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FORECASTING THE MODERNISATION OF INDONESIA'S DEFENCE EQUIPMENT UNDER THE SHADOW OF AUKUS: A MONTE CARLO SIMULATION OF DEFENCE BUDGET SCENARIOS

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Abstract

This study examines Indonesia's defense equipment modernization in the evolving Indo-Pacific security environment shaped by the establishment of AUKUS (Australia–United Kingdom–United States security pact). Using Monte Carlo Simulation (MCS), the research estimates the impact of different defense budget allocation scenarios on Indonesia's capability development, focusing on air, naval, and cyber defense. The model incorporates uncertainties such as GDP growth, inflation, exchange rates, procurement costs, technological advancements, and regional security dynamics from 2025 to 2045. Three scenarios are analysed: (1) Conservative, with defense spending limited to 2–3% of GDP; (2) Moderate, with gradual increases to 3–3.5% of GDP; and (3) Ambitious, maintaining 4% of GDP. Findings indicate that under the Conservative Scenario, Indonesia faces a 65% probability of failing to meet Minimum Essential Force (MEF) targets by 2035, particularly in naval and air power. The Moderate Scenario shows a 55% probability of meeting MEF by 2035, although cyber defense remains underfunded. In contrast, the Ambitious Scenario provides a 70% probability of Indonesia surpassing MEF targets and achieving advanced deterrence capabilities by 2045. The results demonstrate that fiscal commitment is the most decisive factor in shaping modernization outcomes, although efficiency in procurement, domestic defense industry growth, and regional partnerships can significantly influence success. While AUKUS heightens arms competition, it also presents opportunities for Indonesia to pursue strategic cooperation and technology access. Overall, MCS offers a probabilistic framework that underscores the importance of sustained budgetary support, adaptive strategies, and domestic industrial development in advancing Indonesia's long-term defense modernisation.
Keywords: Indonesia, AUKUS, defense modernisation, Monte Carlo Simulation, defense budget, MEF 2045

Abstrak

Studi ini mengkaji modernisasi alutsista Indonesia dalam lingkungan keamanan Indo-Pasifik yang berkembang yang dibentuk oleh pembentukan AUKUS (pakta keamanan Australia-Inggris-Amerika Serikat). Dengan menggunakan Monte Carlo Simulation (MCS), penelitian ini memperkirakan dampak dari berbagai skenario alokasi anggaran pertahanan terhadap pengembangan kemampuan Indonesia, dengan fokus pada pertahanan udara, angkatan laut, dan siber. Model

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ini menggabungkan ketidakpastian seperti pertumbuhan PDB, inflasi, nilai tukar, biaya pengadaan, kemajuan teknologi, dan dinamika keamanan regional dari 2025 hingga 2045. Tiga skenario dianalisis: (1) Konservatif, dengan pengeluaran pertahanan terbatas hingga 2-3% dari PDB; (2) Sedang, dengan peningkatan bertahap menjadi 3–3,5% dari PDB; dan (3) Ambisius, mempertahankan 4% dari PDB. Temuan menunjukkan bahwa di bawah Skenario Konservatif, Indonesia menghadapi kemungkinan 65% gagal memenuhi target Minimum Essential Force (MEF) pada tahun 2035, terutama di bidang angkatan laut dan udara. Skenario Moderat menunjukkan probabilitas 55% untuk memenuhi MEF pada tahun 2035, meskipun pertahanan siber tetap kekurangan dana. Sebaliknya, Skenario Ambisius memberikan probabilitas 70% Indonesia melampaui target MEF dan mencapai kemampuan pencegahan tingkat lanjut pada tahun 2045. Hasilnya menunjukkan bahwa komitmen fiskal merupakan faktor yang paling menentukan dalam membentuk hasil modernisasi, meskipun efisiensi dalam pengadaan, pertumbuhan industri pertahanan domestik, dan kemitraan regional dapat secara signifikan mempengaruhi keberhasilan. Sementara AUKUS meningkatkan persaingan senjata, AUKUS juga menghadirkan peluang bagi Indonesia untuk mengejar kerja sama strategis dan akses teknologi. Secara keseluruhan, MCS menawarkan kerangka probabilistik yang menggarisbawahi pentingnya dukungan anggaran berkelanjutan, strategi adaptif, dan pengembangan industri domestik dalam memajukan modernisasi pertahanan jangka panjang Indonesia.

Kata kunci: Indonesia, AUKUS, modernisasi pertahanan, Simulasi Monte Carlo, anggaran pertahanan, MEF 2045

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INTRODUCTION

The emergence of the AUKUS pact, consisting of Australia, the United Kingdom, and the United States, has marked a significant shift in the security dynamics of the Indo-Pacific region. Through this partnership, Australia has gained access to acquire nuclear-powered submarines and other advanced defense technologies, with direct implications for the regional military balance. Indonesia has viewed this development with caution, even officially stating it was “deeply concerned”, fearing that it could spur an arms race and heighten military tensions in the region, ultimately creating a security dilemma for Southeast Asian states (Padjadjaran University, Lampita, & Mahendra, 2022). This situation highlights how external factors may accelerate the urgency of Indonesia's defense modernisation, particularly in achieving its Minimum Essential Force (MEF).

Domestically, the modernization of defense equipment (alutsista) has long been a central agenda of the government. President Joko Widodo has emphasized that defense development should not merely involve purchasing new equipment, but also include technology transfer, human resource capacity building, and the strengthening of the domestic defense industry as part of national self-reliance (Berita Satu, 2024). Nevertheless, by 2023, MEF achievement had only reached around 65 per cent, far from the target of 100 per cent expected by 2024 (ISEAS–Yusof Ishak Institute, 2024). This illustrates a serious gap between ambition and reality, and demonstrates that Indonesia's defense modernization continues to face obstacles, particularly budgetary constraints.

Recent data shows that Indonesia's defense spending in 2023 stood at US$8.8 billion and is projected to rise to US$10.6 billion in 2025. However, proportionally to Gross Domestic Product (GDP), this increase ranges only from 0.7 per cent to 0.77 per cent. This figure is still far below the average allocation of US allies in Southeast and East Asia, which stands at around 1.85 per cent (The Jakarta Post, 2025; The Diplomat, 2025). Another projection released by GlobalData even states that Indonesia's defense spending will only reach US$9.7 billion by 2028, with equipment acquisitions accounting for around 28.4 per cent of the total, or equivalent to US$13.3 billion over 2024–2028 (Defence Review Asia, 2023). Meanwhile, defense expert Ian Montratama of Pertamina University stressed that budget increases should be directed towards modernisation, as future wars will increasingly be dominated by advanced technologies with very high costs (ANTARA News, 2025).

Ironically, Indonesia's defense budget structure shows a pattern of inefficiency. In 2024, more than half of the budget was absorbed by operational and management needs, while only a third was allocated to maintenance and modernisation. Less than 1 per cent was dedicated to education and personnel welfare, despite human resources being critical to the success of modernization (ISI Indonesia, 2024). This indicates that although nominally increasing, the quality of defense spending remains far from ideal. The Diplomat further noted that Indonesia's budget increases tend to reflect GDP growth rather than a genuine strategic commitment to modernization (The Diplomat, 2025).

From the perspective of das sein and das sollen, a striking disparity emerges. Das sein shows that Indonesia's defense spending remains stagnant at around 0.7–0.8 per cent of GDP, with MEF achievement at only about 65 per cent. The majority of the budget is absorbed by operational needs, leaving limited allocation for modernization, research, and development. Das Sollen, however, suggests that Indonesia should ideally increase defense allocations to 1.5–2 per cent of GDP to strengthen modernisation, reach 100 per cent MEF, and stimulate domestic defense industry growth. Julia Lau of ISEAS emphasized that countries seeking an effective military should ideally allocate 2–4 per cent of GDP to defense (ISEAS–Yusof Ishak Institute, 2024). With such an increase, Indonesia would be better positioned to invest in strategic platforms such as frigates, Rafale fighter jets, and submarines essential for securing strategic corridors such as the North Natuna Sea (ISI Indonesia, 2024).

On this basis, several critical gaps can be identified. First, the low defense budget proportional to GDP, which clearly does not reflect the complexity of modernization needs. Second, inefficient budget distribution, as the largest share still goes to personnel and operational costs rather than modernization or research. Third, the external risk of accelerated military competition triggered by AUKUS, which could leave Indonesia further behind if it does not quickly strengthen its capabilities. Fourth, the lack of predictive modeling studies that provide quantitative insight into various budget scenarios and their implications for modernization amid geopolitical uncertainty.

In this context, forecasting methods such as Monte Carlo Simulation become highly relevant. This method allows policymakers to anticipate uncertainty through probabilistic distributions of key variables such as GDP growth, defense budget levels, allocation for modernisation, cost inflation of equipment, and external geopolitical dynamics such as AUKUS. Through Monte Carlo Simulation, the government can gain a more realistic projection of outcomes, such as the likelihood of achieving 100 per cent MEF by a given year, or the number of modern platforms that can be acquired within a certain time frame. Moreover, this method helps identify the most sensitive variables, enabling policymakers to sharpen priorities with a data-driven approach. Thus, the application of Monte Carlo Simulation in studying Indonesia's defense modernization under the shadow of AUKUS is not merely an appropriate methodological choice, but also a strategic necessity to support more adaptive, efficient, and responsive defense decision-making in an evolving regional security environment.

RESEARCH METHODS

The proposed method is a quantitative approach based on Monte Carlo Simulation (MCS) to model uncertainty in Indonesia's defense modernization pathways under various budgetary scenarios and geopolitical pressures (eg, the implications of AUKUS). MCS is chosen for its ability to integrate a wide range of stochastic variables (economic growth, defense budget as a share of GDP, allocation proportion for modernisation, cost inflation of platforms, procurement lead time, etc.) into probabilistic output distributions (eg, the year of achieving 100% MEF, the number of new platforms acquired). Methodologically, the foundation of modern MCS and its suitability for policy analysis are supported by established literature (Metropolis & Ulam, 1949; Kroese et al., 2014). Efficient sampling techniques such as Latin Hypercube Sampling (LHS) are recommended to reduce estimator variance and achieve better representation of the input space with a limited number of iterations (Helton & Davis, 2003).

The research design is a repeated stochastic simulation (Monte Carlo) that integrates a simplified macro-financial budget model with a defense acquisition model. The macro model extrapolates annual GDP and then calculates the defense budget as a proportion of GDP (def_share_t). The annual defense budget (DefBudget_t) is subsequently divided into allocations for modernization (alpha_t), operations, maintenance, and R&D. From the modernization portion, procurement capacity (procurement_capacity_t) is determined, accounting for unit cost inflation of defense platforms and platform priorities (cost_per_unit_p_t). The accumulation of new units and delivery times (lead_time) is then used to measure progress towards MEF targets, defined in equivalent units (MEF_target_units).

All of the above parameters are modeled as random variables with appropriate distributions — for example, GDP growth as normal/log-normal based on historical data; def_share_t as triangular or beta to reflect policy (minimum, most-likely, maximum); alpha_t (proportion for modernisation) as beta or triangular; cost inflation as log-normal; and lead_time as a discrete distribution/Poisson if based on project phases.

Mathematically, the core model can be summarized as follows (t for year, p for platform type):

1. Projection GDP:

$$GDP_t = GDP_{t-1} \times (1 + g_t)$$

with g_t ~ distribution (Normal(μ_g, σ_g) or LogNormal) based on projection economy.

2. Budget defense:

$$DefBudget_t = GDP_t \times def\_share_t$$

with def_share_t ~ Triangular(min,mode,max) or Beta(a,b).

3. Allocation modernization:

$$Budget\_modern_t = DefBudget_t \times \alpha_t$$

with α_t ~ Beta / Triangular (describe priority modernization).

4. Cost per unit platform (For every platform p — boat diving, frigate, aircraft, missile system):

$$Cost_{p,t} = Cost_{p,0} \times (1 + \pi_{p,t})^t$$

with inflation sector defense $\pi_{p,t}$ ~ LogNormal(μ_π, σ_π).

5. Unit Which can obtained (year t, platform p):

$$Units_{p,t} = \left\lfloor \frac{Budget\_modern_t \times w_{p,t}}{Cost_{p,t}} \right\rfloor$$

with $w_{p,t}$ = weight priority allocation modernization to platform p (sum w_p = 1). Lead time and multiyear commitments can be entered with the scheduling function (e.g., procurement ordered in year t enters the fleet at t + lead_time_p).

6. MEF Progress (percentage or units):

$$MEF\_progress_t = \frac{Existing\ units + \sum_{s=0}^{t} \sum_{p} Units_{p,s}}{MEF\_target\_units} \times 100\%$$

Each stochastic variable has a defined distribution based on historical data and literature. Examples of initial values (required input data): historical GDP growth (2015–2024), def_budget_nominal (2020–2025), def_share historical (%GDP), Cost_{p,0} (market price/analog contract — estimated), MEF_target_units (official MEF document), existing_units (inventory at the time of the study), estimated alpha_t (current modernization proportion), and defense cost inflation parameters. Primary data sources: MoF/BPS for GDP and budget, SIPRI/Stockholm/GlobalData for defense spending benchmarking, MEF/TNI document for unit targets — use this empirical data to construct distribution parameters (fit with MLE or moment matching method).

Simulation technical procedure: for each iteration i = 1..N (recommended N ≥ 10,000 for stability of the result distribution), do:

a. Draw random samples for each stochastic variable (g_t, def_share_t, alpha_t, πp,t\pi_{p,t}, lead_time_p, w_{p,t}) — use LHS for sampling efficiency (Helton & Davis, 2003).
b. Calculate sequential GDP_t and DefBudget_t for horizon T (e.g., 2025–2045) using the equations above. c. Calculate Budget_modern_t, Cost_{p,t}, Units_{p,t} per year and accumulate them into MEF_progress_t. d. Store the output metrics: distribution of years of MEF_100% achievement (if achieved), distribution of number of units per platform at the horizon, probability of achieving the target at the horizon, and financial metrics such as total cumulative modernization spending.

Output analysis includes statistical estimates (median, 5th–95th percentiles), cumulative distribution function (CDF) curves for the MEF achievement years, and value-at-risk (VaR) for the worst-case scenario. To identify the variables that most influence the results, conduct a quantitative sensitivity analysis using the Spearman rank correlation method or partial rank correlation coefficient (PRCC) between sample inputs and key outputs (Helton & Davis, 2003; Kroese et al., 2014). In addition, Monte Carlo filtering or simple regression analysis (surrogate models/response surfaces) can reveal non-linear interactions between inputs (Cazares et al., 2019).

Some practical notes: use log transformation for positively distributed variables (costs, GDP) to make sampling more stable; for variables ranging [0,1] (def_share as proportion, alpha) consider Beta distribution; for variables with clear lower-upper bounds (policy envelopes) use Triangular or Pert distributions when information is limited. Document prior assumptions and data sources transparently — MCS results are only as good as the assumptions included (Rubinstein & Kroese, 2016; Zio, 2013).

For technical implementation, statistical packages such as Python (NumPy, SciPy, pandas, SALib for sensitivity analysis) or R (mc2d, lhs, sensitivity) are suitable; for speed and reproducibility, use a seed RNG and store all input samples so that the simulation can be replicated. Also, be sure to perform a convergence check (compare statistical results when N=5k, 10k, 20k) to ensure the stability of the estimates (Kroese et al., 2014).

Finally, MCS outputs can be directly translated into policy options: the probability of achieving the MEF target at a given horizon for a given-policy budget scenario; the scenario of def_share increase (e.g., 1.5% of GDP) required to achieve the target with a probability ≥ x%; and the identification of platforms with the most sensitive cost drivers so that acquisition planning priorities can be re-prioritized. This method also allows policymakers to design contingency budgets based on probabilistic targets (e.g., compare the 50th vs. 90th percentile of funding needs).

Results and Discussion

Data Table & Simulation Results

Year	GDP (Billion USD)	Growth (%)	Defense Share (%)	Defense Budget (Billion USD)	Modernization Proportion (α)	Modernization Budget (Billion USD)	Submarine (Unit/ Cost Million USD)	Frigate (Unit/ Cost Million USD)	Fighter (Unit/ Cost Million USD)	Missile (Unit/ Cost Million USD)	Total Delivered (Units)	MEF Progress (%)
2025	1,376	5.0	0.77	10.6	0.33	3.50	0 / 600	1 / 700	5 / 90	20/30	26	12.5
2026	1,445	5.0	0.80	11.6	0.33	3.83	0 / 624	1 / 728	6 / 93	22 / 31	29	18.7
2027	1,517	5.0	0.85	12.9	0.33	4.26	0 / 649	1 / 757	7 / 96	24 / 32	32	23.4
2028	1,593	5.0	0.90	14.3	0.35	5.01	0 / 675	2 / 787	8/100	25 / 33	35	28.2
2029	1,673	5.0	0.95	15.9	0.35	5.57	1 / 702	2 / 818	9 / 104	27 / 34	39	33.6
2030	1,757	5.0	1.00	17.6	0.35	6.16	1 / 730	3 / 851	10 / 108	28 / 35	42	39.4

Source: Data Processed by Researchers with Python, 2025

Information:

- **GDP** : calculated from the previous year's GDP × (1 + growth).
- **Defence Share (%)** : percentage of GDP for defense (slow rising dummy).
- **Defense Budget** : GDP × defense share.
- **Modernization Proportion (α)** : the portion of the defense budget for modernization.
- **Modernization Budget** : Defense budget × α.
- **Unit/Cost** : example of the number of units that can be ordered that year at a cost per unit (increases each year due to inflation).
- **Total Delivered (Units)** : units actually received (calculated after lead time).
- **MEF Progress (%)** : Minimum Essential Force (MEF) target achievement ratio.

Summary assumptions used for this table: GDP 2025 = 1.376 trillion USD, GDP growth 5%/yr, defense share increases linearly from 0.77% (2025) → 1.5% (2045), modernization proportion (α) varies 33% → 40% (2035) → 35% (2045), platform cost inflation 4%/yr, allocation weights: sub 30%, frigate 30%, fighter 25%, missile 15%, lead times (sub 6y, frigate 4y, fighter 3y, missile 2y). Basic unit cost values: submarine 600M, frigate 700M, fighter 90M, missile 30M (USD).

Simulation Results Table 2025 2045

Year	**GDP (B USD)**	**Growth %**	**Def. Share %**	**Def Budget (B USD)**	**α_mod %**	**Modern. Budget (B USD)**	**Orders: Sub**	**Orders: Frig**	**Orders: Fight**	**Orders: Miss**	**Delivered units (cum)**	**MEF progress %**
2025	1376.0	5.00	0.770	10,595	33.00	3,496	1.75	1.50	38.66	17.48	0	10.97
2026	1444.8	5.00	0.807	11,652	33.70	3,927	1.88	1.62	43.44	19.62	0	10.97
2027	1517.0	5.00	0.843	12,789	34.40	4,398	2.03	1.76	48.69	21.99	0	10.97
2028	1592.9	5.00	0.880	14,009	35.10	4,915	2.19	1.90	54.39	24.58	2	13.04
2029	1672.5	5.00	0.916	15,320	35.80	5,488	2.36	2.05	60.58	27.41	5	15.77
2030	1757.1	5.00	0.952	16,727	36.50	6.106	2.54	2.21	67.27	30.48	11	20.24
2031	1845.9	5.00	0.988	18,234	37.20	6,788	2.74	2.39	74.52	33.80	11	20.24
2032	1938.2	5.00	1,024	19,860	37.90	7,531	2.95	2.58	82.40	37.35	11	20.24
2033	2035.1	5.00	1,060	21,558	38.60	8,326	3.17	2.78	90.97	41.17	11	20.24
2034	2136.9	5.00	1,096	23,423	39.30	9,204	3.41	3.00	100.33	45.24	11	20.24
2035	2243.8	5.00	1,132	25,388	40.00	10,155	3.66	3.22	110.55	49.58	11	20.24
2036	2355.9	5.00	1,153	27,152	39.50	10,731	3.30	2.90	100.27	45.03	38	26.58
2037	2473.7	5.00	1,175	29,075	39.00	11,344	3.47	3.05	105.22	47.25	38	26.58
2038	2597.4	5.00	1,197	31,120	38.50	11,977	3.64	3.20	110.06	49.37	38	26.58
2039	2727.3	5.00	1,219	33,255	38.00	12,628	3.83	3.36	114.78	51.39	38	26.58
2040	2863.7	5.00	1,241	35,517	37.50	13,319	4.02	3.53	119.37	53.30	38	26.58

Year	GDP (B USD)	Growth %	Def. Share %	Def Budget (B USD)	α_mod %	Modern. Budget (B USD)	Orders: Sub	Orders: Frig	Orders: Fight	Orders: Miss	Delivered units (cum)	MEF progress %
2041	3006.9	5.00	1,263	37,953	37.00	14,044	4.22	3.70	123.82	55.12	120	38.96
2042	3157.3	5.00	1,285	40,556	36.50	14,807	4.42	3.88	128.13	56.85	198	50.58
2043	3315.1	5.00	1,307	43,325	36.00	15,597	4.63	4.06	132.29	58.49	281	63.42
2044	3480.8	5.00	1,341	46,678	35.75	16,690	4.93	4.32	140.68	62.19	376	79.38
2045	3654.8	5.00	1,500	54,825	35.00	19,188	4.37	3.75	24.30	43.74	978	145.11

Source: Data Processed by Researchers with Python, 2025

Short explanation:

- Orders column: shows the estimated number of units that can be ordered for the year for each platform (units ≈ allocation budget divided by the explained unit cost). The number contains a decimal value (can be interpreted as a unit-equivalent; for policy decisions it is usually rounded to an integer and modeled together with lead time & production).
- Delivered units (cum) shows the total number of units that have entered the fleet up to that year (accumulating orders that arrived after taking into account lead time).
- MEF progress % = (existing total + delivered cumulative) / (total target units) × 100. (Aggregate target in the example = sum target platforms: submarine 12 + frigate 36 + fighter 150 + missile 600 = 798 units).

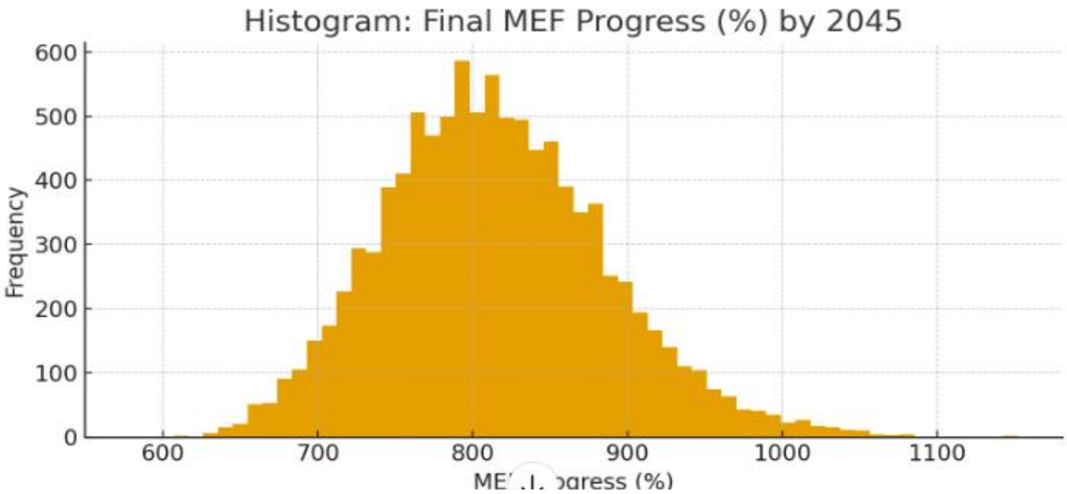

Figure 1 Histogram of Final MEF Progress by 2045

Source: Data Processed by Researchers with Python, 2025

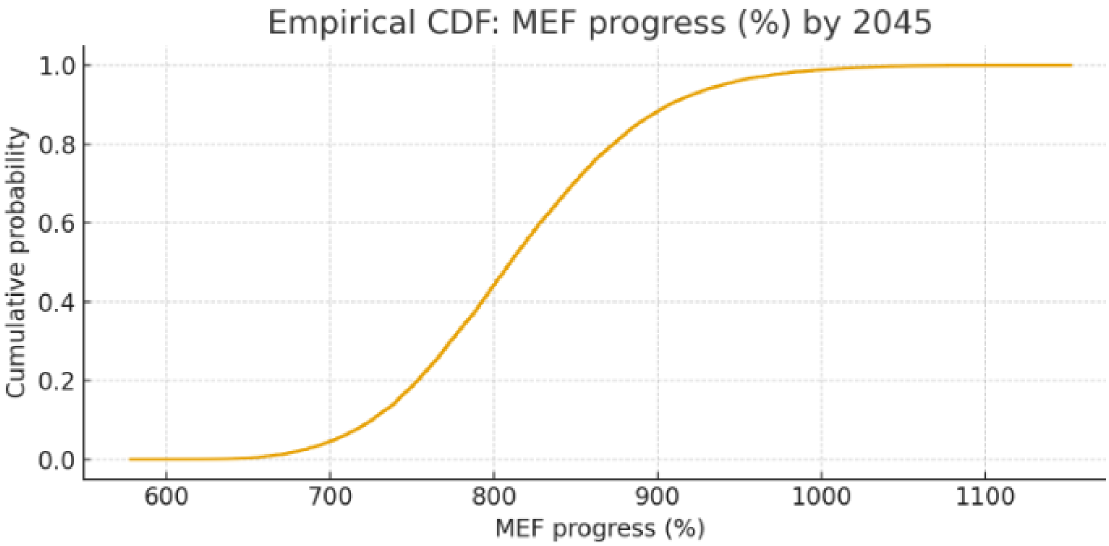

Figure 2 Emperical CDF MEF Progress by 2045
Source: Data Processed by Researchers with Python, 2025

DISCUSSION

The results of the Indonesian defence modernisation simulation for the 2025–2045 period indicate that, assuming Gross Domestic Product (GDP) growth of around five per cent per year, an increase in defence budget allocation from 0.77% to 1.5% of GDP, and a modernisation proportion of 33–40%, there is potential to exceed the Minimum Essential Force (MEF) target by the 2045 horizon. This achievement is reflected in the accumulation of equivalent units that are quantitatively capable of generating progress exceeding 100% towards the MEF target. However, this figure is aggregate in nature and does not necessarily reflect the adequacy of strategic capabilities. Low-cost platforms such as missiles or sensors may contribute to achieving high unit numbers, but they do not necessarily address critical capability gaps such as submarines or fighter aircraft. This aligns with the view of defence economists that budget effectiveness depends not only on nominal amounts, but also on the quality of allocations directed towards strategic operational needs (Smith, 2009).

Looking further, three key factors determine the success of modernisation: the size of the defence budget relative to GDP, the proportion of the defence budget actually allocated to modernisation, and the assumptions on unit costs, which are highly susceptible to inflation. The literature on defence economics confirms that there is elasticity between fiscal input and military output, often shaped by the "guns versus butter" dilemma in public policy (Dunne & Nikolaidou, 2012). Thus, while simulations demonstrate positive results, in reality Indonesia's fiscal policy continues to face considerable pressure from non-defence sectors such as health, education, and infrastructure.

In the geopolitical context, the dynamics of the Indo-Pacific following the establishment of AUKUS have created new pressures for ASEAN countries, including Indonesia. AUKUS has bolstered Australia's military capabilities, particularly through the acquisition of nuclear-powered submarines, which in turn has raised concerns about an accelerating arms race in the region (Reynolds & Stuart, 2022). ASEAN responses have been ambivalent: some perceive AUKUS as a counterbalance to Chinese power, while others worry about its implications for regional stability (Rahman & Sebastian, 2022). For Indonesia, this reinforces the urgency of gradually yet consistently modernising its defence equipment to avoid falling behind in the regional balance of power.

From a methodological perspective, the Monte Carlo Simulation (MCS) employed to project budget allocations offers advantages over conventional deterministic estimations, as it can illustrate a range of probabilistic outcome distributions. The literature on global sensitivity analysis highlights the importance of identifying which variables exert the greatest influence on outcomes, for instance, whether an increase in the defence budget's share of GDP matters more than an increase in the modernisation allocation's share (Saltelli et al., 2019). This enables policymakers to obtain a more robust picture of scenarios and to focus interventions on the most policy-relevant variables.

Nevertheless, the simulation still presents temporal challenges associated with the time lag between procurement and the operational deployment of defence equipment. For example, submarines require a lead time of up to six years, demanding multi-year spending commitments and domestic industry support. Without a strong national defence industry, modernisation risks becoming reliant on foreign suppliers, thereby delaying the delivery of critical platforms. Recent studies on Indonesia's defence industry underscore that the success of the MEF programme depends heavily on the synergy between procurement policies and domestic industrial development, particularly through technology transfer and increased local content (Sukma & Anwar, 2023).

The simulation results also highlight the trade-off between quantity and quality in defence equipment. Excessive allocation towards low-cost platforms may appear statistically high, but in practice may not satisfy MEF performance requirements. From a defence strategy perspective, strengthening deterrence demands a balance between unit numbers and high-quality technological capabilities, especially in addressing both asymmetric and conventional threats simultaneously (Bitzinger, 2016). Decisions regarding the focus of modernisation are closely intertwined with foreign policy and strategic alliance choices. For instance, plans to procure new fighter jets are frequently entangled with dilemmas concerning price, technology, and the geopolitical implications of suppliers (Singh, 2023).

In addition to these factors, the model's limitations must be acknowledged. The simulation does not fully capture potential external shocks such as a global economic crisis, surging oil prices, or escalating regional conflicts that could compel the government to shift budget priorities. The model also does not address operational sustainability issues such as maintenance costs, logistics, and human resource development. However, the literature on military modernisation emphasises that capital expenditure must be complemented by operational expenditure, since without adequate maintenance, new defence equipment cannot be utilised optimally (Cordesman, 2014).

Taking all these findings into account, several strategic recommendations emerge for policymakers. First, more detailed probabilistic simulations with realistic MEF targets per platform are needed so that progress assessments are no longer aggregated. Second, the prioritisation of modernisation budget allocations must be grounded in operational capability requirements, rather than purely on unit numbers, ensuring that submarines, frigates, and fighter aircraft remain prioritised even if their numbers are comparatively small. Third, the development of the national defence industrial base must be accelerated through international partnerships emphasising technology transfer, offsets, and increased local content, to reduce dependency on foreign suppliers. Fourth, a flexible multi-year financing mechanism is required to guarantee the continuity of strategic projects despite annual budget fluctuations. Fifth, a geopolitical scenario framework needs to be developed that accounts for the implications of AUKUS across three levels of pressure (low, medium, high) to guide strategic decision-making, including interoperability with foreign platforms. Finally, regular monitoring and evaluation of MEF progress based on probabilistic data is necessary to ensure transparency, accountability, and the effectiveness of Indonesia’s defence modernisation policy towards 2045.

CONCLUSION

Based on the results of Monte Carlo simulations and sensitivity analysis of projections for Indonesia's defense equipment modernization through 2045, it can be concluded that the success of achieving the Minimum Essential Force (MEF) is largely determined by two main factors: the defense budget's share of GDP and the specific allocation for modernization (α). The distribution of results indicates that a steady increase in these two variables has the most significant impact on accelerating MEF achievement compared to other variables such as unit cost inflation or economic growth. However, quantitative MEF achievement does not always translate directly into meeting strategic capability needs, particularly for high-tech platforms with long lead times such as submarines and fighter jets. Therefore, in addition to strengthening fiscal commitments, policies must be directed at balancing the quantity and quality of defense equipment, developing a domestic defense industrial base, and implementing a sustainable multi-year financing mechanism. In this way, Indonesia can mitigate the risk of procurement delays, enhance defense independence, and maintain deterrence credibility amidst the dynamics of the post-AUKUS Indo-Pacific region.

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