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OPERATIONS RESEARCH MODEL IN CONVENTIONAL MILITARY DECISION-MAKING

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Abstrak — *This study aims to analyze the robustness and risk of military decisions through the application of an operations research model based on sensitivity analysis. Conventional military decision-making has historically relied on doctrine, experience, and the intuition of commanders. This approach is adaptive, but has limitations in testing the resilience of military decisions to changes in strategic and operational parameters. The research methodology uses a quantitative approach with operations research modeling and sensitivity testing for key parameters such as time, cost, and risk. The main results indicate that military decisions based on operations research models have a more consistent level of robustness than conventional approaches. The study's conclusions confirm that operations research models play an effective role as objective and measurable military decision-support systems. This research contributes to strengthening the systems and decision science approaches in the study of conventional military decision-making.*

Keywords: *Military Decisions, Operations Research Models, Sensitivity Analysis, Robustness, Risk.*

1. *INTRODUCTION*

Conventional military decision-making is a critical process that determines the success or failure of a military action. Military decisions have traditionally been dominated by the doctrinal approach and experience of the commander-in-chief. In the military context, the terms commander and commander are used differently to reflect the different command functions, with the commander acting as a user of force and the commander as a builder of force. This difference in function has implications for decision outcomes and is relevant in analyzing the robustness of military decisions. While effective under certain condi tions, this approach is difficult to evaluate quantitatively, particularly in assessing the robustness and risk of military decisions when parameters change. This research identifies a gap in the limited systemic and quantitative approaches to testing the robustness of military decisions. Therefore, this research proposes the use of operations research models and sensitivity analysis to fill this gap.

2. METHODOLOGY

2.1 Research Design

This research uses a quantitative design with an operations research modeling approach as a formal representation of the conventional military decision-making system.

This approach was chosen because it allows:

- *formulation of decisions in the form of a system model*
- *testing of decision behavior against para meter changes*

• measurable evaluation of robustness and risk.

Conceptually, this research design positions military decisions as system outputs, influen ced by a set of variables and parameters whose sensitivity can be tested.

2.2 Research Object and Data Collection Techniques

The research object focuses on conventional military decision-making scenarios, specifi cally decisions involving:
• resource constraints,
• time pressure,
• varying levels of risk.

The scenarios are positioned as generic representations of military decisions, rather than case studies of specific operations, to maintain doctrinal neutrality and methodo logical repeatability. The data used are secondary, obtained through:
• documentation studies,
• scientific literature reviews,
• open defense publications, and operations research studies.

Jenis Data	Sumber	Fungsi dalam Penelitian
Literatur OR	Jurnal ilmiah	Dasar pemodelan keputusan
Kajian pertahanan	Publikasi terbuka	Konteks keputusan militer
Dokumen konseptual	Buku & laporan ilmiah	Penentuan variabel & parameter

Table 1. Types of Data and Research Sources

2.3 Research Instrument

The research instrument is designed to repre sent key elements in systems-based military decision-making, including:
• Operations Research Model.
Used as the primary analytical tool to formalize the relationship between decision variables and parameters.
• Decision Variables.
Represent the alternative military decisions that can be selected.
• Decision Parameters.
Used to test the sensitivity and robustness of decisions.
• Scientific Secondary Data.
Used to support the justification of the model and assumptions. This instrument allows for objective, struc tured, and auditable analysis.

2.4 Analysis Techniques

The analysis techniques in this research are carried out through several systematic stages:
• Operations Research Model Design. Structuring the military decision model as a formal system.
• Variable and Parameter Identification. Determining the components that influence decisions.
• Sensitivity Analysis Implementation. Testing the impact of parameter changes on decisions.
• Robustness and Risk Evaluation. Assess the stability of the decision and its level of vulnerability.

Tahap	Aktivitas	Tujuan
1	Pemodelan sistem	Representasi keputusan militer
2	Penetapan parameter	Dasar uji sensitivitas
3	Analisis sensitivitas	Uji robustness & risiko
4	Interpretasi hasil	Penilaian kualitas keputusan

Table 2. Stages of Analysis Techniques

The following table forms the main foundation of the sensitivity analysis, where each para meter is tested to see its impact on the robustness and risk of military decisions.

3. RESEARCH RESULTS AND DISCUSSION

The results of this study indicate that military decisions based on operations research models exhibit higher stability than conven tional approaches when key parameters vary. The analysis focuses on the robustness and risk of military decisions resulting from varia tions in key parameters: time, cost, and risk.

Komponen	Simbol	Makna dalam Keputusan Militer
Alternatif keputusan	x	Pilihan keputusan militer
Waktu	t	Durasi pengambilan keputusan
Biaya	c	Penggunaan sumber daya
Risiko	r	Tingkat ketidakpastian keputusan

Table 3. Parameters and Variables of the Operations Research

Model

3.1 Results of Sensitivity Analysis on Time Parameters

The sensitivity analysis was conducted by varying the time parameter (t) with respect to the baseline conditions of military decisions. The change in time is intended to represent the tempo pressures of decision-making in a military environment.

Variasi Waktu	Perubahan Nilai t	Dampak terhadap Keputusan Militer	Tingkat Robustness
Baseline	0%	Keputusan awal	Tinggi
Skenario A	−10%	Tidak berubah	Tinggi
Skenario B	−20%	Perubahan minor	Sedang
Skenario C	+10%	Tidak berubah	Tinggi
Skenario D	+20%	Perubahan alternatif	Rendah

Table 4. Results of Sensitivity Analysis of Time Parameter (t)

Initial interpretation: Military decisions are relatively robust to time variations up to ±10%, but begin to show a decline in robustness when changes exceed that threshold.

3.2 Results of Sensitivity Analysis on Cost Parameters

Cost parameters (c) were tested to represent military resource limitations and pressures on asset utilization efficiency.

Variasi Biaya	Perubahan Nilai c	Dampak terhadap Keputusan Militer	Tingkat Risiko
Baseline	0%	Keputusan awal	Rendah
Skenario A	−10%	Tidak berubah	Rendah
Skenario B	−20%	Penyesuaian alokasi	Sedang
Skenario C	+10%	Tidak berubah	Rendah
Skenario D	+25%	Perubahan keputusan	Tinggi

Table 5. Results of Cost Parameter Sensitivity Analysis (c)

Initial interpretation: Military decisions exhibit moderate sensitivity to costs. Significant cost increases increase decision risk, although they do not necessarily directly change decision alternatives.

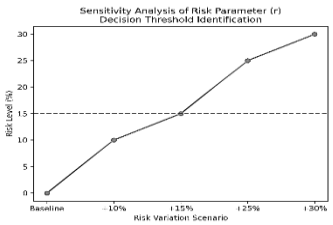
3.3 Sensitivity Analysis Results for Risk Parameters

The risk parameter (r) was tested to observe changes in decisions due to increasing levels of environmental uncertainty.

Variasi Risiko	Perubahan Nilai r	Dampak terhadap Keputusan Militer	Profil Risiko Keputusan
Baseline	0%	Keputusan awal	Stabil
Skenario A	+10%	Tidak berubah	Stabil
Skenario B	+15%	Perubahan minor	Terkendali
Skenario C	+25%	Perubahan signifikan	Tidak stabil
Skenario D	+30%	Alternatif berubah	Tinggi

Table 6. Risk Parameter Sensitivity Analysis Results (r)

The following graph shows the relationship between variations in risk levels and military decision responses. An increase in the risk parameter value above the threshold indicates a change in decision-making from a relatively stable state to a more vulnerable state. The threshold marks the transition point at which changes in risk levels begin to significantly impact the stability of military decisions. The threshold is established based on the results of the sensitivity analysis and is used as an indicator of decision change, not as an absolute normative limit.



Graph 1. Results of Risk Parameter Sensitivity Analysis (r)

Initial Interpretation: Compared to time and cost, risk is the most sensitive parameter. An increase in risk above a certain threshold immediately triggers a change in military decisions.

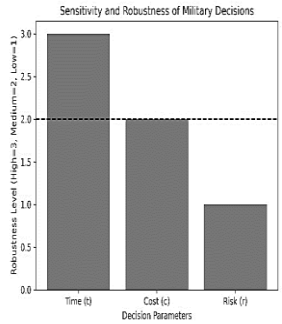
3.4 Summary of Sensitivity Analysis Results

To provide a comparative overview, the results of the sensitivity analysis are summa rized as follows.

Parameter	Ambang Sensitivitas	Robustness Keputusan	Dominasi Risiko
Waktu (t)	±10%	Tinggi	Rendah
Biaya (c)	±20%	Sedang	Sedang
Risiko (r)	±15%	Rendah	Tinggi

Table 7. Summary of Military Decision Sensitivity and Robustness

The table above shows that risk parameters have the most dominant influence on changes in military decisions, while time and cost serve as supporting factors for decision resilience.



Graph 2. Summary of Robustness of Military Decisions to Key Parameter Variations.

The graph summarizes the robustness of military decisions to variations in time, cost, and risk parameters. Robustness values are visualized ordinally (high–medium–low) to show differences in decision resilience. A threshold line marks the boundary between relatively stable decisions and decisions that are vulnerable to parameter changes. The robustness coding is for comparative visuali zation purposes and is not intended as an absolute quantitative measurement.

3.5. Research Discussion

3.5.1 Identification of Dominant Parameters Affecting the Robustness of Military Decisions

This study identified the parameters that most influence the robustness of military decisions. Based on Tables 4–6 and summarized in Table 7, it can be seen that each parameter exhibits varying levels of sensitivity. Analytical synthesis reveals:

• Time (t) exhibits high robustness up to a threshold of ±10%.

• Cost (c) is moderate, with the impact of risk increasing at extreme variations.

• Risk (r) is the most sensitive parameter, with a threshold of ±15% directly triggering a change in decision.

Parameter	Karakter Sensitivitas	Dampak Utama	Implikasi Keputusan
Waktu (t)	Rendah–Sedang	Stabilitas tempo	Penyesuaian taktis
Biaya (c)	Sedang	Tekanan sumber daya	Re-alokasi
Risiko (r)	Tinggi	Ketidakpastian sistem	Perubahan keputusan

Tabel 8. Pemetaan Parameter terhadap Robustness Keputusan Militer

These results confirm that the robustness of military decisions is not determined uniformly, but rather depends heavily on the risk parameters as the dominant variables.

3.5.2 Comparison of Conventional Approaches and Operations Research Models

Focuses on evaluating whether operations research models provide added value compared to conventional approaches in terms of consistency and accountability of military decisions. Key findings include:

• Conventional approaches are adaptive, but difficult to retest and not transparent to parameter changes.

• Operations research models allow for explicit tracing of cause-and-effect relationships, sensitivity analysis, and risk evaluation.

Aspek	Konvensional	Model Riset Operasi
Dasar keputusan	Doktrin & pengalaman	Model sistem
Uji sensitivitas	Tidak eksplisit	Eksplisit
Robustness	Variatif	Lebih konsisten
Akuntabilitas	Subjektif	Terukur

Table 9. Comparative Discussion of Military Decision-Making Approaches

The key difference is not in which decision is more correct, but rather in the ability of operations research models to systematically test the robustness of decisions, something that conventional approaches alone cannot achieve.

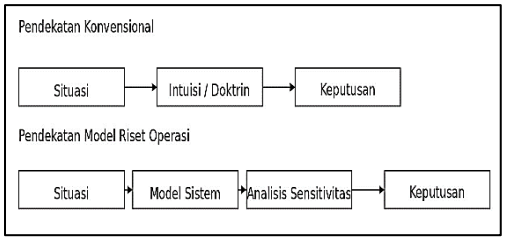


Figure 1. Comparison of Conventional and Operations Research Model-Based Military Decision-Making Flows

3.5.3 Integrating a Systems Approach in Military Decision Risk Evaluation

Assess the role of a systems approach in integrating risk evaluation into the military decision-making process. With a systemic analysis, the systems approach views military decisions as:

• part of a larger system,

• *influenced by interacting variables,*
• *susceptible to non-linear change.*

Elemen Sistem	Fungsi	Dampak
Parameter	Sumber variasi	Sensitivitas
Model	Alat analisis	Konsistensi
Analisis sensitivitas	Uji ketahanan	Robustness
Evaluasi risiko	Mitigasi	Stabilitas keputusan

Table 10. The Role of the Systems Approach in Military Decision-Making

The systems approach does not replace the role of the commander-in-chief, but rather strengthens the quality of decisions by provi ding a testable framework for risk evaluation and robustness.

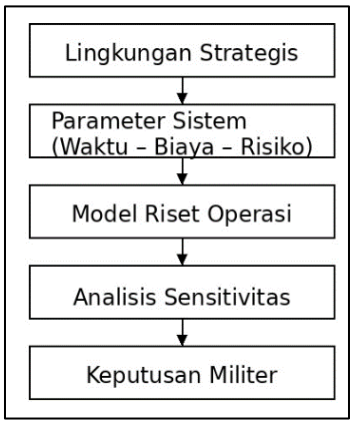


Figure 2. Integration of Systems Approach in Military Decision Making

4. CONCLUSIONS AND RECOMMENDATIONS

4.1 Conclusions

- *This study analyzes the robustness and risk of conventional military decisions through the application of an operations research model based on sensitivity analysis with a systems approach. The results show that the robustness of military decisions is influenced differently by each parameter, with risk being the most dominant factor triggering decision changes, while time and cost play supporting roles in decision robustness to a certain extent.*

- *The application of an operations research model allows for more consistent, trans parent, and measurable analysis of military decisions compared to conven tional approaches that rely solely on doctrine and experience. This approach does not replace the role of the comman der-in-chief, but rather serves as a deci sion support system that strengthens the quality of decision evaluation.*
- *Furthermore, the systems approach provi des a more comprehensive framework for integrating risk evaluation and the interactions between parameters, allo wing for more objective assessment of military decisions in complex and dyna mic environments.*

4.2 Recommendations

- *Based on the research findings, it is recommended that operational research models and sensitivity analyses be developed as part of military decision support systems, particularly at the planning and evaluation stages of high-risk decision alternatives.*

- *Further research is recommended using empirical data and more specific decision scenarios at the strategic, operational, and tactical levels, and combining this approach with simulation and multi-criteria decision analysis. The systems approach can also be utilized as an analytical tool in military decision-making education and training without dimini shing the role of experience and profes sional judgment of officers/ commanders.*

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