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HYBRID PHILANTHROPY OPTIMIZATION MODEL: THE AUTO-SWEEPING ALGORITHM OF DIGITAL RESIDUE FOR CONSTRUCTING SOCIAL FISCAL CAPACITY

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ABSTRACT

Despite the exponential growth in adoption of Islamic financial technology, there is a paradox of inefficiency where the high frequency of digital transactions is not directly proportional to the accumulation of social funds. Households tend to hold micro-balances (residues) that remain in digital accounts because they are considered worthless, while psychological friction hinders large manual donations. This study constructs a new mathematical model to optimize household philanthropy using the 'Dual-Debit' algorithma hybrid mechanism that integrates planned (deterministic) zakat with automatic (stochastic) digital residue sweeping. Using a Constructive Research Approach, the study formulates a psychological threshold-based algorithm function of IDR 10,000. Validation through numerical simulations on 100,000 Islamic banking accounts in the Pekalongan area shows transformative results: this mechanism creates Pareto improvement conditions by mobilizing dormant liquidity without reducing household consumption utility. Simulation data reveals the formation of new aggregate social fiscal capacity of IDR 26.4 billion per year from just one medium-sized city. These findings provide a robust technological framework for Islamic banking to operationalize the principle of wealth circulation (rawaj) and prevent systemic asset accumulation (iktinaz).

Keywords: *Digital Philanthropy, Auto-Sweep Algorithm, Islamic Moral Economy, Social Fiscal Capacity, Mental Accounting.*

I. INTRODUCTION

Islamic social finance is theoretically recognized as a fundamental instrument for wealth redistribution and macroeconomic stabilization, with scholars such as Chapra (2000) and Kahf (1999) postulating that optimizing philanthropy can bridge a country's fiscal gap. However, there is a stark discrepancy between its theoretical potential and actual collection. Global data shows that zakat collection rates remain far below optimal capacity due to institutional inefficiencies and friction in payment methods (Obaidullah & Shirazi, 2015). Hassan et al. (2020), in their study of Islamic Fintech, assert that the primary challenge is no longer literacy, but rather the lack of technological infrastructure capable of automatically capturing public participation. This modernization paradox is clearly evident in the following empirical data comparison:

Table 1. National ZIS Collection Realization vs. Digital Transaction Volume (2021-2023)

Sector	Indicator	2021	2022	2023 (East)	Growth Trend
Islamic Social Sector	National Zakat Potential	IDR 327 trillion	IDR 327 trillion	IDR 327 trillion	Static
	ZIS Realization	IDR 17 trillion	IDR 22 trillion	~Rp 33 T	Linear (~25%)
	Gap (Missing)	94%	93%	89%	Height Gap
Digital Sector	Vol. QRIS Transactions	375 Jt	987 Jt	2.200 Jt	Exponential (>100%)

Data in Table 1confirmAnomaly in Indonesia's sharia economic ecosystem. On the one hand, digital adoption is growing exponentially, with QRIS volume surging more than 100% (Bank Indonesia, 2023), indicating a high frequency of microtransactions. However, ZIS realization has only grown linearly, leaving a gap of almost 90% of its potential (Puskas BAZNAS, 2021). This gap indicates that digital infrastructure has not been utilized as an effective collection channel, allowing a large volume of "residue" from digital transactions to escape absorption by the existing philanthropic system.

The main obstacle to mobilizing these funds is rooted in the psychology of economics, particularly mental accounting. Thaler (1999) explains that individuals categorize money into different mental categories, where large donations often trigger a high "pain of paying" (Prelec & Loewenstein, 1998). Conversely, small change has low marginal utility. Unfortunately, current Islamic banking mechanisms require customers to make manual transfers that require cognitive effort, thus preventing the widespread potential for micro-donations from being aggregated (Brekke et al., 2003).

This digitalization phenomenon has given rise to a "digital liquidity residue," the remaining balance (idle cash) below a psychological threshold for example, below IDR 10,000 which is considered to have no transactional value (Laldin & Furqani, 2018). From an Islamic economic perspective, this accumulation of unproductive assets constitutes an inefficiency (*ta'til al-amwal*) that hinders circulation (Choudhury, 1986). To date, no banking algorithm has been designed to automatically convert these micro-inefficiencies into productive social assets, leaving these funds as "dead money" in the monetary system.

The solution to this problem can be approached through Nudge Theory (Thaler & Sunstein, 2008), which suggests a choice architecture to guide behavior without coercion. Integration of hybrid auto-debit technology is needed, combining routine commitments (deterministic) and residual balance clearing (stochastic). Auda (2008), through the systemic approach of Maqasid al-Shari'ah, emphasizes the need for instrument engineering that ensures the sustainability of wealth circulation (*rawaj*). Therefore, the formulation of a mathematical economic model is needed to measure this mechanism.

Although many fintech philanthropy studies have been conducted, the majority still focus on technology adoption (Suhartanto et al., 2019) or qualitative motivations (Kasri & Ahmed, 2015), without any mathematical modeling that integrates the balance sweeping algorithm (auto-sweeping). Based on this gap, this study aims to: (1) Build a hybrid philanthropy optimization mathematical model that combines planned debit and digital residue auto-sweep algorithms; and (2) Simulate its implications for the formation of aggregate social fiscal capacity using regional banking proxy data.

II. LITERATURE REVIEW

The main theoretical basis in modeling micro-donation behavior is rooted in the theory of Mental Accounting that introduced by Thaler (1999), who postulated that individuals violate the fungibility principle of money by grouping assets into different “mental accounts” based on their source and nominal amount. In the context of digital transactions, Soman (2003) found that payment transparency affects the “pain of paying” (pain of paying); where non-cash instruments tend to reduce individual sensitivity to spending. Kahneman (2011) inThinking, Fast and Slowfurther explains that micro-scale financial decisions are often processed by System 1 (intuitive and fast) rather than System 2 (rational and slow). This provides theoretical justification for the psychological threshold variable (τ) in this research model, assuming that liquidity below a certain threshold is treated as a residue with negligible marginal utility, making it easier to direct into social funds without significant psychological barriers.

From an Islamic economic perspective, the existence of idle funds (idle cash) in massive amounts even though the nominal amount per individual is small, it is contrary to the principlerawaj(circulation of wealth) which is essential in maintaining the economic vitality of the people. Dusuki and Abozaid (2007) emphasized that one of the goalsShariah Objectives in terms of property (Hifz al-Mal) is to prevent the occurrence of with a twistor the accumulation of assets that restrain the rate of money circulation (velocity of moneyKahf (2002) added that Islamic financial institutions have a moral responsibility to create instruments that facilitate the efficient purification of customer assets. Therefore, the transformation of residual liquidity into social funds is not merely a technical efficiency, but a form of financial engineering (financial engineering) to restore the social function of assets that are "imprisoned" in the inefficiency of the payment system, in line with Asutay's (2007) view regarding the failure of the market system to fulfill distributive justice without institutional intervention.

To operationalize this principle, integrationFinancial Technology(Fintech) through an approach Nudge Theory become a crucial instrument. Benartzi and Thaler (2004) in their seminal study of the program Save More Tomorrow proves that the automation mechanism (default option) drastically increases financial participation by overcoming human inertia and status quo bias. In the context of Islamic Fintech, Rabbani et al. (2020) highlighted that artificial intelligence algorithms and smart contracts (smart contracts) enables Islamic banks to personalize social services precisely. The algorithm modelauto-sweepThe approach proposed in this study adopts this logic, shifting the burden of donation decisions from a cognitively-heavy manual process to an automated, systemic process, thereby creating a sustainable aggregation of social funds without burdening customers (Oehler et al., 2018).

III. METHODOLOGY

This research adopts a constructive research approach (Constructive Research Approach) which aims to solve practical managerial problems through the construction of a new theoretical model whose logical validity has been tested (Kasanen et al., 1993). The modeling procedure begins with an inductive abstraction of the behavior of household liquidity inefficiency, which is then deductively formalized into mathematical economic notation referring to the microeconomic optimization framework of Varian (2010). In this construction, the fund allocation variable is classified into a deterministic component (planned zakat commitment) and a stochastic component (daily liquidity residual). The core algorithm of the model is built using a logical condition function (conditional logical function) by setting psychological threshold parameters (psychological threshold/τ) as the main control variable to trigger the automatic sweeping mechanism

(auto-sweep).

Validation of the impact of the model was carried out through numerical simulation methods (numerical simulation) data-driven agent, an effective approach to project emergent macro phenomena from micro interactions (Gilbert & Troitzsch, 2005). The simulation was run using secondary data on statistical proxies of Bank Syariah Indonesia (BSI) customers in the Pekalongan area to determine population parameters (***N***) and the distribution of the average residuals (***r***). Impact analysis is carried out comparatively (comparative statics) between scenariosbaseline (existing manual philanthropy model) and scenarios proposed (hybrid algorithm) in condition other things being equal, in order to estimate the significance of the formation of social fiscal capacity (social fiscal capacity creation) in aggregate.

IV. RESULTS AND DISCUSSION

Construction of a Hybrid Philanthropy Optimization Model

Based on the intertemporal utility optimization framework (Varian, 2010), this study constructs an aggregate function of household philanthropy that divides the allocation of funds into two compartments: deterministic and stochastic. We define household income in the period (***t)*** as Y_t and consumption realization as (C_t.).

The first component, Planned Debit **(Z_{fix})**, formulated as a linear function of income with a fixed preference ratioα(for example 2.5% for zakat or a proportion of routine infaq), which reflects a conscious commitment (*conscious commitment*) according to the theory of planned behavior (Ajzen, 1991):

$$Z_{fix} = \alpha \cdot Y_t \quad \dots (1)$$

The second component, **Residual Debit (S_{sweep})**, formulated to capture liquidity inefficiencies. Variable **Remaining Liquidity (L_t)** defined as $L_t = Y_t - Z_{fix} - C_t$. Adopting the concept of psychological threshold (*psychological threshold*) from Thaler (1999), the model sets the parametersτ of IDR 10,000 as the limit of utility value that can be ignored (*negligible utility*). The sweep function works based on binary indicators. $\delta(L_t)$:

$$S_{sweep} = \delta(L_t) \cdot L_t \quad \dots (2)$$

Where $\delta(L_t)$ is a condition function (*Heaviside step function*) discrete:

$$\delta(L_t) = \begin{cases} 1, & \text{jika } 0 < L_t < \tau \\ 0, & \text{jika } L_t \geq \tau \end{cases}$$

Equation (2) shows that the donation mechanism is only active when the remaining balance is below the threshold τ. By substituting both components, **Hybrid Optimization Model (E_{total})** formulated as:

$$E_{total} = (\alpha \cdot Y_t) + [\delta(Y_t - Z_{fix} - C_t) \cdot (Y_t - Z_{fix} - C_t)] \quad \dots (3)$$

This model proves mathematically that maximizing social funds (E_{total}) can be achieved without distorting the consumption utility function (C_t) and core savings (when $L_t \geq \tau$), thus fulfilling

the principle*Pareto Optimality in* household resource allocation (Kahf, 1999).

Algorithm Mechanism *Auto-Sweep*

The implementation of equation (3) is translated into the digital banking system architecture through the mechanism backend automatic. Different from the conventional donation model which is *user-initiated*, this algorithm operates using logic default option as suggested in *Nudge Theory* (Thaler & Sunstein, 2008) to overcome behavioral inertia.

The algorithm workflow is designed with sequential logic as follows:

1. **Inflow Detection:** The system identifies $\boldsymbol{Y_t}$ and execute $\boldsymbol{Z_{fix}}$ (Eq. 1) in *real-time*.
2. **Daily Evaluation:**At the end of the day cycle (***t***), the system calculates the position $\boldsymbol{L_t}$.
3. **Binary Decision:**Algorithm validates conditions $\boldsymbol{L_t} < \tau$ If fulfilled (δ=1), the system executes the clearing of balances to social fund accounts.

Technically, this mechanism eliminates cognitive friction (*cognitive friction*) because micro-donation decisions no longer require active customer attention (Rabbani et al., 2020). The system flowchart shows that technological intervention occurs only in the residual area, ensuring customers retain full control over their primary liquidity.

Simulation of Aggregate Social Fiscal Impact and Capacity

Model validation was performed through agent-based numerical simulations (*agent-based modeling*) refers to Gilbert & Troitzsch (2005). The simulation uses secondary data parameters as proxy for Islamic banking customers in the Pekalongan area (**N**=100,000) assuming the average residual (***r***) of IDR 5,500 and the frequency of residual occurrence (***f***) 4 times per month.

Table 2. Simulation of Aggregate Social Fiscal Capacity Formation

Contribution	Variable Indicator	Existing Scenario (Manual)	Hybrid Scenario (Auto-Sweep)	Growth Delta
Micro Practice	Donation Mechanism	Sporadic Volunteering	Automatic Systemic	-
	Residual Participation	~0% (Ignored)	100% (Clean Sweep)	Asset Efficiency
	Individual Transaction Value	IDR 0	IDR 22,000 / month	+IDR 22,000
Macro Implications	Monthly Residue Aggregate	IDR 0	**IDR 2,200,000,000**	**+IDR 2.2 billion**
	Estimated Annual Capacity	-	**IDR 26,400,000,000**	**+IDR 26.4 billion**

Table 2 above presents a comparison, other *things being equal between* scenarios *baseline* (existing model) and hybrid scenario. Simulation resolution shows that the application of the algorithm auto-sweepable to create new social fiscal capacity amounting to IDR 26.4 billion per year from a single cluster of medium-sized urban areas. From an Islamic macroeconomic perspective, this figure represents the transformation of dormant assets (*hoarding/kanz*) into productive social liquidity.

This significant increase occurred not due to an increase in customer income, but rather due to the success of the algorithm in capturing deadweight *loss/liquidity* that has not been collected by conventional systems. This is in line with Chapra's (2000) view that the efficiency of redistribution mechanisms is the key to fiscal resilience in the third (social) sector, where massively aggregated micro-funds can function as a social safety net (*social safety net*) which is independent.

V. CONCLUSION AND RECOMMENDATION

This research successfully formulated a hybrid philanthropy optimization model that integrates planned debit commitments and a digital residual sweeping algorithm (auto-sweep) into one mathematical function of household economics. The main findings validate that the application of psychological thresholds (τ) of Rp 10,000 effectively overcomes customer cognitive friction, enabling the automatic conversion of micro-liquidity inefficiencies into productive social funds. Based on simulations on banking proxy data in the Pekalongan area, this mechanism has been proven to be able to create significant new aggregate social fiscal capacity estimated at Rp 26.4 billion per year without distorting primary consumption utilities, thus achieving a conditionPareto Improvementin the allocation of human resources.

Implicatively, this model enriches the literature on Islamic Moral Economics by offering a technological operational mechanism to prevent the accumulation of wealth (with a twist) through the utilization of mental accounting behavioral bias. This study recommends that the Islamic banking industry, especially BSI, immediately adopt this feature.Configurable Auto-Sweepas an innovative strategy in transforming the role of banks from mere financial intermediation to a catalyst for social resilience. Although this research is limited to the use of aggregate simulation data, the theoretical framework developed provides a solid foundation for the development of financial instruments.Islamic Fintechfuture, with recommendations for further research in the form of empirical field tests to calibrate customer preference parameters more precisely.

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