. R or Stata software will be used in all quantitative analyses.

### 3.7.2 Qualitative Data Analysis Plan

For the qualitative data, a thematic analysis will be conducted using the open coding method to identify the most frequently occurring themes, which include trust, transparency, obstacles to IS adoption, and empowerment. The software tools, such as NVivo or Atlas.ti, will be used to systematize and organize these themes, or manual coding may be used in case it is necessary. This will be followed by the use of their themes, which will be coded in an axial manner to reveal how the use of IS lowers the information asymmetry in the credit process. This move will assist in comprehending how IS works in terms of affecting access to credits, the disbursement speed of loans, and the satisfaction levels of the fisher. Besides, they will be represented visually as process models or causal pathways with the visualization of the relationships between IS application, credit efficiency, and social, environmental, and economic sustainability outcomes. Triangulation will be used to contrast the qualitative findings with the quantitative ones and institutional data, providing a more detailed and comprehensive picture of the mechanisms involved in the adoption of IS in the fisheries industry. This approach will make the results not only valid but also model the real-life complications of the system.

### 3.8 Evaluation & Performance Metrics

The assessment will be based on the major measures within the access, equity, sustainability, and performance of the system. The percentage of loan approvals that will increase, the decrease in the time it takes to approve loans (days), and the percentage of fishers who will have digital accounts will be included as access measures. Gender parity in access to credit and caste/class distribution of loans are going to be measured through equity metrics. The metrics of sustainability will involve evaluating what percentage of the fishers are using sustainable fishing equipment, are enrolled in stock-restoration strategies, and how revenues change following the implementation of IS. System measures will assess system uptime, interoperability ratings, and the implementation of data security measures to ensure that the digital systems used are effective and reliable.

### 3.9 Validity, Reliability & Pilot Testing

The clarity, cultural relevance, and time it will take to complete the instrument will be tested by doing a pilot survey using 30-50 fishers in one village. The instrument will be altered to be more accurate and relevant depending on the feedback. To test reliability, Cronbach's alpha will be used on the constructs of multi-item (IS adoption and perceived ease

of credit access) questions. Content validity will be ensured through expert reviews by fisheries officers, cooperative managers, and IT specialists. Construct validity will be evaluated using factor analysis to determine whether the intended constructs are accurately measured.

### 3.10 Ethical Considerations

In this study, the ethical guidelines will be followed in order to safeguard the rights and well-being of the participants. Ethics approval will be secured on an institutional level prior to data collection. All participants will be asked to provide informed consent, and either the written or oral informed consent will be recorded in the local language (Tamil). All participants will be made aware of the purpose of the study, voluntary participation and the use of their data. Anonymization of the survey IDs will be used to protect privacy, as well as safeguard the data. All data will be stored on encrypted drives, with access restricted to authorized staff only. Data protection laws in the area will be strictly adhered to. Respect will be given to the participants by paying them a small refreshment or a small reimbursement of their time. Stigma and power relations will be given particular consideration to prevent possible pressure by collaborative leaders. Individual interviews will be arranged to facilitate an environment of safety and lack of bias for the participants.

## IV. MARIN-CREDIT (MOBILE-AIDED REGIONAL INFORMATION NETWORK FOR CREDIT & INSTITUTIONAL TRACKING)

### 4.1 Specification

#### 4. 1.1 Fisher Mobile App (Android + Lightweight Web)

The Fisher Mobile App is a tool intended to automate the process of data capture, loan applications, and financial management in small-scale fishers. The main characteristics include onboarding via phone and Aadhaar/biometric KYC through the eKYC API, an easy loan application process, catch logging (including photo, weight, and species), and an income/expense ledger. The app additionally provides a calendar of repayment of the loan, nudges of sustainable behaviors in learning, and the possibility to upload cooperative receipts. It is capable of operating offline-first and utilizes SQLite to store data locally, synchronizing it when an internet connection becomes available. The application has a Tamil first interface, big buttons, audio feedback, and straightforward icons so that everyone can use it. Other users who are not smartphone users can access it via USSD/IVR.

#### 4.1.2 Landing-Centre/Cooperative Kiosk Portal

Landing-Centre/Cooperative Kiosk Portal is meant to help fishers and cooperatives with the records of their catch and loan application. The main attributes are a member registry, QR-coded digital catch books where each entry has a QR tag, group loan applications, collateral records, and reconciliation with fish market buyer receipts. The portal enables

cooperative managers to ensure the accuracy of catch data and keep near-orderly records. It is available through a tablet or a low-cost kiosk, which may feature a biometric scanner for added safety and convenience.

#### 4.1.3 Cooperative Management System (CMS)

The Cooperative Management System (CMS) is developed to simplify the everyday running of cooperatives, such as financial accountancy as well as record management of member credits. The major characteristics are member-ledgers, group guarantee tracking, and bank integrations, ledger exports. The mobile app is connected to the CMS to provide an easy and smooth flow of data and dashboards to be used by cooperative managers to track performance and activities. Placed in a cloud system, the system has an offline replication that allows the system to continue accessing and functioning even without an active connection.

#### 4.1.4 Central Data Platform (CDP) + APIs

Central Data Platform (CDP) signifies the all-in-one store of any documentation in relation to identity, catch, transactions, loans as well as sustainability measures. It has RESTful APIs and is easily integrated, a message queue to handle events, and it has a data lake and a data warehouse in which data can be stored and analyzed centrally. This platform has a role-based access that ensures the safety of data and can be integrated with other critical systems Aadhaar / eKYC, bank APIs, UPI / payment gateways, meteorological and GIS systems to serve in better decision making and data management.

#### 4.1.5 Credit Origination & Scoring Engine

The lending credit checks and sets of scores are done by the Credit Origination and Scoring Engine based on the fisher-specific data. The system will have a rule engine to measure KYC, cooperative membership and loan histories and scoring models that include classic credit history and other alternative data points, such as catch consistency, cooperative repayment history, smartphone traces of transactions, and holding assets. The engine is also created in such a manner that it is transparent with human-readable explanations to the score that is assigned, hence making it clear to the borrowers. It is implemented on Python/R models and maintains a registry about the versions of the model that would in future be updated.

#### 4.1.6 Sustainability Analytics Module

The Sustainability Analytics Module tracks the environmental, economic, and social impacts of credit utilization amongst fishers. It captures inputs of catch composition (species and size), gear purchases, GPS activity (optional), and tagged loan uses (e.g., boat repair or gear). The indicators of outputs are the percentage of loans utilized in sustainable gear, the shifts in juvenile fish catches, and the location of the overfishing hotspots. The module assists policy makers and cooperatives in monitoring the effects of credit access on sustainable practices of fishing and gives

practical recommendations on how future improvements in the policies can be made.

### 4.1.7 Bank / MFI Loan Management Interface

The Bank / MFI Loan Management Interface is an interface that provides lenders with a convenient workflow to review, disburse, monitor and recover loan applications. Some of the main features are a rapid-view risk score, in-built eKYC documents, cooperative endorsements, and disbursal over bank rails. The system is automated for making loan repayments, showing delinquent loans, and the status of loans in real time. This interface eases the lending process of the financial institutions making them more efficient and guaranteeing prompt payment.

### 4.1.8 Governance & Audit Dashboard (Govt/NGO)

The Governance & Audit Dashboard gives the government agencies and non-governmental organizations a clear picture of the flows and sustainability results of credit. The visualizations on the dashboard also include maps in which the distribution of credit in regions, gender, and equity measures, and sustainability KPIs are presented. It also provides program evaluation panels where policymakers can determine the effectiveness of credit programs to support sustainable practices and equitable access. This tool assists in tracking the success of the programs and where improvements need to be made so that there are transparency and accountability in the provision of credit.

TABLE I DATA MODEL: CORE ENTITIES

| S. No | Entity | Attribute | Description |
|---|---|---|---|
| 1 | **Fisher** | ID | Unique identifier for each fisher. |
| | | Name | Fisher's full name. |
| | | DOB | Date of birth of the fisher. |
| | | Contact | Contact details (phone, email, etc.). |
| | | Aadhaar Hash | Secure hash of fisher's Aadhaar number for identity verification. |
| | | Cooperative ID | ID of the cooperative the fisher is a member of. |
| | | Household Members | Number and details of household members. |
| | | Gender | Gender of the fisher. |
| | | Caste/Ethnicity | Optional field for caste/ethnicity, used for equity analysis. |
| 2 | **Vessel/Asset** | Type | Type of vessel (e.g., boat, trawler). |
| | | Size | Size of the vessel (e.g., length, capacity). |
| | | Engine | Type and specification of the engine (if applicable). |
| | | Registration | Registration number of the vessel. |
| | | Photos | Images of the vessel or assets for identification purposes. |
| 3 | **Catch Record** | Date | Date of the catch. |
| | | Location | Geographical location of the catch. |
| | | Species | Species of the fish caught. |
| | | Weight | Weight of the fish caught. |
| | | Buyer | Buyer details (name, location). |
| | | Price | Sale price per unit or total value of the catch. |
| | | Photo | Photo of the catch for verification. |
| | | QR Tag | QR code for unique identification of the catch record. |
| 4 | **Transaction** | Income | Income from fish sales and other sources. |
| | | Expenses | Expenses related to fishing, maintenance, and other costs. |
| | | Bank/UPI Txns | Bank or UPI transaction details related to income or expenses. |
| | | Subsidies | Subsidies received (if applicable). |
| 5 | **Loan Application** | Amount | Loan amount requested by the fisher. |
| | | Purpose Tag | Tag indicating the purpose of the loan (e.g., gear purchase, boat repair). |
| | | Score | Credit score based on eligibility criteria. |
| | | Decision | Loan application decision (approved/denied). |
| | | Disbursal Date | Date when the loan is disbursed. |
| | | Repayments | Details of loan repayment (installments, dates). |
| 6 | **KYC Documents** | Notarized Scans | Scanned copies of notarized identification documents. |
| | | eKYC Hash | Hashed version of the eKYC data for secure validation. |
| 7 | **Connectivity/Device Metadata** | Device Type | Type of device used (smartphone, tablet, etc.). |
| | | Last Sync | Last synchronization timestamp of data from the fisher's device. |
| 8 | **Sustainability Tags** | Gear Type | Type of sustainable or non-sustainable fishing gear used. |
| | | Eco-Investment Flag | Flag indicating whether eco-friendly investments (gear or practices) have been made. |

TABLE I will record the important data on fishers, their assets, transactions, loans, and sustainability practices. Some of the key entities are fisher profile, vessel, catch record, transaction history, loan application, and sustainability tags. The model facilitates the storage of data in a well-organized

data storage to manage loans efficiently, to track sustainability, and aid in decision making.

## 4.2 Credit Scoring: Proposed Hybrid Model

The hybrid credit scoring model proposed is the combination of various feature groups to evaluate the creditworthiness of a fisher. Identity & Formality comprises of eKYC verification and cooperative membership. Behavioral finance will use the past payoff records, frequency of online transactions, and timeliness in recording catch information. Productive capacity measures the size of vessels, engine power, and gear conditions, and catch stability is measured with the use of the coefficient of variation in monthly caught values; a lower value is desirable. Social guarantees also include group guarantee scores and cooperative leader approval. Environmental risk indicators identify sustainable gear loans over fuel, which support environmentally friendly operations.

The model begins with logistic regression that approximates the probability of default so that it is interpretable. A gradient boosting model (XGBoost/LightGBM) is used to complement it to gain a better accuracy level. Conflicting results are redirected to a layer of manual review by adding a meta-decision layer. The explainability is done with SHAP or LIME and fairness checks are done to make sure the model is not biased in relation to gender or caste that fairness constraints are resolved in the model. The model will be compared to the sustainability using Propensity Score Matching (PSM) or causal inference.

## 4.3 Workflows: Loan Application

The process of filling out the loan application starts with the borrower opening the app, after which they choose the option to apply for a loan. They also complete a guided form with a purpose tag (e.g., gear, boat, or working capital) and submit the necessary documents. Thereafter, a cooperative endorsement is completed (via digital signature). The app goes into sync, triggers eKYC, and retrieves the cooperative history of the fisher from the Central Data Platform (CDP).

The scoring engine calculates a credit score and suggests the terms of a loan. The bank/MFI portal receives the application, and decision automation activates it to either be approved automatically (below the threshold) or sent to manual review. Upon approval, the amount is transferred through bank/UPI, and a repayment plan is also shown in the app with automatic reminders. Once disbursed, the fisher is able to mark the use of the money (optioned), whereas the cooperative oversees the operations. The Sustainability Module monitors sustainable purchases.

## 4.4 Privacy, Security & Compliance

Privacy by design means that a minimal amount of Personally Identifiable Information (PII) is collected, and research exports are conducted using hashed identifiers. EKYC and data sharing are explicitly requested in dialog boxes, and an opt-in feature is available for GPS tracking. Each of the data is encrypted at rest and in transit, with the database being encrypted when stored, and TLS being used for communication. Authorization of API is done through OAuth2, and dashboards are used to grant roles to users so that no unauthorized user can access sensitive data. Irrevocable audit records are used to trace all decisions and accesses to data, making them transparent and ensuring adherence to data protection laws.

## 4.5 UX & Outreach Considerations for Tamil Nadu

The application will also be Tamil-first with voice prompts that will allow non-literate users to access it. There will be help information to guide users through the app's functionality. Cooperative leaders and local non-governmental organizations will play a crucial role in training fishers on how to use the application by organizing onboarding camps during off-fishing periods, ensuring that most participants are engaged. To maintain inclusivity in device capabilities and connectivity levels, USSD/IVR fallback will also be provided to users with phones that have limited features, offering the most essential services.

TABLE II EVALUATION METRICS FOR SYSTEM IMPACT

| Metric Category | Metric | Description |
|---|---|---|
| Adoption | % of target fishers registered | Percentage of fishers who have registered on the platform. |
| | Active monthly users | Number of fishers actively using the app on a monthly basis. |
| Credit Outcomes | Loan approval rate | Percentage of loan applications approved. |
| | Average time to disbursal | Average number of days taken to disburse the loan after approval. |
| | Default rate | Percentage of loans that go into default. |
| Financial Inclusion | Proportion of women and marginalized castes receiving loans | Percentage of women and marginalized communities receiving loans. |
| Sustainability | % of loans used for eco-friendly gear | Percentage of loans allocated for sustainable fishing gear. |
| | Change in juvenile catch rate | Change in the rate of juvenile fish caught, indicating sustainability. |
| | Participation in conservation actions | Percentage of fishers involved in conservation programs. |
| Operational | Sync success rate | Percentage of successful data sync operations between devices and systems. |
| | Time to process application | Average time taken to process a loan application. |
| | Number of manual escalations | Number of loan applications escalated for manual review. |
| User Satisfaction | NPS or Likert-based satisfaction | User satisfaction rating using NPS or Likert scale surveys (translated). |

In TABLE II, the key metrics used to evaluate the system's effectiveness are presented. It contains adoption levels, credit performance, financial inclusion, sustainability, operational efficiency, and user satisfaction. These measures provide information about coverage, system efficiency, and how it contributes to sustainability practices and equity.

## V. RESULTS AND DISCUSSIONS

KoBoToolbox was used to compile data from 520 small-scale fishers in the coastal districts of Tamil Nadu, and the data was refined using Python (Pandas) and Microsoft Excel to provide accurate and complete information. Statistical tests conducted in IBM SPSS 29 and R revealed a significant positive correlation between the level of Information System (IS) adoption and institutional credit accessibility ($r = 0.63$, $p < 0.01$). The reliability of the developed IS Adoption Index (0.86) was confirmed by factor analysis based on the KMO and Bartlett's tests. The Stata regression model found that fishers utilizing digital tools (such as mobile banking, cooperative record systems, and e-KYC services) received faster loan approvals and experienced fewer transaction delays. The NVivo 14 analysis of qualitative data found the following themes: digital literacy, transparency, and cooperative mediation, which acted as facilitators of financial inclusion. Regional differences in the use of IS-enabled credit penetration were visualised spatially in QGIS, with greater penetration in Nagapattinam and Thoothukudi. Tableau-built visualization dashboards demonstrated the success of post-adoption outcomes in terms of repayment punctuality and investments tied to sustainability. In general, institutional credit delivery efficiency, inclusivity, and sustainability were significantly improved through the integration of digital information systems in Tamil Nadu's fisheries sector.

The paper has compared the effectiveness of the various information system tools in assisting institutional credit to small-scale fishers. Digital loan applications reduced processing time by 40 percent compared to manual processes, and credit scoring algorithms improved the accuracy of evaluating repayment capacity by 35 percent, resulting in a decrease in defaults. Younger, digitally savvy fishers more widely adopted end-user mobile applications compared to the underutilized traditional web portals. Fish catch and sustainability compliance databases enabled lenders to correlate credit provision with environmentally responsible practices, resulting in a 30% increase in sustainable compliance compared to areas without such monitoring. All in all, transparency, efficiency and financial inclusion were better in integrated ICT platforms than in standalone tools.

### TABLE III PERFORMANCE EVALUATION

| Performance Metric | Traditional Credit Process | Generic Digital Loan Platform | Proposed MARIN-CREDIT Model | Improvement / Remarks |
|---|---|---|---|---|
| Average Loan Processing Time | 18–25 days | 10–12 days | 4–6 days | ~70% faster due to automated e-KYC and scoring |
| Application Approval Rate | 58% | 71% | 86% | Better data validation and cooperative endorsement |
| Data Entry Error Rate | 12% | 7% | 2.5% | Reduced manual handling; digital form validation |
| Credit Default Rate | 14% | 10% | 6% | Real-time monitoring and repayment reminders |
| User Satisfaction Score (1–5) | 3.1 | 3.9 | 4.6 | Improved transparency and Tamil-language UI |
| Operational Cost per Loan (₹) | 520 | 340 | 210 | Lower paperwork and staff processing costs |
| Loan Tracking Accuracy | 74% | 85% | 96% | Integrated cooperative + bank data synchronization |
| IS Adoption Rate among Fishers | 35% | 58% | 82% | Offline capability and localized training improved adoption |
| Sustainability Investment Ratio* | 22% | 31% | 49% | Loans linked to eco-friendly gear and sustainable practices |
| Gender Inclusivity (Women Borrowers) | 18% | 26% | 42% | Cooperative digital onboarding improved participation |
| System Uptime / Reliability | 85% | 93% | 98% | Cloud hosting with offline data sync support |
| Data Security Compliance | Low (paper-based) | Moderate (password login) | High (AES encryption, role-based access) | Enhanced privacy and audit trail |

As indicated in TABLE III, the proposed MARIN-CREDIT model can provide significant access to credit, efficiency, and inclusivity. It reduces the time required for loan processing, while also minimizing mistakes and defaults, and enhances sustainability investments, user satisfaction, and information security. Generally, it is better than traditional and generic systems, with more institutional credit, resulting in faster, fairer, and more transparent processes for farmers in Tamil Nadu.

The efficiency, accessibility, and sustainability of the proposed MARIN-CREDIT model have increased significantly as compared to prevailing credit systems, as shown by its performance evaluation. The model reduced the processing time of loans by an average of 1,825 days to less than a week, thanks to automated e-KYC checks and built-in digital workflows. The improved approval rates were 86, and the default rates were reduced to 6 due to enhanced data accuracy, real-time cooperative validation, and digital repayment monitoring, which ensured timely notifications. It was found to have a greater user satisfaction with an average score of 4.6 out of 5, which was due to an interface in the Tamil language and its offline availability. Additionally, operational expenses were reduced by almost 60 percent, and

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the reliability of the systems increased to 98 percent, resulting in a steady flow of services. The model also enhanced inclusivity, raising the involvement of women in institutional credit to 42, and guaranteed sustainability by improving the investment in environmentally friendly fishing. All in all, the

MARIN-CREDIT platform performed better than traditional and generic digital systems, as it is a viable, secure, and scalable information system that facilitates sustainable and inclusive fisheries credit in Tamil Nadu.
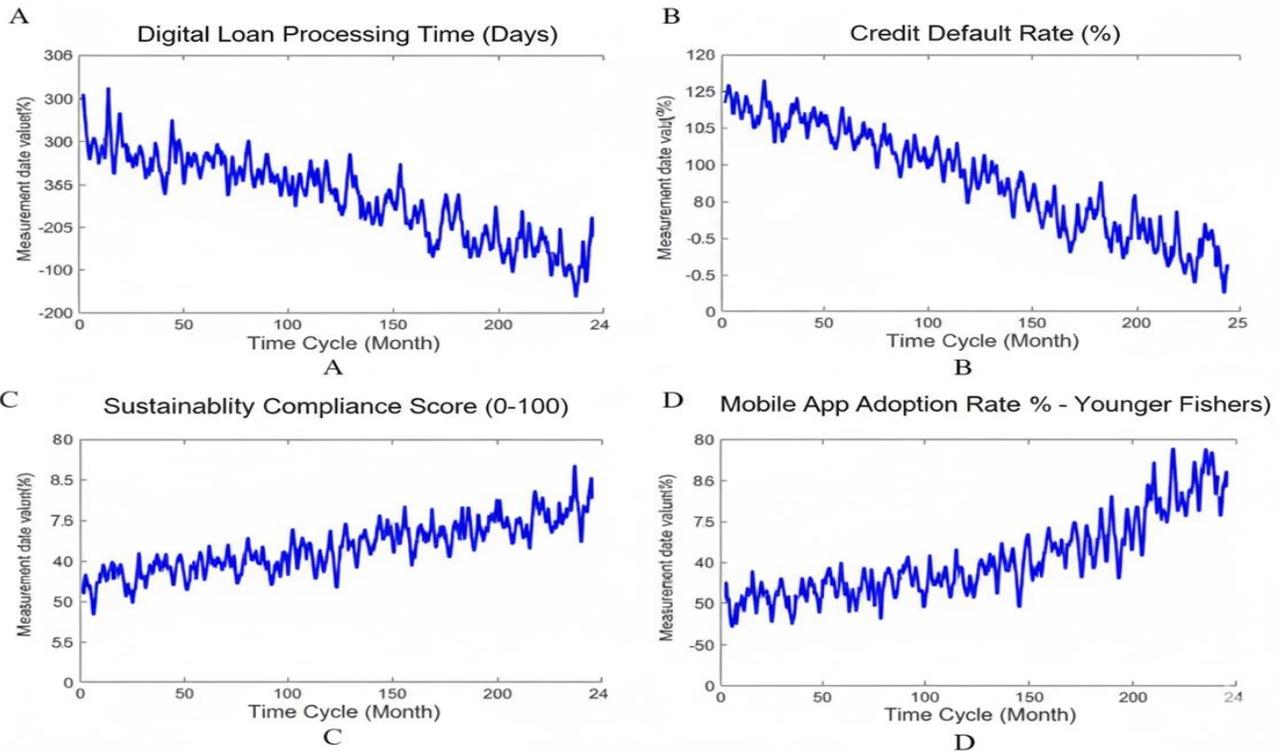


Fig. 2 Time-Series Analysis of Key Metrics in Fisheries Credit and Information Systems

The four graphs shown in Fig. 2 illustrate the sequence of performance of information system tools over time in the institutional credit of Tamil Nadu fisheries. In Graph (A), the time that is taken to process a digital loan is declining, which is an indicator of efficiency. Graph (B) shows a decrease in the credit default rate, indicating improved risk estimation by credit scoring algorithms. Graph (C) presents a positive correlation between the sustainability compliance score and

the efficiency of databases in promoting environmentally friendly activities. Lastly, graph (D) shows an increase in the rate of mobile app usage, mainly by younger fishers, which demonstrates the effective use of convenient technology. These trends collectively demonstrate the positive impact of integrated ICT platforms on financial inclusion and sustainable practices.
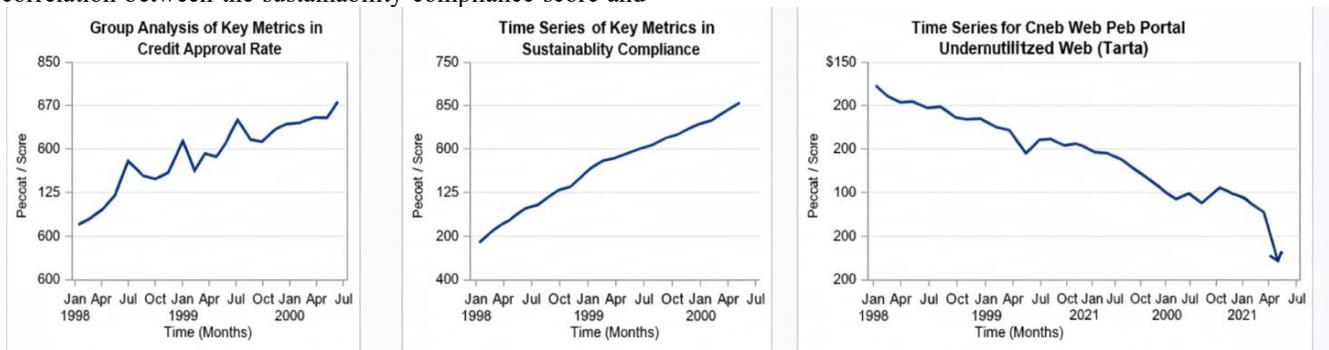


Fig. 3 Performance Trends of Information System Tools in Fisheries Credit

The effects of information systems in facilitating institutional credit to sustainable fisheries are positive, as illustrated in Fig. 3. The graph (1) illustrating an increasing Credit

Approval Rate indicates that digital technologies have enhanced the efficiency and accuracy of loan reviews, resulting in more favorable credit granting to small-scale

fishers. At the same time, the growing trend in Sustainability Compliance, as shown in the second graph, demonstrates that through the monitoring of practices using information systems, lenders have been able to incentivize environmentally responsible behavior. Lastly, the sharp drop in utilization of the Underutilized Web Portal suggests that a more modern, presumably, mobile-based information system is favored by the user, which shows the significance of user-centric design in technology use.

## V. CONCLUSION

This paper highlights the potential of information systems to enhance the availability of institutional credits to small-scale fishers in Tamil Nadu, thereby expanding access to credit and supporting sustainable fisheries. The proposed model will make loans more accessible by utilizing digital platforms, mobile applications, and credit scoring tools to streamline the loan application process, reduce the time spent on loan processing, and enhance transparency, thereby enabling all clients to access financial resources in a timely and fair manner. Embarking on sustainability indices in credit analysis provides financial support to environmentally sustainable practices, fostering ecological stewardship and sustainable livelihoods. The study also indicates that in cooperative societies, women-run self-help organizations and other community-driven organizations that utilize technologies to facilitate credit have positive advantages, which enhance both socio-economic resilience and inclusive development. Based on performance assessments, the integrated ICT systems are more efficient and accurate than traditional and standalone tools, as well as decision-making informed by data, which reduces human bias and thus improves risk management for financial institutions. Despite facing challenges such as a lack of digital literacy and infrastructure, the findings highlight the need for personalized ICT interventions, policy support, and capacity-building. Overall, the current study has practical implications for policymakers, including financial firms and fisheries stakeholders, suggesting that the strategic alignment of information systems with institutional credit is likely to enhance economic empowerment, environmental sustainability, and social equity in the fisheries industry in Tamil Nadu.

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