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A DIGITAL CITIZEN-SCIENCE APPROACH TO STRENGTHENING FISH SIZE-FREQUENCY DATA COLLECTION: A MOBILE APPLICATION FOR IMPROVING IOTC STATISTICAL REPORTING BY SRI LANKA

[NUWAN D. P. GUNAWARDANE, T.K. SINESHA KARUNARATHNE, J. SUDAGARAN, ISHARA T. KANKANAMGE, VIMUKTHI KUMARASIRI, S.D. WICKKRAMAARACHCHI, H. GUWANI HATHURUSINGHE.]

DEPARTMENT OF FISHERIES AND AQUATIC RESOURCES, MALIGAWATTA, COLOMBO 10, SRI LANKA

Purpose: To present Sri Lanka's proposed digital citizen-science approach for improving fish length-frequency data collection through a mobile application, particularly in coastal fisheries.

Expectations: To enhance geographical sampling coverage, data quality and representativeness, while strengthening national fisheries statistics and IOTC reporting through community participation and digital technologies.

Action Intended: The WPDCS is invited to:

- NOTE the proposed initiative and its potential contribution to addressing size-frequency data gaps.
- PROVIDE technical feedback and recommendations for improving the methodology and quality assurance procedures.
- ENCOURAGE knowledge-sharing among CPCs on innovative, cost-effective approaches to fisheries data collection.

Discussions (for information and open discussion):

The paper is intended to inform meeting members about Sri Lanka's proposed citizen-science-based mobile application for strengthening fish length-frequency data collection, particularly in coastal fisheries, as described in Sections 2 and 3. It outlines the application's conceptual framework, data collection methodology, verification procedures, spatial coverage and expected benefits. Members are invited to discuss the proposed approach, share experiences and provide technical feedback on its implementation, particularly regarding data quality assurance, photographic measurement protocols and its potential contribution to improving IOTC statistical reporting.

Feedback (to collect input and suggestions)

The paper seeks feedback and technical comments from WPDCS members on the proposed citizen-science approach and mobile application for collecting fish length-frequency data. Members are also encouraged to share relevant experiences and suggestions to strengthen the methodology, improve data reliability and assess the potential applicability of similar approaches in other CPCs.

Conclusion (to record a concluded position or summary)

[The paper seeks confirmation from WPDCS members that the proposed citizen-science-based mobile application represents a useful complementary approach to strengthening fish length-frequency data collection, particularly in coastal fisheries. Members are invited to acknowledge the proposed pilot implementation in 2027 and provide recommendations for its further development and evaluation, as outlined in Sections 3 and 4. The outcomes and recommendations from the pilot implementation will be reported to the subsequent session of WPDCS in 2027.]

Recommendation (to ask the meeting to endorse a recommendation)

i. NOTE the proposed citizen-science-based mobile application developed by Sri Lanka to strengthen fish length-frequency data collection, particularly in coastal fisheries;

ii. RECOMMEND the consideration and application of citizen-science-based approaches by CPCs as a complementary mechanism to address existing gaps in fish length-frequency data collection and improve geographical and temporal sampling coverage; and

iii. ENCOURAGE CPCs to explore similar digital approaches, taking into account their national fisheries data collection requirements and operational capacities.

Decisions (to request formal approval of actions)

The paper seeks approval from the WPDCS to recommend the consideration and adoption of citizen-science-based digital approaches by CPCs as a complementary mechanism to address gaps in fish length-frequency data collection and improve sampling coverage.

Abstract

Reliable fish size-frequency data are essential for stock assessment, sustainable fisheries management and meeting statistical reporting requirements of the Indian Ocean Tuna Commission (IOTC). Although Sri Lanka collects and submits size-frequency data, gaps remain in sampling coverage and representativeness, particularly across the country's numerous and geographically dispersed landing sites. These limitations can affect the completeness of IOTC reporting and contribute to recurring data-related compliance challenges.

To address this challenge, the Department of Fisheries and Aquatic Resources (DFAR), Sri Lanka, has developed a mobile fish measurement application, which is currently being implemented through a pilot citizen-science programme. The application enables registered volunteers, including university students, school societies, Young Nature Clubs, NGOs and fisheries stakeholders, to contribute standardized fish measurements. Volunteers receive online training through the DFAR Learning Management System covering fish identification and accurate measurement procedures.

The application records species, length, date, location, fishing area, vessel and other relevant catch information. Submitted observations are reviewed and validated by DFAR officers before being incorporated into the national fisheries database and, where appropriate, used for IOTC Form 4SF reporting. The system also enables DFAR to monitor sampling coverage and identify remaining data gaps. The pilot aims to substantially expand sampling capacity at relatively low cost, reduce IOTC size-frequency data gaps, improve Sri Lanka's statistical reporting and compliance performance, and establish a scalable digital citizen-science model for fisheries data collection.

Keywords: Fish length-frequency; citizen science; crew-based observer; photographic measurement; coastal fisheries; mobile application; spatial sampling; IOTC.

1. Introduction

Length-frequency information is a fundamental input to fisheries science. It supports the description of population structure, monitoring of size composition, stock assessment and evaluation of fisheries management measures (Schnute, and Fournier, 1980). For Sri Lanka, reliable and representative size data are also important for meeting the statistical reporting requirements of the IOTC. However, collecting measurements from a large number of landing sites and fishing operations is logistically demanding. Gaps in

temporal, geographic and fleet coverage can reduce the representativeness of the resulting data (Maldeniya et al., 2013).

The main challenge in collecting fish length-frequency data is particularly evident in Sri Lanka's coastal fisheries. Unlike multi-day offshore fisheries, where catches are generally landed at designated fishery harbours, coastal fisheries involve numerous, geographically dispersed landing sites and smaller-scale fishing operations, making systematic and representative length sampling more difficult. Conventional coastal fisheries data collection relies largely on field officers visiting landing sites to collect catch and effort information through port sampling. However, limited sampling coverage, human-resource constraints and difficulties accessing smaller landing sites affect the representativeness of the data collected (Gunawardane, 2021). Consequently, the proposed mobile application aims to address this gap by enabling wider participation in fish length-data collection and improving geographical coverage across Sri Lanka's coastal fisheries.

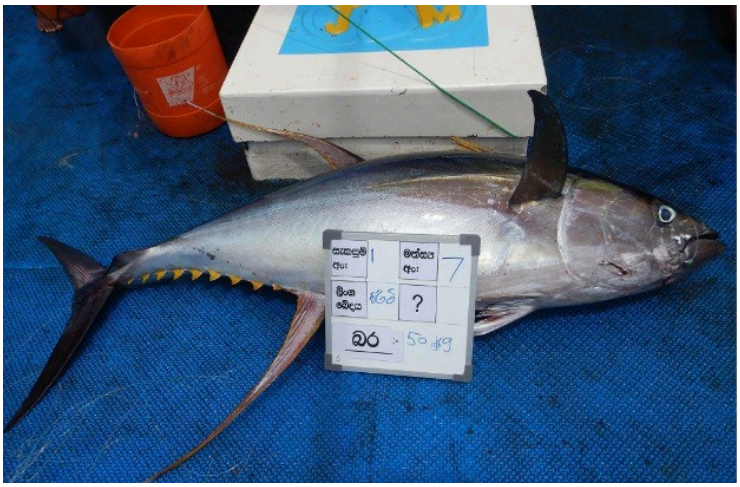
Photographic records can provide a reliable and cost-effective means of collecting fish length data, provided that images are captured under standardized conditions using a reference scale and appropriate camera positioning (Lee et al., 2009; Monkman et al., 2020). Over the years, Sri Lanka has made considerable progress in exploring and developing photographic approaches for fish length measurement to strengthen fisheries data collection. Two notable initiatives have been developed and presented by Sri Lanka to the respective Indian Ocean Tuna Commission (IOTC) Working Parties. The first is the crew-based observer programme, implemented since 2018, which provides an opportunity to utilize fish photographs collected by crew-based observers during fishing operations for length-related data collection (Gunawardane et al., 2018 and Gunawardane et al., 2024). The second is the Photo-Based Method for Collecting Fish Length Data of Coastal Tuna in Sri Lanka, presented to the IOTC Working Party on Methods, which introduced a photographic approach for collecting fish length information from coastal tuna fisheries (Ayeshya et al., 2025). These initiatives demonstrate Sri Lanka's continued efforts to explore practical and cost-effective photographic methodologies to complement conventional fish measurement techniques. Building on this experience, the present study proposes to further expand the application of photographic data collection through a simplified mobile application and a citizen-science approach, with particular emphasis on improving the geographical coverage and availability of fish length-frequency data from coastal fisheries.

Building on the experience gained through the implementation of the crew-based observer programme since 2018 and the subsequent development of photographic methods for fish length measurement in coastal tuna fisheries, the Department of Fisheries and Aquatic Resources (DFAR), Sri Lanka, has taken a further step towards digitalizing and expanding fisheries data collection through the development of a citizen-science-based mobile application. The application is intended to enable registered volunteers and fisheries

stakeholders to submit standardized observations; university students, school societies, Young Nature Clubs, non-governmental organizations and fisheries stakeholders as potential contributors. Online training is provided through the DFAR Learning Management System, with content covering fish identification and accurate measurement procedures.



(a)



(b)

Figure 01: Fish length measurement protocols for (a) crew-based observations Gunawardane et al., 2024, (b) photographic submissions (Ayeshya et al., 2025)

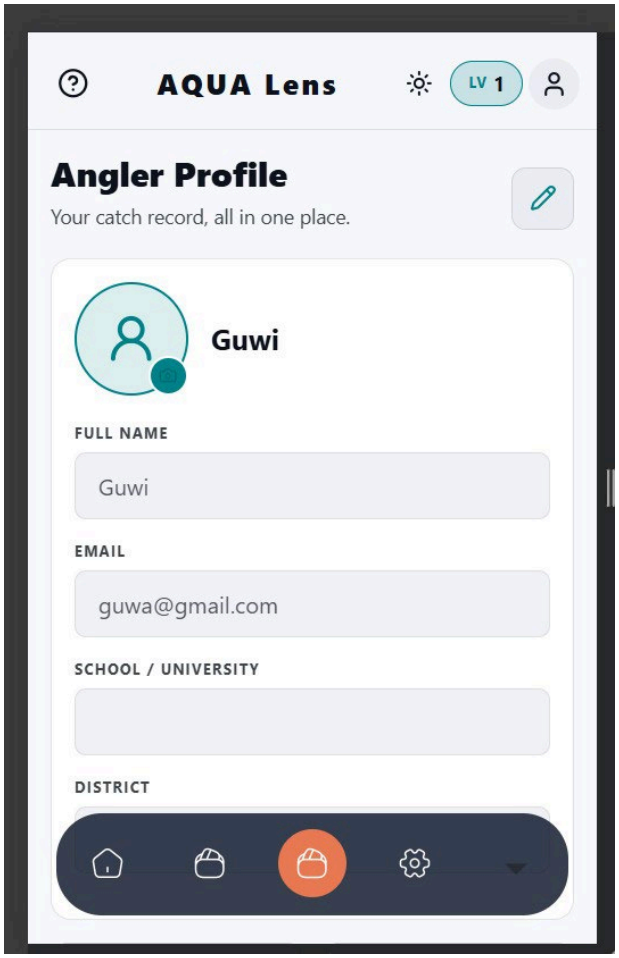
The proposed mobile application specifically targets this data gap by facilitating the collection of fish length-frequency data from Sri Lanka's coastal fisheries. By enabling registered citizens and fisheries stakeholders to submit fish photographs and associated catch information, the application aims to expand sampling coverage across geographically dispersed coastal landing sites. This approach is expected to complement conventional data-collection methods, improve the availability and spatial representation of length data, and strengthen the evidence base for fisheries stock assessment and IOTC statistical reporting.

2. Conceptual framework and methodology

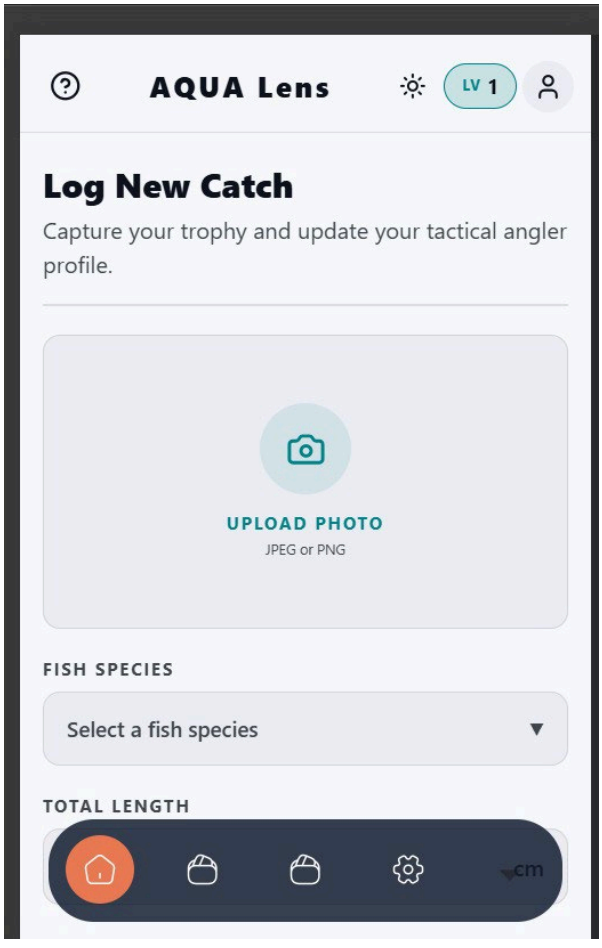
The proposed mobile application aims to expand fish length-data collection across Sri Lanka's coastal fisheries, particularly in geographically dispersed landing sites that are difficult to cover consistently through conventional sampling. Each observation is geographically referenced and assigned to a predefined spatial grid, enabling DFAR to monitor sampling distribution, identify data-deficient areas and assess geographical coverage. The application is designed with a simplified, user-friendly interface that allows individuals with minimal technical knowledge to submit fish observations, photographs and relevant catch information. Registered participants, including university students, school societies, Young Nature Clubs, NGOs and

fisheries stakeholders, receive online training through the DFAR Learning Management System covering fish identification, measurement procedures and photographic requirements.

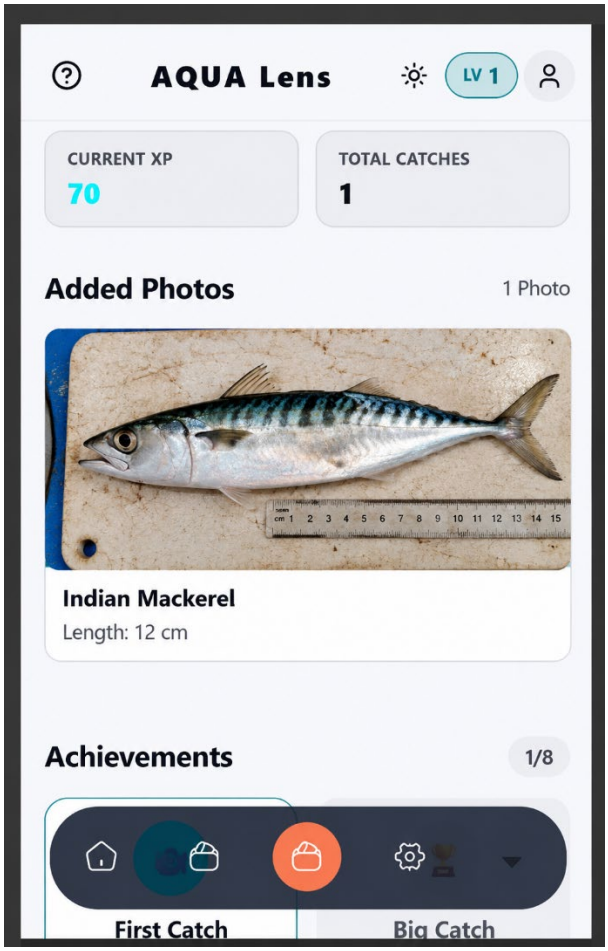
The mobile application follows a simple, step-by-step submission process, beginning with user registration and login, followed by the selection of fish species, entry of relevant catch information, and uploading of fish photographs. Users can also provide measurement details and location information associated with their observations. Once submitted, records are forwarded to the DFAR verification process, where officers review the information before accepting valid observations into the national fisheries database. The main stages of this process are illustrated in Figure 01 through screenshots of the mobile application.



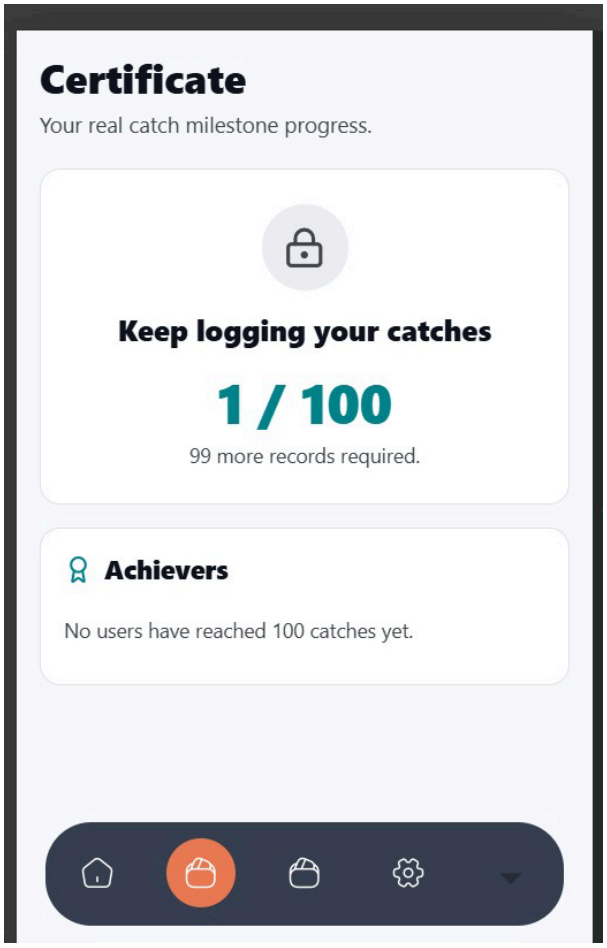
(a) User profile



(b) data submission section



(c) Adding a measurement



(d) Award section

Figure 02. Sequential steps of fish data submission through the DFAR mobile application.

Table 1. Data fields and their purpose in the mobile application.

Data field	Purpose / notes
Contributor ID / registration status	Traceability and user verification; avoid exposing personal details in analysis datasets.
Species	Species identification; use a controlled species list and retain an "uncertain" option.
Length and length type	Record measured length and specify total, fork or standard length.
Photograph / image ID	Retain original image and link it to the observation record.
Date and time	Observation date/time; retain upload timestamp separately if different.
Capture, landing and submission locations	Store separately where available; state coordinate source and accuracy.

Fishing area, vessel and catch details	Context for stratification, traceability and consistency checks.
Verification status and reviewer metadata	Accepted/returned/rejected decision, reviewer, date and reason.

Users submit information including species, length, date, photograph, location, fishing area, vessel and other relevant catch details. Photographs intended for length estimation should clearly display the entire fish and its measurement axis, together with a known measurement reference positioned in the same plane as the fish to minimize measurement errors arising from perspective distortion. The length measurement convention, such as fork length, total length or standard length, should be consistently recorded.

Submitted observations undergo a verification and quality-control process conducted by DFAR officers before acceptance into the national fisheries database. This process includes verification of contributor details, species identification, catch information, photograph quality, measurement suitability, date and location accuracy, and potential duplicate submissions. Based on the review, records are accepted, returned for clarification or rejected. Only verified observations meeting the required measurement criteria are incorporated into length-frequency analyses, while original photographs and associated records are retained to ensure traceability and facilitate subsequent review.

Geospatial analysis is undertaken by assigning observations to predefined coastal grid cells using their recorded geographic coordinates. The methodology distinguishes fishing-ground, landing-site and submission locations wherever such information is available, ensuring that submission coordinates are not automatically interpreted as actual fishing locations. Grid-based summaries of observation numbers, species composition, length measurements and temporal coverage are used to identify geographical and sampling gaps and guide future data-collection activities.

Following verification, approved records are integrated into the national fisheries database and may be utilized for national fisheries analysis and, where appropriate, IOTC Form 4SF reporting. The pilot programme is evaluated using indicators such as participant registration and activity, total submissions, verification acceptance rates, photographic suitability, measurement accuracy against conventional direct measurements, species and landing-site coverage, spatial grid representation, temporal coverage and the cost and staff time required per accepted measurement. Comparisons between crew-based observer records and citizen-science submissions will help assess the contribution of the application towards improving the availability, quality and geographical representation of coastal fisheries length-frequency data.

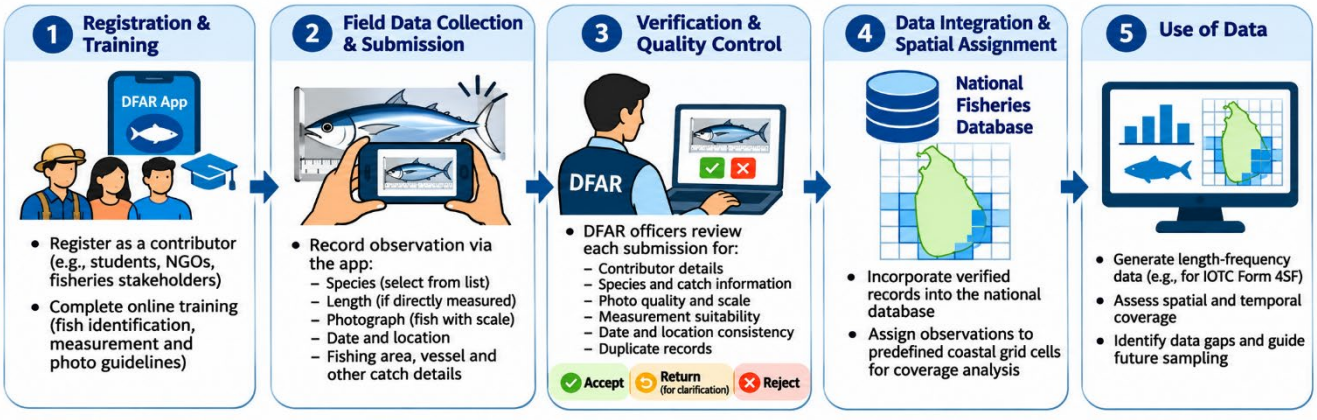


Figure 02. Data collection methodology through the DFAR mobile application.

The project also aims to encourage active participation among Generation Z (Gen Z) by incorporating a reward-based engagement mechanism into the mobile application. To motivate continued participation, users are awarded digital badges based on the number of successfully submitted and verified fish-length measurements. This gamification approach is intended to promote sustained engagement, recognize individual contributions and foster a sense of involvement among younger generations in fisheries science, citizen science and marine resource conservation.

Table 2. Proposed quality-control and verification criteria

Check	Example acceptance criterion / action
User details	Contributor is registered and required profile fields are complete.
Species and catch information	Species/catch fields are complete and plausible; uncertain IDs routed for review.
Photograph quality	Fish is identifiable; full measurement axis visible for length estimation.
Scale and geometry	Known reference is visible in the same plane; otherwise no photo-derived length is assigned.
Length definition	Measurement convention is recorded and consistent with the protocol.
Location	Coordinate type is identified; capture, landing and submission locations are not conflated.
Duplicates and anomalies	Potential duplicates, implausible lengths and coordinate anomalies are flagged.

3.0 Expected Benefits of the Project

The proposed project is expected to strengthen Sri Lanka's fisheries data collection system by expanding the availability, geographical coverage and accessibility of fish length-frequency data, particularly from coastal fisheries. By engaging citizens, university students, youth organizations and fisheries stakeholders, the initiative will create a broader participatory network for fisheries data collection while reducing dependence on conventional field-based sampling alone. The utilization of photographic records, including those generated through the existing crew-based observer programme, will provide opportunities to derive additional scientific information from photographs already collected during fishing operations. The simplified mobile application, together with its verification mechanism, is expected to improve data accessibility, traceability and quality before integration into the national fisheries database. Furthermore, spatial mapping of submitted observations will help identify geographical sampling gaps and support more targeted data-collection activities. The reward-based badge system is expected to encourage sustained participation among younger generations and promote public awareness of fisheries science and marine resource management. Ultimately, the project aims to improve the representativeness of national fish length-frequency statistics, strengthen scientific inputs for fisheries stock assessments, support evidence-based management decisions and contribute to improving Sri Lanka's statistical reporting and compliance with IOTC requirements.

4.0. Way Forward

The proposed mobile application will be implemented initially as a pilot project during 2027 to evaluate its practical applicability and effectiveness in collecting fish length-frequency data from Sri Lanka's coastal fisheries. The pilot will focus on registering and engaging citizen-science participants, particularly university students, youth organizations and fisheries stakeholders, while providing the necessary online training and technical guidance. The performance of the application will be assessed based on participant engagement, the number of observations submitted, verification and acceptance rates, photographic measurement accuracy, and geographical coverage of sampling locations. Feedback from participants and DFAR officers will also be incorporated to improve the application's functionality and data-quality assurance procedures. Following the pilot implementation, the findings, operational experiences, challenges and recommendations will be compiled and presented to the next session of the IOTC Working Party on Data Collection and Statistics (WPDCS) in 2027. Based on the outcomes, DFAR will consider further improvements and the potential expansion of the programme to achieve wider national coverage of coastal fisheries.

The proposed initiative is currently at the pilot-planning stage; therefore, sample sizes, implementation dates, application performance statistics and measurement accuracy are yet to be established through field implementation. The reliability of photograph-derived length measurements will depend on image quality, the

availability of a known measurement reference and appropriate photographic positioning to minimize measurement errors. Furthermore, the geographic coordinates recorded at the time of submission may differ from the actual fishing locations, which should be clearly distinguished during spatial analysis. Participation through the citizen-science approach may also introduce spatial or species-related sampling biases, requiring appropriate monitoring of sampling coverage and representativeness. Data protection, participant consent, user authentication, photograph ownership, data retention and access permissions will also need to be addressed to ensure responsible data management.

5.0 Discussion

The proposed citizen-science mobile application represents a further development of Sri Lanka's efforts to strengthen fisheries data collection through digital and photographic methodologies. Building on the experience gained from the crew-based observer programme implemented since 2018 and subsequent photo-based fish length measurement initiatives, the application aims to extend data collection beyond conventional sampling locations, particularly addressing the challenges associated with geographically dispersed coastal fisheries. The involvement of university students, Generation Z, youth organizations and fisheries stakeholders provides an opportunity to establish a wider participatory network for fisheries data collection. The simplified interface and reward-based badge system are expected to encourage participation and sustained engagement, while the DFAR verification mechanism provides an essential quality-control step to maintain the reliability of submitted observations. Furthermore, the integration of geographic information enables the identification of sampling gaps and supports improved spatial representation of coastal fish length data. Although the accuracy of photographic measurements and the representativeness of citizen-science submissions require further evaluation, the proposed pilot offers an opportunity to assess the practical application of this approach. If successfully implemented, the initiative could complement existing fisheries sampling programmes, improve the availability of length-frequency information and strengthen Sri Lanka's capacity to meet national fisheries management and IOTC statistical reporting requirements.

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