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Financing Indonesia's Free School Meals via Cash Waqf-Linked Sukuk: A Monte Carlo Simulation

Rifki Hilman Fauzi[1], Niko Faiz Fahrezi[1*], Muhammad Zigan Alsofi[1], Muhammad Aiman Hakim[2], Firila Najma Wahidah[3], Marhamah Muthohharoh[1]

[1]Department of Islamic Economics, Faculty of Economics and Management, IPB University, Jl. Raya Dramaga, Kampus IPB Dramaga, Kab. Bogor 16680, Jawa Barat, Indonesia
[2]Faculty of Ushuluddin, Al-Azhar University, Nasr City, Cairo 11884, Egypt
[3]Department of Statistics, Faculty of Science, University of British Columbia, 2207 Main Mall, Vancouver, BC V6T 1Z4, Canada

*) Corresponding author: Niko Faiz Fahrezi
E-mail: nikofahrezi@apps.ipb.ac.id; nikofaizf@gmail.com

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Abstract. Fiscal and health sector stability are essential pillars for a nation's well-being. However, implementing massive structural programs like the Universal Free School Meals (MBG) in Indonesia presents critical financing gaps. A purely debt-based approach could trigger crowding-out effects and breach intergenerational equity. Alternatively, from an Islamic public finance perspective, health preservation can be sustained ethically. This study aims to examine the financial resilience and optimal configuration of an alternative extra-budgetary model: the Sustainable Agromaritime Waqf (SAW) for Nutrition via Cash Waqf Linked Sukuk (CWLS). Employing Monte Carlo simulation over a 10-year projection with 10,000 iterations, findings reveal that full-scale CWLS financing is mathematically irrational due to compound food inflation. However, an optimal sweet spot exists: by maintaining an IDR 400 Trillion (approximately USD 22.2 billion) endowment, CWLS can sustainably cover 5.0% of targeted MBG operational needs. Cultivating this mechanism shields the state budget from usurious debt and advances society towards a holistic *Falah* Welfare state.

Abstrak. *Stabilitas sektor fiskal dan kesehatan merupakan pilar esensial kesejahteraan bangsa. Namun, implementasi program masif seperti Makan Bergizi Gratis (MBG) di Indonesia menghadirkan ancaman kesenjangan pembiayaan. Memaksakan pendekatan berbasis utang berpotensi memicu crowding-out effect dan melanggar keadilan antargenerasi. Sebaliknya, perspektif keuangan publik Islam menawarkan pemeliharaan kesehatan secara etis. Penelitian ini bertujuan menguji ketahanan finansial dan konfigurasi optimal dari pembiayaan extra-budgetary alternatif: Sustainable Agromaritime Waqf (SAW) for Nutrition melalui instrumen Cash Waqf Linked Sukuk (CWLS). Menggunakan simulasi Monte Carlo dengan 10,000 iterasi selama proyeksi 10 tahun, temuan membuktikan bahwa pembiayaan MBG berskala nasional secara penuh menggunakan CWLS adalah irasional secara matematis akibat terkompaunnya inflasi pangan. Namun, penelitian menemukan titik keseimbangan optimal: dengan dana abadi Rp 400 Triliun (sekitar USD 22.2 Miliar), CWLS mampu membiayai 5.0% kebutuhan operasional MBG secara tersegmentasi. Implementasi mekanisme ini tidak hanya melindungi APBN dari jeratan utang ribawi, tetapi juga menghantarkan masyarakat menuju kesejahteraan holistik pada Kuadran Falah.*

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INTRODUCTION

The Golden Indonesia 2045 Vision serves as a comprehensive framework that necessitates the development of high-quality human capital, fundamentally liberated from the threat of stunting. According to data from the Indonesian Nutritional Status Survey (SSGI), the national stunting prevalence remained at a critical level of 19.8% in 2024. In response to this emergency, the implementation of the Universal Free School Meals (MBG) program is executed not merely as a constitutional state mandate (Oktawila et al., 2025), but rather as a strategic political-economic instrument to elevate the nation's intellectual capacity and nutritional status (Waluyo, 2025; Desiani & Syafiq, 2025).

Global literature demonstrates that the Universal Free School Meals (UFSM) initiative has established efficient governance, resulting in favourable progress toward massively eradicating food insecurity and enhancing academic performance (Cohen et al., 2021; Zuercher et al., 2022; Gundersen & Ziliak, 2018; Kenney et al., 2020; Micha et al., 2018). Furthermore, these nutritional fulfillment guidelines extend beyond mere commercial social assistance; within the Islamic social finance paradigm, this initiative represents a tangible actualization of *maqasid al-shari'ah*. The primary objective of this program is not about profit maximization, but rather the protection of life *(hifdz an-nafs)* and intellect *(hifdz al-aql)* for future generations (Shihab, 2007; Nurhayati & Fitriyana, 2020; Alshater et al., 2021).

Nevertheless, the expansion of these social welfare programs brings the logical consequence of increasingly complex fiscal capacity demands. The budget for the MBG program, projected to reach IDR 400 trillion (USD 22.2 billion) at full scale, creates structural pressures on the State Budget (APBN), which is simultaneously confronting macroeconomic volatility and global uncertainty (Kemenkeu RI, 2025). Given this massive initiative possesses distinct consumption characteristics, an implementation relying purely on state funding frequently traps the government in the phenomenon known as the Paradox of the Welfare State (Bailey, 2015). In this context, the noble intention of alleviating poverty potentially triggers a fiscal sustainability crisis due to the excessive exploitation of state resources. Additionally, a distribution system heavily dependent on the state treasury faces the risks of information asymmetry, operational inefficiencies, and potential fraud in the field (Hoesada, 2024).

To contextualize the urgency of a non-debt financing model, it is crucial to examine the global landscape of school meal financing. In developed nations such as the United States and Sweden, Universal Free School Meals are predominantly funded through federal agricultural subsidies and municipal tax revenues, which often strain local government budgets during economic downturns (Rothbart et al., 2023). Similarly, in developing contexts, India's Mid-Day Meal Scheme and Brazil's National School Feeding Program (PNAE) rely heavily on state and federal taxation, making them highly susceptible to fiscal deficits and political budget cuts. A critical gap in the current global literature is the over-reliance on conventional taxation and sovereign debt to sustain these massive consumption programs. There is a distinct absence of perpetual, community-driven financing models that do not encumber the national balance sheet.

In this regard, waqf is a fundamental instrument of Islamic social finance that holds significant potential to foster sustainable development by enabling the productive management and accelerating the achievement of the SDGs (Ali & Kassim, 2020; Fahrezi, 2025; Hassan et al., 2021). The primary challenge faced by policymakers stems from the consumptive and recurring characteristics of MBG expenditures. Theoretically, if this program is forced to operate under a debt-based financing scheme, the state will not only aggressively widen the fiscal deficit (Rothbart et al., 2023) but also violate intergenerational equity by burdening future generations with taxes for benefits that are no longer relevant to them. The discourse in Islamic finance literature asserts that reliance on usurious debt instruments in social programs will create structural economic fragility and contradict distributive justice (Rudnyckyj, 2017; Ganaie, 2025). Current global trends indicate a management convergence where countries are beginning to adopt Social Impact

Bonds to fund public services outside the national budget (Carè & De Lisa, 2019). This highlights the urgency for Indonesia to initiate a paradigm shift toward equity-based financing and community participation.

To bridge the gap between fiscal demands and sharia compliance principles, this study positions the Sustainable Agromaritime Waqf (SAW) for Nutrition scheme as the primary pillar of alternative financing. As an extra-budgetary innovation, this model utilizes the Cash Waqf Linked Sukuk (CWLS) instrument. Unlike conventional fiscal instruments, CWLS governance mandates the preservation of the principal endowment fund, while the allocation for food financing is sourced exclusively from the investment yield. This framework is precisely evaluated using the CIBEST Model to ensure the simultaneous creation of social and spiritual impacts (Beik & Arsyianti, 2015). Materially, this scheme elevates beneficiaries from nutritional poverty; spiritually, the integration of waqf instruments ensures operations that are free from the entrapment of usurious debt, thereby effectively steering the state ecosystem toward the *Falah* Quadrant (comprehensive welfare).

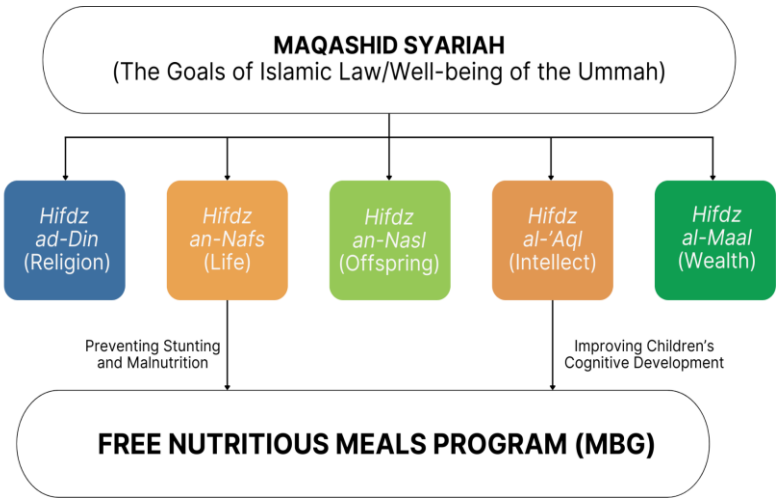
The exploration of the CWLS instrument has attracted considerable academic interest; however, the existing literature is predominantly dominated by qualitative and descriptive reviews. Similar attention has yet to be directed towards implementing quantitative stress tests to measure the resilience of waqf funds in financing the MBG program. This study aims to fill this literature gap by applying the Monte Carlo Simulation.

Currently, the Monte Carlo method is recognized as the gold standard (Value at Risk) in Islamic financial risk literature for capturing market volatility and mitigating the probability of default (Alam et al., 2018; Mongid et al., 2023; Senova et al., 2023; Boubaker & Nguyen, 2020; Asl & Rashidi, 2021). It is anticipated that the findings from these simulation projections will not only produce a strategic blueprint for the Fiscal Authority and the National Nutrition Agency in Indonesia but also contribute significantly as a model for Islamic fiscal governance policies at the regional level, aligning with the discourse on CWLS model adoption currently being intensively reviewed in Malaysia (Najmuddin & Ishak, 2025). This paper is organised as follows; Section 1 provides the introduction of the study. Subsequently, Section 2 and Section 3 discuss the literature framework and methodology, respectively. The following section elaborates on the findings of the simulation analysis, and the final section concludes with the strategic implications of this policy.

LITERATURE REVIEW

The Preservation of Future Generations and *Maqashid al-Shari'ah*

Etymologically, *maqasid al-shari'ah* denotes the objectives established by Islamic law to actualize the welfare (*maslahah*) of humanity, both in this world and in the hereafter (Asy-Syatibi, 2014). This public welfare is materialized through the protection of five fundamental pillars: faith (*hifdz ad-din*), life (*hifdz an-nafs*), intellect (*hifdz al-aql*), lineage (*hifdz an-nasl*), and property (*hifdz al-maal*) (Al-Zuhaili, 1997; Al-Qardhawi, 2007). In the context of contemporary public policy, the provision of adequate nutrition is no longer perceived merely as the fulfillment of basic biological needs, but rather as an essential instrument for safeguarding the quality of the nation's future generations.



Source: Authors (2026)

Figure 1. *Maqashid sharia* framework in public nutrition policy

The Universal Free School Meals (MBG) program possesses a robust philosophical justification within the *Maqasid al-Shari'ah* framework. Direct nutritional interventions aim to prevent stunting and malnutrition, which serve as a manifestation of the obligation to protect life *(hifdz an-nafs).* Furthermore, optimal nutritional intake correlates directly with children's cognitive development, representing a tangible form of intellect protection *(hifdz al-aql)* (Shihab, 2007; Fachmi & Mansah, 2025). Therefore, its financing scheme must strictly adhere to sharia principles to ensure the divine blessing *(barakah)* and ethical integrity of the program from inception to implementation.

Food Security and State Structural Intervention

Addressing food insecurity cannot rely on sporadic policies; rather, it necessitates structural interventions and modifications at the macroeconomic level (Dahlgren & Whitehead, 1991). Global literature demonstrates that Universal Free School Meals (UFSM) constitute one of the most effective structural policies proven to eliminate hunger within the school environment, while simultaneously enhancing student attendance and academic performance significantly (Cohen et al., 2021; Zuercher et al., 2022). Despite its proven effectiveness, this universally scaled program demands an extraordinary mobilization of financial resources (Marcus & Yewell, 2022). Empirical studies across various developed nations indicate that the burden of provisioning raw materials and food logistics infrastructure frequently creates exponential pressure on both regional and national budgets (Rothbart et al., 2023). Consequently, this necessitates the development of innovative financial engineering frameworks to ensure the sustainable operationalization of the program.

A Paradigm Shift in Financing: Debt vs. Social Equity

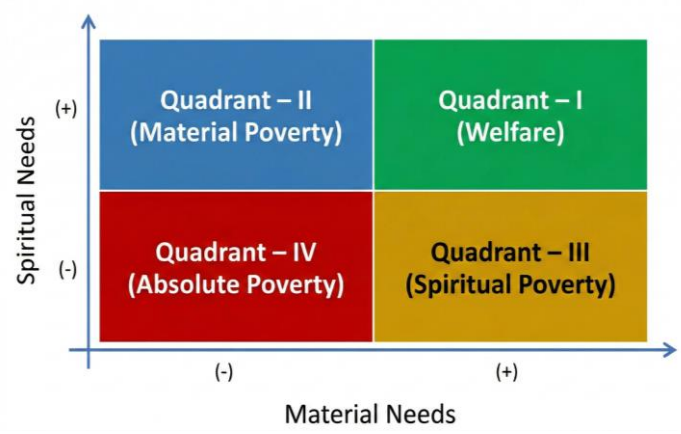
The escalating fiscal burden arising from social welfare programs frequently entraps governments in the phenomenon known as the Paradox of the Welfare State (Bailey, 2015), wherein the noble intention to alleviate poverty inadvertently triggers a future fiscal sustainability crisis due to severe budget depletion. Historically, developing nations have demonstrated a tendency to respond to such deficits through debt-based financing instruments. However, academic literature provides empirical evidence that enforcing the financing of social programs through conventional debt not only creates structural economic fragility but also fundamentally violates the principle of intergenerational equity (Rudnyckyj, 2017; Ganaie, 2025).

In alignment with the global trajectory that is increasingly shifting towards the utilization of Social Impact Bonds (SIB) to fund public services (Carè & De Lisa, 2019), Islamic finance offers a significantly superior

resolution through social equity-based instruments, specifically waqf. Through the innovation of Cash Waqf Linked Sukuk (CWLS), the government possesses the strategic capacity to mobilize public philanthropic funds where the principal endowment is perpetually preserved. Simultaneously, the generated investment yield is exclusively allocated for the MBG program. This precise mechanism effectively mitigates the risk of state budget deficits without relying on usurious debt (Ascarya, 2022; Thaker et al., 2021; Biancone & Radwan, 2018; Thaker, 2018; Hasan et al., 2022).

Holistic Welfare: The CIBEST Model Approach

Evaluating the success and welfare significance of social programs solely through conventional macroeconomic indicators, such as Gross Domestic Product (GDP) or the Gini Ratio, is no longer adequate within the perspective of Islamic economics. The fulfillment of material needs must proceed in harmony with the fulfillment of spiritual necessities. To accurately measure this dual impact, the CIBEST (Center of Islamic Business and Economic Studies) Model, developed by Beik and Arsyianti (2015), provides a highly comprehensive analytical framework.



Source: Beik & Arsyianti (2015)

Figure 2. The CIBEST (Center of Islamic Business and Economic Studies) model quadrants

The CIBEST Model classifies the level of welfare into four distinct quadrants: Quadrant I *(Falah,* representing comprehensive material and spiritual prosperity), Quadrant II (Materially affluent but spiritually impoverished), Quadrant III (Materially impoverished but spiritually affluent), and Quadrant IV (Absolute poverty). If the MBG program is financed utilizing interest-bearing debt instruments (Conventional Government Bonds), the state may succeed in fulfilling the physical nutritional needs of the children (materially). However, this approach would systemically plunge the entire policy ecosystem into spiritual poverty (Quadrant II). Conversely, the implementation of the SAW-Nutrition scheme through CWLS ensures that material requirements (nutrition) are fulfilled by waqf financing sources that are strictly free from the elements of *riba* (usury), *gharar* (uncertainty), and *maysir* (gambling). Consequently, this ethical financing mechanism effectively propels the society toward Quadrant I *(Falah).*

Previous Studies and Research Gap

Existing literature on the intersection of school meal financing and Islamic social finance remains highly fragmented. Prior studies on school meal programs primarily evaluate nutritional and educational outcomes or analyze state-funded fiscal burdens (Cohen et al., 2021; Rothbart et al., 2023), largely ignoring non-sovereign alternative financing. Conversely, the expanding body of knowledge on Cash Waqf Linked Sukuk (CWLS) and Islamic public finance heavily concentrates on qualitative conceptual frameworks, regulatory analyses, or qualitative assessments of micro-scale empowerment (Ascarya, 2022). While recent

scholarship acknowledges the potential of waqf for macroeconomic sustainability, there is a prominent absence of empirical, quantitative risk assessments. No prior study has conducted a stochastic stress test to evaluate the long-term mathematical resilience of CWLS when deployed to co-finance massive, recurring national consumption initiatives like the Universal Free School Meals program. This study directly addresses this gap by introducing a Monte Carlo simulation to bridge qualitative Islamic finance paradigms with robust quantitative fiscal policy engineering.

METHOD

This study employs a quantitative approach based on financial risk simulation, integrated with an Islamic public policy evaluation framework. The data utilized comprise secondary time-series and cross-sectional proxy data sourced from official authorities, including the Ministry of Finance of the Republic of Indonesia (State Budget Financial Notes, Recent Economic Development Reports, and Sukuk Information Memorandums), Statistics Indonesia (Consumer Price Index and Volatile Food Inflation), and the Indonesian Waqf Board (Cash Waqf Potential Data).

To project the resilience of the Cash Waqf Linked Sukuk (CWLS) instrument in financing the Universal Free School Meals (MBG) program, this research establishes a 10-year simulation time horizon (2025–2034). While the MBG program is closely associated with the current five-year political administration, a 10-year projection is methodologically imperative for two reasons. First, the demographic objective of eradicating stunting to support the Golden Indonesia 2045 Vision requires sustained, multi-administration intervention rather than a short-term political cycle. Second, from a financial engineering perspective, the resilience of a perpetual waqf endowment and the compounding effect of its residual yield against stochastic inflation can only be accurately observed over a long-term horizon (minimum one decade), whereas a five-year projection would prematurely truncate the compound growth trajectory. The target variable of MBG beneficiaries is projected to grow dynamically from the initial roll-out phase (20 million individuals) to full scale (82.9 million individuals).

Prior to examining financial feasibility, the success parameters of this program are strictly constrained by the CIBEST (Center of Islamic Business and Economic Studies) Model framework (Beik & Arsyianti, 2015). Within this model, the CWLS scheme is mandated to utilize solely the investment yield for food expenditures, while the principal endowment fund must be perpetually preserved. This ensures that the financing of the MBG program does not compromise the state's fiscal stability or entrap the ecosystem within Quadrant II (materially affluent but spiritually impoverished due to usurious debt), but rather navigates the nation toward Quadrant I (*Falah:* comprehensive material and spiritual welfare), while the CIBEST framework in this study is applied primarily in a descriptive manner to illustrate the program's positioning within the welfare quadrants rather than through a full empirical estimation.

Given the high volatility of financial markets and the uncertainty of global food prices, this study employs a Monte Carlo Simulation with 10,000 iterations to measure the Value at Risk (VaR) and the sustainability probability of the sukuk instrument (Alam et al., 2018; Senova et al., 2023). In contrast to standard linear regression, the Monte Carlo method enables the modeling of stochastic (randomly distributed) variables to simulate future macroeconomic shocks. There are two primary stochastic variables in this model: Sukuk Yield (rt), assuming a normal distribution based on historical data of Retail SBSN series SWR006 and ST009 with a mean (μ) of 6.4% and a standard deviation of 0.5%; and Food Inflation (it), utilizing the BPS Volatile Food inflation proxy with a mean (μ) of 4.5% and a standard deviation of 0.5%.

To better capture the realities of a national-scale policy, the original simulation is expanded to include demographic and regional stochastic variables. The model now integrates Demographic Beneficiary Growth

γ_t based on birth rate projections, and a Regional Operational Cost Variation Factor ρ_r to account for logistical price disparities between urban centers and Frontier, Outermost, and Underdeveloped (3T) regions. The expanded Annual MBG Cost Model is formulated as follows:

$$C_t = \sum_{r=1}^{R} (B_{r,t-1} \times (1+\gamma_t) \times P \times \rho_r \times D \times (1+i_t)^t) \quad (1)$$

where C_t represents the Total MBG Cost in year t, R denotes the designated regional clusters, $B_{r,t-1}$ is the baseline number of beneficiaries in region r, γ_t is the stochastic demographic growth rate, P is the base price per meal (IDR 15,000 or ~USD 0.83), ρ_r constitutes the regional cost multiplier (ranging from 1.0 in Java to 1.3 in Eastern Indonesia), D denotes the effective school days (261 days), and i_t constitutes the stochastic food inflation factor. This multivariable incorporation ensures that the simulated expenditure accurately reflects logistical realities and population dynamics over the 10-year horizon.

Furthermore, the Waqf Revenue and Allocation Model is calculated through the following sequential equations:

$$Y_t = W_{t-1} \times r_t \quad (2)$$

$$S_t = \min(Y_t, \alpha \times C_t) \quad (3)$$

$$W_t = W_{t-1} + Y_t - S_t \quad (4)$$

where Y_t is the waqf yield in year t, W_t is the Principal Endowment Fund, S_t represents the actual expenditure for the MBG program, and α is the targeted financing coverage percentage (Target Coverage). The sequence of Equations (2) through (4) asserts the waqf principal protection mechanism, wherein actual expenditure is strictly prohibited from exceeding the generated yield. The unutilized residual yield is reinvested into the principal endowment fund to generate a compounding effect that serves as a shock absorber against future food inflation.

Rather than testing conventional associative hypotheses, this study conducts macroeconomic policy stress tests to identify the optimal equilibrium (sweet spot) between the scale of the endowment fund and the MBG coverage target. The Moderate Scenario assumes an accumulated waqf fund of IDR 200 Trillion (USD 11.1 billion), while the Optimistic Scenario assumes IDR 400 Trillion (USD 22.2 billion). The success of the simulation is measured using Sustainability Probability $P_{sustain}$, defined as the percentage of the 10,000 iterations in which the CWLS scheme successfully finances the target coverage for 10 consecutive years without experiencing default or eroding the initial waqf principal value:

$$P_{sustain} = \frac{\sum_{j=1}^{10000} I(\forall t \in [1,10], S_{j,t} \geq \alpha C_{j,t})}{10000} \times 100\% \quad (5)$$

RESULTS AND DISCUSSION

Fiscal Challenges and the MBG Program Financing Gap Amidst Global Uncertainty

Indonesia's current macroeconomic landscape is confronted with the challenge of balancing accelerated economic growth with fiscal space stability. The Recent Economic Development report (Kemenkeu RI, 2025) indicates that the Global Uncertainty Index continues to escalate due to geopolitical dynamics and financial market volatility. Amidst these external pressures, the government has designed a massive structural intervention through the Universal Free School Meals (MBG) program to propel the Golden

Indonesia 2045 Vision. According to the 2025 State Budget Financial Note, the government has allocated an initial budget of IDR 71 Trillion (approximately USD 3.94 billion) for the roll-out phase. However, as the program reaches full scale in 2029, targeting 82.9 million beneficiaries, operational costs are estimated to skyrocket to IDR 400 Trillion (USD 22.2 billion) annually.

This massive, daily recurring consumptive funding requirement presents a severe financing gap threat. The APBN KiTa realization report (Kemenkeu RI, 2026) asserts the fiscal authority's commitment to consistently maintaining the budget deficit within a safe threshold (Sitepu, 2023; Sinaga et al., 2025). Enforcing the full financing of the MBG program utilizing the State Budget (APBN) purely through debt-based financing instruments constitutes a highly perilous policy that threatens future debt management (Febriansyah et al., 2025). Theoretically, this approach would trigger a crowding-out effect that sacrifices other priority expenditure allocations and violates the principle of intergenerational equity, wherein future generations are burdened with taxes to repay debt for food they no longer consume (Ganaie, 2025). Furthermore, the distribution of social programs that rely solely on conventional bureaucratic channels is highly susceptible to operational inefficiencies and the risk of fraud in the field (Hoesada, 2024). These facts underscore the urgency of a paradigm shift from debt-based financing towards an equity-based model utilizing community participation through the establishment of a social perpetual endowment.

Architectural Design of the Sustainable Agromaritime Waqf (SAW) for Nutrition

In response to these fiscal space constraints, this study designs an alternative financing model entitled the Sustainable Agromaritime Waqf (SAW) for Nutrition. This architectural design is constructed as a closed-loop ecosystem that integrates Islamic social finance instruments, fiscal authorities, and the agromaritime real sector. Integrating productive waqf instruments directly with agromaritime and forestry sectors has been recognized as a strategic catalyst for strengthening national food security frameworks (Ali, 2022). This architecture utilizes the Cash Waqf Linked Sukuk (CWLS) as an anchor instrument bridging public philanthropic liquidity with the financing requirements of strategic national projects.

The operational mechanism of the SAW-Nutrition scheme is represented through five continuous business process stages. The first stage is waqf fund mobilization. In this stage, retail communities, corporations, and philanthropic institutions deposit cash waqf through Islamic Financial Institutions Receiving Cash Waqf (LKS-PWU) to the *Nazhir* (BWI, 2024). In accordance with fundamental sharia principles, this principal fund is locked as a perpetual endowment, ensuring its principal value remains undiminished.

The second stage is CWLS Investment, where in the *Nazhir* places 100% of the principal waqf funds into a specialized series of State Sharia Securities (SBSN), namely the CWLS-MBG issued by the Ministry of Finance. The absolute advantage of this scheme is principal preservation; these hundreds of trillions in funds act as an underlying asset that will never be depleted by inflation or program consumption costs. The third stage involves yield distribution. The government pays periodic coupons (yields) to the *Nazhir*, which are subsequently channeled entirely to the National Nutrition Agency (BGN) acting as the *Mauquf 'alaih* (beneficiary) and program operator.

The fourth stage constitutes a strategic intersection between Islamic financing and food security, namely the agromaritime off-taking process. BGN is mandated to utilize the liquid funds from the sukuk yield to directly absorb local food supplies (such as rice, eggs, meat, and milk) from farmer and breeder cooperatives in their respective regions. Through this mechanism, BGN acts as a giant off-taker, providing market certainty and price stability guarantees for food producers, which in turn creates a positive policy spillover that stimulates the agricultural economic cycle at the rural level (Dwijayanti, 2024). Utilizing sharia financial innovations to empower local communities in this manner has been proven as a critical driver for sustainable grassroots economic development (Ali et al., 2025). The fifth and final stage is

nutritional output. The fifth and final stage is nutritional output, where the absorbed local food supplies are processed in certified public kitchens and distributed as Universal Free School Meals to the students.

To operationalize CWLS as a robust complementary financing instrument, the roles of key stakeholders within this ecosystem must be unequivocally delineated. The Indonesian Waqf Board (BWI) acts as the central *Nazhir*, responsible for mobilizing, aggregating, and safeguarding the principal endowment from retail and corporate *waqif*. The Ministry of Finance serves as the sovereign issuer of the CWLS-MBG, providing absolute security for the principal fund while distributing periodic, state-guaranteed yields. The National Nutrition Agency (BGN), positioned as the primary *Mauquf 'alaih* (beneficiary entity) and program operator, is responsible for executing the budget mapping and utilizing the yield exclusively for food logistics procurement. At the grassroots level, Local Farmer and Breeder Cooperatives serve as the primary supply chain anchors, absorbing the macroeconomic spillover of the program. Finally, the Ministry of National Development Planning (Bappenas) oversees the macro-integration of this extra-budgetary scheme into the National Medium-Term Development Plan (RPJMN) to ensure demographic and regional distribution alignment.

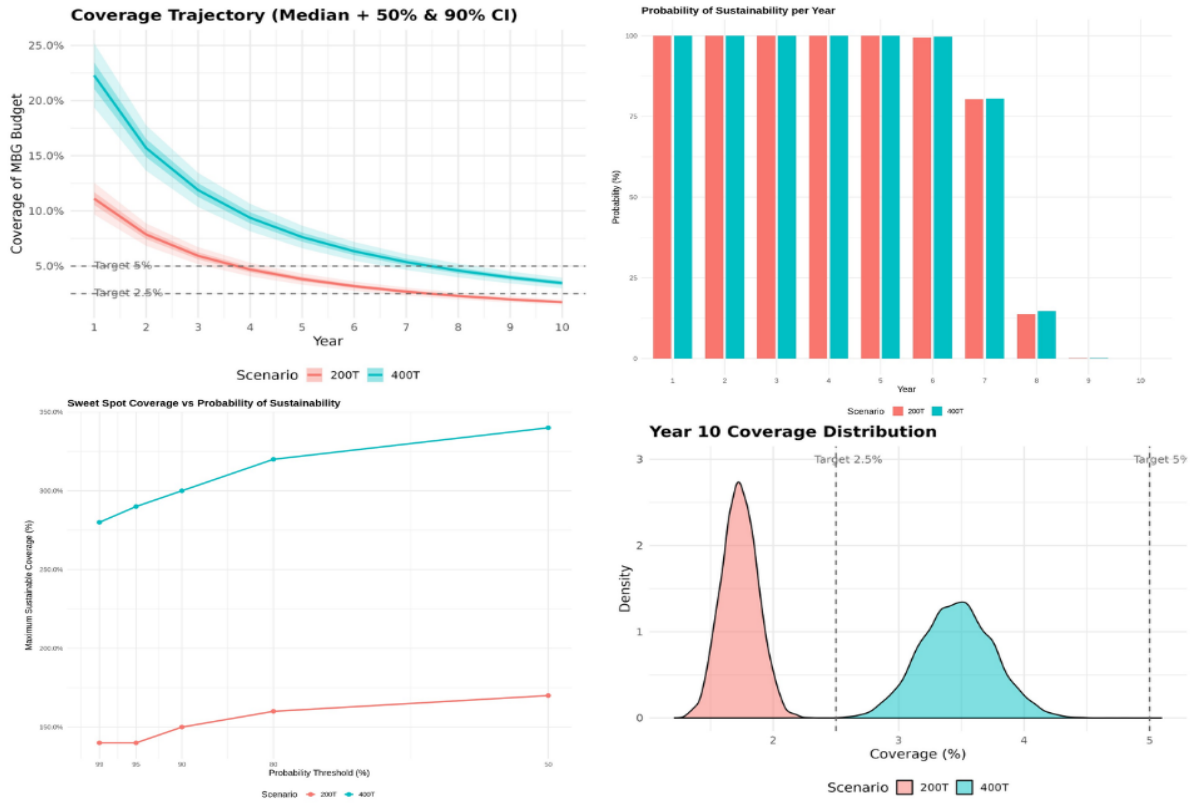
Monte Carlo Simulation Results and the Rationalization of Targeted Co-Financing

To quantitatively assess the financial resilience of the SAW-Nutrition design, this study conducts risk simulation testing utilizing the Monte Carlo method. The simulation input parameters (Table 1) are rigorously constructed based on historical data from official authorities to accurately reflect the realities of financial market and macroeconomic volatility. The Yield value (r_t) is assumed to fluctuate at an average of 6.4 percent with a standard deviation of 0.5 percent, precisely replicating the historical performance trajectory of the SWR006 and ST009 series. Simultaneously, the food inflation variable (i_t) utilizes the Volatile Food proxy from Statistics Indonesia, featuring a mean of 4.5 percent and a standard deviation of 0.5 percent.

Table 1. Input parameter for Monte Carlo simulation

Variable	Proxy/ Measurement	Value/ Distribution	Source
Waqf Fund (W_0)	Target CWLS Endowment	IDR 200 Trillion (USD 11.1 billion) & 400 Trillion (USD 22.2 billion)	Author Assumption
Yield (r_t)	SWR & ST Historical Coupon	Mean: 6.4% Std Dev: 0.5%	Kemenkeu RI (2024)
Inflation (i_t)	Volatile Food Inflation	Mean: 4.5% Std Dev: 0.5%	BPS (2024)
MBG Cost P	Cost per meal	IDR 15,000 (~USD 0.83)/child/day	National Nutrition Agency (2024)
Demographic Growth (γ_t)	Birth Rate Projections	Mean: 1.1% Std Dev: 0.2%	BPS (2024)
Regional Multiplier (ρ_r)	Logistical Price Disparities	Range: 1.0 (Java) to 1.3 (Eastern Indonesia)	Author Assumption

The simulation process conducted over 10,000 iterations across a 10-year projection period (2025–2034) produced crucial findings. These results, summarized in Figure 3, capture the coverage trajectory, the annual sustainability probability, the optimal sweet-spot threshold, and the year-10 coverage distribution generated by the CWLS–MBG financing scheme.



Source: Authors, processed data (2026)

Figure 3. Monte Carlo simulation results on CWLS-MBG financial resilience: (a) coverage trajectory, (b) probability of ≥ 20% Coverage, (c) sweet spot analysis, (d) year-10 coverage distribution

Comprehensive Analysis of Monte Carlo Simulation Results

Based on the simulation results visualized in Figure 3, the comprehensive analysis of financial resilience demonstrates significant variation across the projected 10-year period. To provide a meticulous interpretation, the estimation findings are delineated panel by panel as follows:

Panel (a): Coverage trajectory

Based on Figure 3a, the average coverage trajectory illustrates a continuous and steep downward trend in financing capacity from Year 1 to Year 10. In the first year, the average coverage capacity for the IDR 200 Trillion (USD 11.1 billion) scenario was 15.64%, which subsequently decreased continuously to a mere 2.54% by the tenth year. A similar trajectory is observed in the IDR 400 Trillion scenario (USD 22.2 billion), which experienced a drastic degradation from an initial 20.00% coverage down to 5.20%. The high rate of capacity degradation is caused by various factors that influence each other, primarily driven by the compounded pressure of food inflation and yield volatility. This empirical evidence confirms the theoretical expectation that ambitious, universal coverage targets are fundamentally unsustainable in the long term.

Panel (b): Probability of target coverage

The unsustainability of the scheme is further corroborated by Figure 3b, which tracks the probability of meeting the targeted coverage annually. The probability of achieving the targets remained at a perfect 100% during the initial roll-out phase (Years 1 to 4). However, it degraded significantly in the subsequent years. In the end, the probability of successfully financing the target in Year 10 declined to 57.7% for the moderate scenario and 68.4% for the optimistic scenario. This indicates a high susceptibility to default in the latter half of the decade.

Panel (c): Sweet spot analysis

Consequently, this study suggests repositioning the role of CWLS from a primary financing source to a targeted co-financing instrument. Based on the Sweet Spot Analysis in Figure 3c, the estimation results identify the exact threshold for absolute fiscal resilience. To achieve a rigid 99% probability of 10-year sustainability, the coverage target must be strictly locked at 2.0% for the IDR 200 Trillion (USD 11.1 billion) scenario and 4.2% for the IDR 400 Trillion (USD 22.2 billion) scenario. However, operating within an acceptable calculated risk tolerance (a ≥ 50% sustainability threshold), the scheme is proven capable of supporting 2.5% (moderate scenario) and 5.0% (optimistic scenario) of the total MBG requirements. This strategic segmentation ensures the residual yield acts as a compounding shock absorber across generations.

Panel (d): Year-10 Coverage Distribution

Based on Figure 3d, the probability distribution at the end of the simulation period (Year 10) definitively substantiates this degrading phenomenon. The density distribution of the achieved coverage is heavily concentrated at the lower bounds, far below the initial high-level projections. This estimation result provides absolute mathematical proof that financing the entire national MBG program or setting a double-digit target (such as ≥ 20%) relying purely on CWLS instruments is an irrational policy with severe fiscal risks.

Parameter Sensitivity: Food Inflation, Sukuk Yield, and the Compounding Effect

Delving deeper into the aforementioned simulation results, the resilience of the SAW-Nutrition scheme is significantly influenced by the sensitivity of three primary parameters that continuously interact within the model: food inflation pressure, yield endurance, and the compounding effect of the residual funds. First, the food inflation variable (volatile food) acts as the primary eroding factor. Based on historical data from Statistics Indonesia, food inflation exhibits a substantially higher volatility compared to core inflation, averaging at 4.5% with the potential for severe shocks induced by weather anomalies or global supply chain disruptions. In the context of the MBG Program, this inflation directly escalates the Cost per Meal P year over year. This finding corroborates global literature asserting that the budgets for free school lunch programs consistently experience raw material price inflations over time in the absence of adequate hedging mechanisms (Long et al., 2021).

Second, the Sukuk Yield variable r_t acts as the defensive instrument. The historical yield of CWLS series, pegged at an average of 6.4%, is nominally capable of outpacing the average food inflation (4.5%). However, this real spread of 1.9% is excessively narrow to sustain the burden of a beneficiary population that skyrockets from 20 million to 82.9 million children. If the coverage target is forced above 20%, this entire real spread will be completely eradicated by the sheer volume of beneficiaries, causing the yield to lose its capacity to meet the total operational costs C_t .

Third, the Target Coverage variable α, which triggers the compounding effect, serves as the system savior. The rationalization of the 5.0% sweet spot (under the IDR 400 Trillion [USD 22.2 billion] scenario) is not an arbitrary figure; rather, it represents the mathematical boundary where the actual expenditure portion S_t is deliberately suppressed well below the total yield Y_t during the initial years. The unutilized residual yield is not remitted to the state treasury but is instead reinvested to expand the Principal Endowment Fund W_t . This reinvestment mechanism generates what is referred to as the Compounding Effect (the Islamic equivalent of compound interest). Over time, this continually expanding waqf principal will generate a substantially more massive absolute nominal yield by Year 10, acting as a shock absorber that perfectly neutralizes the explosion of food inflation and the surge in student numbers.

Policy Implications and Holistic Welfare within the CIBEST Model Perspective

The identification of the 5.0% sweet spot provides a precise policy justification for the government. Rather than distributing funds uniformly yet ineffectively, the National Nutrition Agency can allocate this CWLS yield exclusively to finance the meals of students in Frontier, Outermost, and Underdeveloped Regions (3T), which currently remain the epicenters of national stunting. This policy segmentation is highly coherent with the implementation of *maqasid sharia*, particularly the pillars of protecting life (*hifdz an-nafs*) and intellect (*hifdz al-aql*), where state intervention is focused on the most structurally vulnerable demographics.

This targeted co-financing approach aligns with the findings of recent global studies emphasizing that universal subsidies often lead to fiscal exhaustion without proportionally benefiting the most marginalized demographics (Cohen et al., 2021). By narrowing the CWLS allocation to specific geographic epicenters of stunting, Indonesia can replicate the efficiency of targeted social safety nets observed in advanced welfare states, yet fundamentally distinguish itself by relying on Islamic philanthropic equity rather than sovereign debt. Furthermore, this policy direction corroborates the discourse in Islamic public finance literature, which argues that waqf should not entirely replace state obligations, but rather act as a strategic fiscal buffer to protect the most vulnerable during macroeconomic shocks (Ali & Kassim, 2020; Ascarya, 2022).

However, to accumulate a waqf endowment reaching the scale of IDR 200–400 Trillion (USD 11.1 billion - USD 22.2 billion), the government faces significant market penetration challenges. Drawing upon consumer behavior theory, philanthropic instruments cannot be marketed relying solely on conventional financial strategies (Solomon, 2017). Relevant authorities are required to employ an emotional and spiritual marketing approach targeting the dominance of retail investors from the Millennial and Gen-Z demographics. The marketing narrative for CWLS-MBG must emphasize transparency and emotional engagement, ensuring that every rupiah endowed directly impacts the eradication of childhood hunger while simultaneously generating a continuous flow of spiritual reward *(jariyah).* This narrative must be structurally supported by instilling the CDIC (Charity, Debt, Investment, Consumption) financial behavior framework, which educates the younger demographic to prioritize philanthropic allocations (waqf) above personal debt and consumptive lifestyles (Arsyianti & Beik, 2020).

Furthermore, from the perspective of Islamic welfare economics, the holistic impact of the SAW-Nutrition scheme can be rigorously evaluated using the CIBEST Model framework (Beik & Arsyianti, 2015). Conventional economic paradigms frequently fall into the Paradox of the Welfare State (Bailey, 2015), where welfare programs financed through debt (Conventional Government Bonds) may succeed in eradicating physical hunger (Material Needs fulfilled), but simultaneously bequeath a burden of usurious debt that compromises the nation's future spiritual blessing and fiscal independence (Spiritual Needs unfulfilled). In the CIBEST analysis, this condition merely shifts the society's status from Quadrant IV (Absolute Poverty) to Quadrant II (Materially Rich, Spiritually Poor).

Conversely, intervention through the Cash Waqf Linked Sukuk guarantees a funding source that is halal, productive, and entirely free from conventional debt entanglement. The harmonization achieved between fulfilling food security and utilizing waqf instruments ensures that the nutritional needs of the nation's children are met (Material) in alignment with the preservation of the nation's spiritual blessing and independence (Spiritual). Ultimately, this scheme propels the entire policy ecosystem toward Quadrant I (*Falah*), representing comprehensive welfare. The success of this solid financial engineering innovation not only addresses the domestic state budget deficit but also positions Indonesia as the epicenter of Islamic fiscal policy innovation on a global scale, as reflected by the growing interest in adopting the CWLS model currently being explored by neighboring countries such as Malaysia (Najmuddin & Ishak, 2025).

CONCLUSION

This study evaluates the financial resilience of the Cash Waqf Linked Sukuk (CWLS) instrument through the Sustainable Agromaritime Waqf (SAW) for Nutrition architecture as an extra-budgetary alternative to fund the Universal Free School Meals (MBG) program. The analytical method used in this study is the Monte Carlo Simulation with 10,000 iterations. Based on the estimation results, financing the full-scale national MBG program utilizing waqf yield is an irrational policy and is highly susceptible to default risk due to food inflation pressure. However, this study found an equilibrium point of persistent sustainability probability at a 5.0% coverage (in the IDR 400 Trillion [~USD 22.2 billion] waqf endowment scenario). In this case, the residual yield can be optimally reinvested to create a compounding effect that protects the waqf principal value.

Based on the results obtained in this study, the authors provide the following recommendations. First, the government and the National Nutrition Agency need to reposition the role of CWLS from a primary financing instrument to a targeted co-financing instrument. The 5.0% yield allocation should be exclusively focused on fulfilling the nutritional needs of students in the Frontier, Outermost, and Underdeveloped (3T) regions, which serve as the epicenter of stunting. This aligns with the fulfillment of *maqasid sharia* in protecting the lives (*hifdz an-nafs*) of the most vulnerable groups.

Second, to ensure the SAW-Nutrition scheme generates a multiplier effect in terms of holistic welfare, the government must integrate CWLS yield governance with the agromaritime real sector. The funds should not be allocated to large corporations; instead, they must be utilized to directly absorb food supplies from local farmer and breeder cooperatives. This mechanism prevents the state from falling into the trap of usurious debt while simultaneously strengthening the rural community ecosystem toward comprehensive welfare within the *Falah* Quadrant of the CIBEST Model, as illustrated descriptively in this study.

Third, to accelerate the accumulation of the cash waqf principal fund to achieve the targeted economies of scale (IDR 200 Trillion to IDR 400 Trillion) [USD 11.1 billion to USD 22.2 billion], the government, through the Indonesian Waqf Board (BWI), needs to adopt an innovative philanthropic marketing strategy. Given the demographic dominance of the younger generation, the literacy strategy must shift from a conventional approach to emotional and spiritual marketing capable of converting the social awareness of Gen-Z and Millennials into tangible waqf actions.

Finally, for the future research agenda, it is highly recommended to include several more complex macroeconomic modeling variables. Considering that this study is limited by the use of constant historical inflation proxy assumptions, subsequent research would be highly beneficial if it integrates the Dynamic Stochastic General Equilibrium (DSGE) model to capture more extreme macroeconomic shocks, as well as to test the elasticity of *waqif* participation in real-time.

Author Contributions

Rifki Hilman Fauzi	:	Conceptualization, Methodology, Writing – Original Draft Preparation, Review & Editing
Niko Faiz Fahrezi	:	Data Collection, Investigation, Supervision, Writing – Review & Editing
Muhammad Zigan Alsofi	:	Substantial Contribution to Research Content, Conceptual Framework Development, and Literature Review
Muhammad Aiman Hakim	:	Research Substantial Development, Validation, Literature Review, Writing – Review & Editing
Firila Najma Wahidah	:	Data Processing, Statistical Analysis, Data Interpretation, Visualization
Marhamah Muthohharoh	:	Supervision, Research Guidance, and Methodological Review

Conflict of Interest

The authors affirm that there are no conflicts of interest regarding the publication of this article.

Generative AI Writing Statement

During the preparation and revision of this manuscript, the authors utilized DeepL primarily for language translation and editing to enhance readability, and Generative AI (Gemini) strictly for brainstorming, and structuring the narrative flow. The Monte Carlo simulations, empirical data gathering, conceptual framework development, and core analytical interpretations were independently conducted by the authors. Following the use of these tools, the authors meticulously reviewed, edited, and verified all outputs to ensure absolute accuracy. The authors assume full responsibility for the accuracy, originality, and integrity of the published work.

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