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Feasibility Analysis of Boat Lift Net Fisheries Assisted by UFL+ Technology Using the SIDIA Digital Agribusiness System

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ABSTRACT

Small-scale fisheries are vital for coastal livelihoods but often face challenges in accessing structured financial assessments for investment decisions. This study evaluated the economic feasibility of boat lift net fisheries using Underwater Fish Lamp Plus (UFL+) technology, with investment analysis conducted through the SIDIA digital agribusiness platform. The results indicated positive financial performance, with a Net Present Value (NPV) of IDR 8.54 million, an Internal Rate of Return (IRR) of 11.14%, a Net Benefit–Cost Ratio (Net B/C) of 1.28, and a Payback Period of 4.93 years. Sensitivity analysis revealed that profitability was highly vulnerable to fish price declines (–10%) and fuel cost increases (+15%), which could shift the investment into unfeasible territory. These findings highlight that while UFL+ technology can enhance catch efficiency and profitability, supportive policies such as cost stabilization and fuel subsidies are essential to safeguard fisher livelihoods. The integration of UFL+ with SIDIA provides a replicable model for strengthening decision-making in coastal fisheries, contributing directly to the Sustainable Development Goals (SDG 14: Life Below Water, SDG 1: No Poverty, and SDG 8: Decent Work and Economic Growth).

INTRODUCTION

Small-scale fisheries play a crucial role not only in providing livelihoods and food security but also in contributing to human health through bioactive compounds derived from aquatic resources **(Isamu *et al.*, 2025)**. The importance of these fisheries is highlighted by studies that underscore their critical role in local economies, as evidenced by the widespread engagement of communities in fishing activities that serve both sustenance and economic needs **(Teh & Pauly, 2018; Chuenpagdee & Jentoft, 2019)**. For instance, estimates suggest that small-scale fisheries constitute more than 90% of the workforce in the fisheries sector, with about 95% of their catch destined for human consumption **(Chuenpagdee & Jentoft, 2019)**. This underscores both their economic significance and cultural heritage within these communities.

Despite their importance, small-scale fisheries often grapple with challenges such as low productivity, limited capital, and heightened vulnerability to market and environmental changes **(Pita *et al.*, 2023; Salmi *et al.*, 2024)**. Threats from climate change and anthropogenic pressures further exacerbate their challenges, as noted in various regions around the world **(Huynh *et al.*, 2021)**. In Southeast Asia, boat lift nets, or bagan perahu, are a prevalent fishing technique that exemplifies this sector. These nets rely heavily on artificial lighting to attract fish during nocturnal fishing operations; thus, the effectiveness of such methods can be closely linked to the quality of lighting, which impacts fish aggregation and catch rates **(Pita *et al.*, 2023; Salmi *et al.*, 2024)**.

Recent advancements in fishing technology aim to enhance the efficiency of these operations. The Underwater Fish Lamp Plus (UFL+) system stands out as a novel approach. Utilizing LED technology, UFL+ represents a significant improvement over conventional surface lamps, enhancing fish aggregation and optimizing fishing durations while potentially reducing operational costs **(Amarullah & Gazali, 2019; Setyaningrum *et al.*, 2024)**. Various studies indicate that the implementation of UFL+ can lead to increased fish catches **(Amarullah & Gazali, 2019)** and reduced energy expenditures **(Setyaningrum *et al.*, 2024)**. Yet, despite the documented technical advantages, the economic viability of UFL+ for small-scale fishers remains an underexplored area.

Concurrently, the integration of digital platforms in fisheries economics has gained momentum. Tools like the Sistem Digital Agribisnis (SIDIA) facilitate comprehensive feasibility analyses by automating calculations of critical investment metrics such as Net Present Value (NPV) and Internal Rate of Return (IRR) **(Pita *et al.*, 2023; Aguión *et al.*, 2025; Fajriah *et al.*, 2025b)**. Although UFL+ and SIDIA are not inherently linked, the operational data from fisheries utilizing UFL+ can be effectively processed within SIDIA, thus enhancing investment decision-making through timely financial recommendations **(Fajriah & Kobajashi, 2025a)**. This technological crossover represents a pivotal development for the sustainability and profitability of small-scale fisheries **(Menon *et al.*, 2018)**.

This research also aligns closely with the global sustainability agenda, particularly the United Nations Sustainable Development Goals (SDGs). By improving the economic resilience of small-scale fisheries through technological innovation, the study contributes to SDG 1 (No Poverty) by supporting household income diversification, SDG 8 (Decent

Work and Economic Growth) by enhancing productivity and investment feasibility in the fisheries sector, and SDG 14 (Life Below Water) by promoting sustainable fishing practices that reduce operational inefficiencies and overexploitation risks. Positioning UFL+ and SIDIA as tools that support these goals underscores the broader policy relevance of this research, ensuring that small-scale fishers are integrated into national and international frameworks for sustainable coastal development.

Given the urgent need for sustainable fishing practices, understanding the financial feasibility of adopting UFL+ within small-scale lift net fisheries is crucial **(Fajriah *et al.*, 2021a, b, 2025a)**. The present study aimed to evaluate the economic viability of this adoption while utilizing the SIDIA platform to assess investment resilience against fluctuations in fish prices and fuel costs. This research promises to be groundbreaking, being the first to merge UFL+ fishing innovations with SIDIA's digital financial analytics, thereby establishing a novel framework for investment decision-making within coastal fisheries.

MATERIALS AND METHODS

Study area

The field experiment was conducted in the coastal waters of Kolono Bay, South Konawe Regency, Southeast Sulawesi, Indonesia (Fig. 1). This location was selected due to its high fishing activity using boat lift nets and the potential for technology adoption. The field trial was carried out from December 2024 to February 2025, covering a full operational cycle of lift net fisheries.

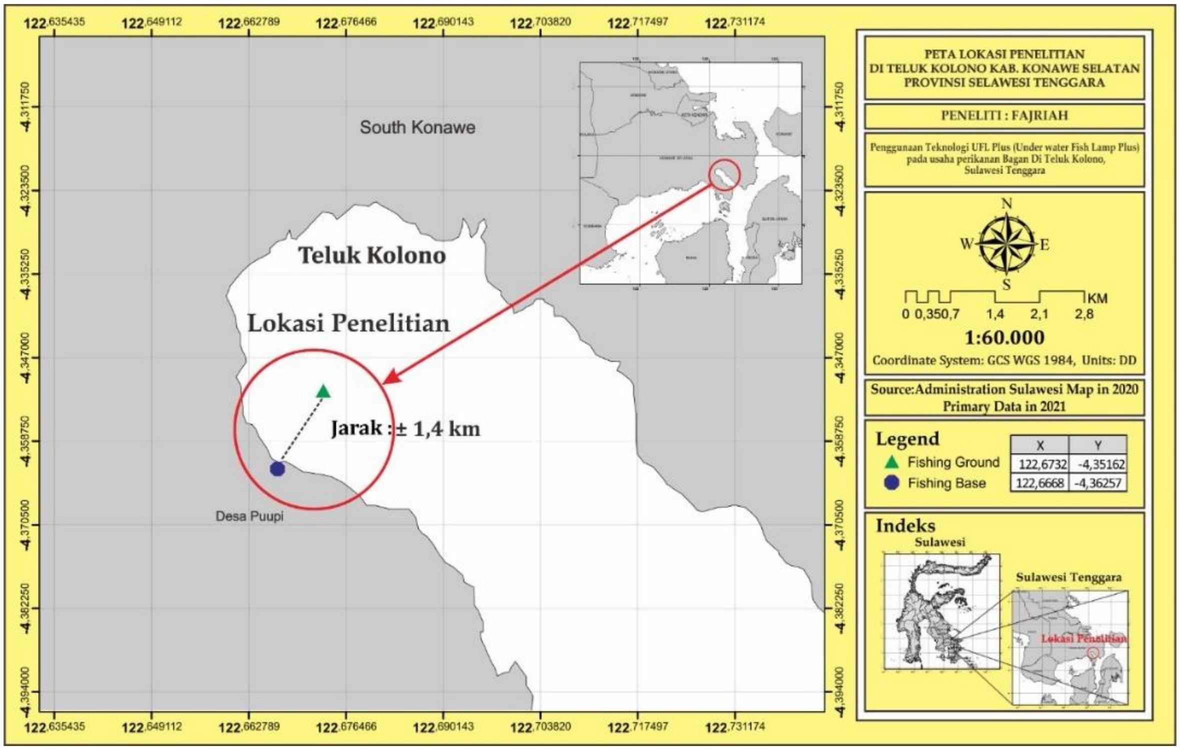

Fig. 1. Map of the study site for field trial

Fishing gear and UFL+ technology

The fishing gear used was a boat lift net, which operates at night by utilizing artificial light to attract fish schools **(Shen *et al.,* 2013)**. The innovation tested was the Underwater Fish Lamp Plus (UFL+), consisting of three main components:

- Lamp unit: Submersible lamp with a total of 60 LED bulbs (48 on the body and 12 on the bottom) with a power of 30 watts, operating at 12–60 V, designed to withstand underwater pressure and prevent water leakage.
- Frame and sinker system: Functions as a support structure to keep the lamp stable at the desired depth.
- Action camera: Integrated to monitor fish aggregation behavior in real-time.

The lamp was deployed at the optimal depth to maximize fish aggregation while minimizing energy consumption. An illustration of UFL+ operation in lift net fisheries is presented in Fig. (2).

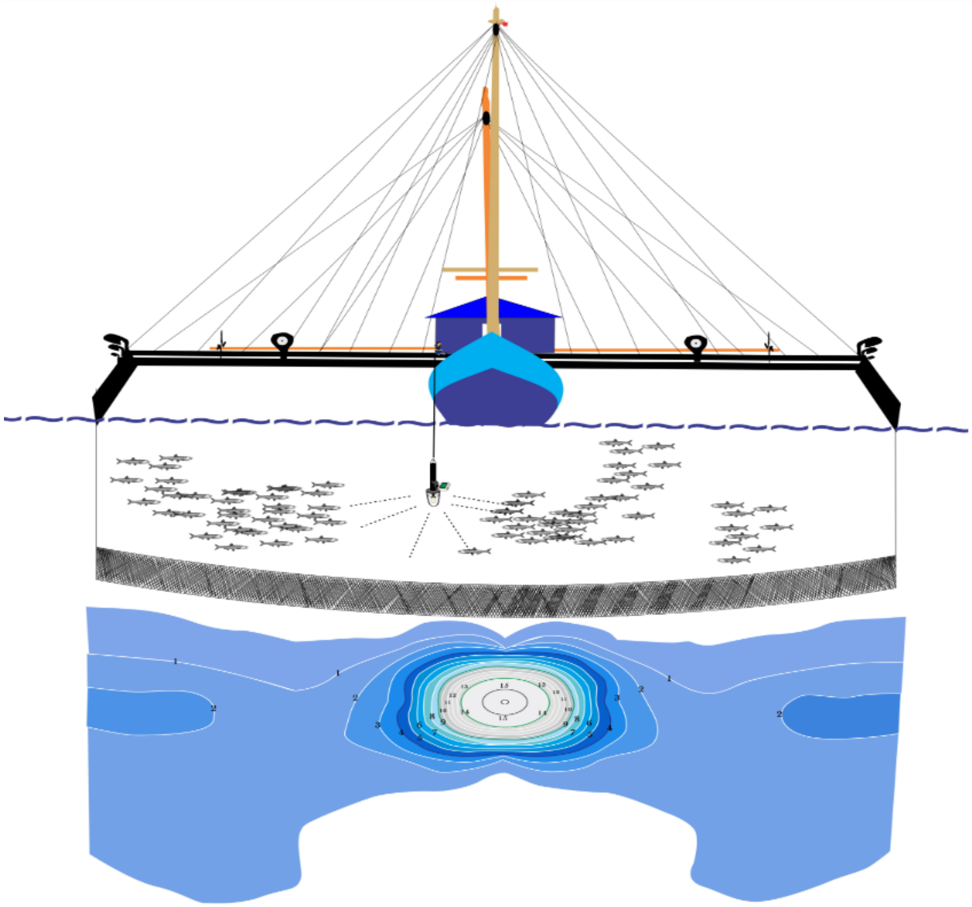

Fig. 2. Schematic illustration of UFL+ deployment and operation in boat lift net fisheries

The system consists of (A) the submersible LED lamp unit with 60 bulbs (48 on the body and 12 at the bottom), (B) the supporting frame and sinker system for stable positioning at the desired depth, and (C) the integrated action camera for real-time monitoring of fish aggregation. Arrows indicate the direction of light dispersion and fish movement toward the net. This configuration enhances fish attraction efficiency while minimizing energy use.

Data collection

Operational and financial data were systematically collected during fishing activities. The operational parameters recorded included the number of trips per year, fishing duration per trip, fuel consumption, ice utilization, and labor requirements. Catch data comprised the total biomass per trip (kg/trip) and the corresponding market price (IDR/kg). The cost structure was categorized into fixed costs—covering capital expenditure, depreciation, maintenance, and overhead—and variable costs, which included fuel, ice, and labor. All data were documented on a daily basis and subsequently aggregated into annual estimates to facilitate the economic feasibility analysis. The complete set of operational and cost parameters used for the analysis is summarized in Table (1).

Table 1. Operational data of boat lift net using UFL+

Parameter	**Value (IDR or unit)**
Investment horizon (years)	7
Discount rate (%)	10
Trips per year	180
Catch per trip (kg)	125
Fish price (IDR/kg)	18,000
Fuel consumption per trip (IDR)	700,000
Ice per trip (IDR)	120,000
Labor wage per trip (IDR)	1,100,000
Annual overhead cost (IDR)	5,000,000
Annual maintenance (5% CAPEX) (IDR)	10,750,000
Total CAPEX (IDR)	215,000,000
Residual value (10% CAPEX) (IDR)	21,500,000

Feasibility analysis using SIDIA

The SIDIA (Sistem Digital Agribisnis) platform was utilized to conduct the investment feasibility assessment. The evaluation focused on four key financial indicators commonly applied in fisheries economics: Net Present Value (NPV), Internal Rate of Return (IRR), Net Benefit–Cost Ratio (Net B/C), and Payback Period (PP). NPV was calculated to determine the present value of net cash flows over the investment horizon, with a positive value indicating economic viability. IRR was used to identify the discount rate at which the NPV equals zero, thereby reflecting the profitability of the investment relative to the cost of capital. The Net B/C ratio measured the relative magnitude of benefits to costs, with a ratio greater than one signifying financial feasibility. Finally, the payback period provided an estimate of the time required to recover the initial capital outlay from net cash inflows.

All analyses were performed under the assumption of a 10% discount rate and a 7-year investment horizon, reflecting the typical planning framework for small- to medium-scale fisheries enterprises. The SIDIA platform allowed these calculations to be conducted in a structured and automated manner, thereby reducing the complexity of manual computations and enabling more accurate and timely decision-making for fisheries investment planning.

Sensitivity analysis

To evaluate the robustness of the investment under varying economic conditions, a sensitivity analysis was performed. The analysis considered two major sources of uncertainty that typically affect small-scale fisheries: fluctuations in output prices and input costs. Specifically, scenarios were developed to simulate fish price variations of ±10% and fuel cost variations of ±15% relative to the baseline values. For each scenario, the core financial indicators—Net Present Value (NPV), Internal Rate of Return (IRR), and Payback Period (PP)—were recalculated. The results provided insights into the extent to which profitability and investment viability were influenced by market volatility and operational cost dynamics, thereby allowing a more comprehensive assessment of risk exposure in UFL+-assisted boat lift net fisheries.

RESULTS

Catch performance with UFL+

The application of UFL+ technology in boat lift net operations demonstrated a significant improvement in fishing performance compared to conventional lighting systems. On average, the use of UFL+ increased catch per trip to approximately 125kg, translated into a higher gross revenue per trip. The enhanced aggregation of fish around the submersible light contributed to an increase in the gross margin, thereby strengthening the profitability of fishing activities at the operational level.

Economic feasibility (SIDIA Output)

The financial simulation using the SIDIA platform indicated that the investment in UFL+-assisted lift net fisheries is economically feasible. The analysis produced a Net Present Value (NPV) of IDR 8,539,380, an Internal Rate of Return (IRR) of 11.14%, a Net Benefit–Cost Ratio (Net B/C) of 1.28, and a Payback Period of 4.93 years at a 10% discount rate (Tables 2, 3). The positive NPV and IRR exceeding the discount rate demonstrate that the investment can generate surplus value over time, while the Net B/C ratio greater than one confirms its economic attractiveness. The payback period of less than five years also suggests that the recovery of capital investment is achievable within a reasonable timeframe for small- to medium-scale coastal fisheries.

Table 2. Operational revenue, variable cost, gross profit, and net annual cash flow of UFL+-assisted boat lift net fisheries (in Indonesian Rupiah, IDR)

Item	Value (IDR)
Revenue per trip	2,250,000
Variable cost per trip	1,920,000
Gross profit per trip	330,000
Gross profit per year	59,400,000
Fixed cost per year	15,750,000
Net annual cash flow	43,650,000

Table 3. Investment feasibility indicators (NPV, IRR, Net B/C, and Payback Period) of UFL+-assisted boat lift net fisheries at a 10% discount rate

Indicator	Value
NPV (IDR)	8,539,380
IRR (%)	11.14
Net B/C	1.28
Payback Period (years)	4.93

Sensitivity analysis

Sensitivity analysis revealed that the feasibility of UFL+-assisted lift net fisheries is highly responsive to changes in key economic variables, particularly fish price and fuel cost. A 10% decrease in fish price resulted in a negative NPV (–IDR 188,631,581) and a prolonged payback period of over 68 years, indicating a high level of vulnerability. Conversely, a 10% increase in fish price significantly improved feasibility, yielding an NPV of IDR 205,710,343, an IRR of 34.71%, and a shortened payback period of 2.55 years. Fuel price fluctuations also affected profitability, with a 15% increase in fuel cost producing a negative NPV (–IDR 83,473,734) and an IRR below zero, while a 15% reduction in fuel cost improved investment performance, reflected in an NPV of IDR 100,552,496 and an IRR of 22.68% (table 4).

Table 4. Sensitivity analysis of UFL+-assisted boat lift net fisheries

Scenario	NPV (IDR)	IRR (%)	Payback Period (years)
Fish price –10%	–188,631,581	-2.03×10^{16}	68.25
Fish price +10%	205,710,343	34.71	2.55
Fuel cost +15%	–83,473,734	–2.23	8.69
Fuel cost –15%	100,552,496	22.68	3.44

These results suggest that while UFL+ technology enhances catch efficiency and overall profitability, the long-term viability of the investment remains sensitive to external market and fuel cost dynamics. The integration of SIDIA in feasibility evaluation provides a rapid and structured approach to quantify these risks, supporting informed decision-making for small-scale fisheries development.

DISCUSSION

The integration of Underwater Fish Lamp Plus (UFL+) technology with the feasibility analysis conducted through the Sistem Digital Agribisnis (SIDIA) platform presents a transformative approach to enhancing the economic performance of small-scale boat lift net fisheries. The results from this study indicate that the successful implementation of UFL+ can increase catch per trip, as previous studies have shown that underwater lighting systems can enhance fish aggregation behaviors through improved visual stimuli and schooling dynamics **(Tilley *et al.*, 2020; Adnan *et al.*, 2021)**. Unlike conventional surface lamps, UFL+ operates at greater depths, where light penetration is better and surface scattering is minimized, effectively attracting more target species and enhancing energy efficiency **(Lindkvist *et al.*, 2020; Tilley *et al.*, 2020; Fajriah & Isamu, 2025a, b)**.

Moreover, the incorporation of an action camera into the UFL+ system facilitates adaptive fishing practices, allowing fishers to monitor fish behavior and optimize strategies for deployment **(Tilley *et al.*, 2020)**. Economic analyses show that metrics such as a positive Net Present Value (NPV), Internal Rate of Return (IRR) exceeding the discount rate, and a Net Benefit-Cost Ratio (Net B/C) greater than one suggest that adopting UFL+ technology can enhance the profitability of coastal fisheries **(Villasante *et al.*, 2021; Innocenti *et al.*, 2022)**. The payback period for this technology, typically under five years, is particularly relevant for small-scale fisheries, where obtaining capital and managing investment risks are significant barriers to adopting new technologies **(Brown *et al.*, 2024)**.

However, a sensitivity analysis indicates that the financial sustainability of investments in UFL+ is highly sensitive to fluctuations in market prices for fish and increases in fuel costs. For example, a mere 10% decline in fish prices or a 15% increase in fuel costs could render such projects economically unfeasible **(Simmance *et al.*, 2022; Wiff *et al.*, 2024)**. Such vulnerabilities highlight the critical role of market stability and household finances in determining the benefits derived from small-scale fisheries co-management **(Putra *et al.*, 2021)**. Therefore, while technological advancements like UFL+ potentially enhance operational efficiency, there remains a pressing need for supportive policies, such as fuel subsidies and price stabilization strategies, to protect fisher livelihoods against economic shocks **(Hwang, 2022)**.

Furthermore, the application of digital platforms like SIDIA marks a significant development in the digital transformation of fisheries management, enabling automated financial assessments and scenario-based analyses that simplify the feasibility evaluation process for practitioners **(Harper *et al.*, 2020; Tetelepta *et al.*, 2023)**. This integration aligns with global trends in "blue economy" initiatives, where technology and data-driven methodologies are utilized to enhance both ecological and economic sustainability in fisheries **(Kurniawan & Aini, 2022)**. This aligns with broader blue economy initiatives, where small-scale fisheries are recognized for their potential to provide not only food and income but also novel bioactive compounds for pharmaceutical and nutraceutical applications **(Isamu *et al.*, 2024)**. Nonetheless, the lack of direct data integration between UFL+ operations and SIDIA poses a limitation, as manual data entry could introduce inaccuracies and delays. Future efforts should focus on establishing interconnected systems that facilitate real-time data exchange between fishing technologies and digital support platforms **(Setyaningrum *et al.*, 2024)**. It is evident that merging innovations like

UFL+ with digital financial tools such as SIDIA can improve operational efficacy, enhance profitability, and provide a more robust decision-making framework for small-scale coastal fisheries. Ensuring the resilience of these systems will require continuous technological advancement and broader institutional support to mitigate the vulnerabilities inherent in the fisheries sector amid economic and environmental fluctuations.

Policy implications and SDG linkages

The findings of this study carry important implications for fisheries policy and management in Indonesia. The sensitivity of UFL+-assisted boat lift net fisheries to fluctuations in fish prices and fuel costs highlights the necessity of policy interventions that can buffer small-scale fishers against market volatility. Government mechanisms such as fuel subsidies, cooperative purchasing schemes, and minimum price guarantees could play a crucial role in maintaining profitability and safeguarding fisher livelihoods. These measures are consistent with national fisheries development strategies that aim to strengthen community-based fisheries and to enhance economic resilience in coastal regions.

Furthermore, integrating UFL+ technology with digital platforms like SIDIA aligns with the digital transformation agenda of Indonesia's marine and fisheries sector, providing a model for data-driven decision-making that can be scaled across coastal communities. This contributes directly to the monitoring of Sustainable Development Goals (SDGs), particularly SDG 1 (No Poverty), SDG 8 (Decent Work and Economic Growth), and SDG 14 (Life Below Water). By embedding these technological and financial innovations into policy frameworks, Indonesia can promote sustainable fisheries while ensuring that small-scale fishers are not excluded from the broader transition toward a blue economy **(Kurniawan & Aini, 2022)**.

CONCLUSION

This study confirmed that adopting Underwater Fish Lamp Plus (UFL+) technology in boat lift net fisheries enhances both catch performance and economic returns when compared with conventional lighting systems. The integration of operational data into the SIDIA digital agribusiness platform enabled a structured and efficient feasibility analysis, producing positive indicators such as an NPV of IDR 8.54 million, IRR of 11.14%, Net B/C of 1.28, and a Payback Period of 4.93 years. However, sensitivity analysis revealed that the investment's viability is highly vulnerable to fluctuations in fish prices and fuel costs, underscoring the need for supportive interventions.

Beyond these baseline results, the study highlights the broader implication that combining technological innovation (UFL+) with digital financial analytics (SIDIA) can serve as a replicable model for improving decision-making and investment planning in small-scale fisheries across Indonesia and other coastal regions globally. Such integration not only strengthens fisher livelihoods but also contributes to the achievement of Sustainable Development Goals, particularly SDG 1 (No Poverty), SDG 8 (Decent Work and Economic Growth), and SDG 14 (Life Below Water). Future research should expand this model by incorporating real-time data streams and assessing ecological as well as socio-economic outcomes, ensuring that the framework can be adapted to diverse fisheries contexts and contribute to long-term sustainability within the blue economy.

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