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Maintenance Management Analysis Of C-130HS Hercules Aircraft Based On Reliability-Centered Maintenance (RCM) At Air Squadron 31, Halim Perdanakusuma Air Base

Analisis Manajemen Pemeliharaan Pesawat C-130HS Hercules Berbasis *Reliability-Centered Maintenance* Pada Skadron Udara 31 Lanud Halim Perdanakusuma

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ABSTRACT
This study aims to evaluate the effectiveness of the current maintenance management system for the C-130HS aircraft in Air Squadron 31 and to develop a strategy for enhancing reliability through the implementation of Reliability-Centered Maintenance (RCM). A qualitative case-study approach was employed, supported by technical analyses using Failure Mode and Effect Analysis (FMEA), the RCM Logic Tree, and the RCM Decision Worksheet. The findings indicate that the existing Time-Based Maintenance (TBM) system is insufficient for managing the actual risks of an aging fleet, as evidenced by the high frequency of failures in the engine system, particularly in the Temperature Datum components, namely the TD Amplifier and TD Valve. The FMEA results identified the Power Section as the subsystem with the highest risk, while the RCM Logic Tree generated recommendations including scheduled maintenance tasks, critical component replacements, and several failure-finding tasks. Integration of these recommendations into the existing PIP, TYI, and SIP inspection schedules demonstrates that RCM can be applied without altering the current framework while significantly improving effectiveness and efficiency. Overall, the study concludes that implementing RCM has strong potential to enhance operational readiness, reduce unexpected failures, and strengthen the organization's maintenance capability.
Keywords : Reliability-Centered Maintenance, FMEA, Aircraft Maintenance

ABSTRAK
Studi ini bertujuan untuk mengevaluasi efektivitas sistem manajemen perawatan saat ini untuk pesawat C-130HS di Skuadron Udara 31 dan untuk mengembangkan strategi peningkatan keandalan melalui implementasi Perawatan Berbasis Keandalan (Reliability-Centered Maintenance/RCM). Pendekatan studi kasus kualitatif digunakan, didukung oleh analisis teknis menggunakan Analisis Mode Kegagalan dan Dampak (Failure Mode and Effect Analysis/FMEA), Pohon Logika RCM, dan Lembar Kerja Keputusan RCM. Temuan menunjukkan bahwa sistem Perawatan Berbasis Waktu (Time-Based Maintenance/TBM) yang ada tidak cukup untuk mengelola risiko aktual dari armada yang menua, sebagaimana dibuktikan oleh frekuensi kegagalan yang tinggi pada sistem mesin, khususnya pada komponen Datum Suhu (Temperature Datum/TD), yaitu Penguat TD dan Katup TD. Hasil FMEA mengidentifikasi Bagian Daya (Power Section) sebagai subsistem dengan risiko tertinggi, sedangkan RCM Logic Tree menghasilkan rekomendasi termasuk tugas pemeliharaan terjadwal, penggantian komponen kritis, dan beberapa tugas pencarian kegagalan. Integrasi rekomendasi ini ke dalam jadwal inspeksi PIP, TYI, dan SIP yang ada menunjukkan bahwa RCM dapat diterapkan tanpa mengubah kerangka kerja saat ini sambil secara signifikan meningkatkan efektivitas dan efisiensi. Secara keseluruhan, studi ini menyimpulkan bahwa implementasi RCM memiliki potensi yang kuat untuk meningkatkan kesiapan operasional, mengurangi kegagalan yang tidak terduga, dan memperkuat kemampuan pemeliharaan organisasi.
Kata kunci: Pemeliharaan Berbasis Keandalan, FMEA, Pemeliharaan Pesawat Terbang.

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1. Pendahuluan

Management as a scientific discipline has long been understood as a process that includes planning, organizing, directing, and controlling (Griffith & Yalcinkaya, 2010). In the context of aircraft maintenance management, these functions become highly crucial to ensure the effective use of resources while also maintaining the operational readiness of the fleet. Operational management, as a branch of management science, focuses on the efficiency of production and maintenance processes, including schedule planning, quality control, and cost management (Heizer et al., 2022). From a strategic perspective, the Resource-Based View (RBV) theory emphasizes the importance of managing internal assets, including the reliability of aircraft systems, as a source of the organization's competitive advantage (Barney & Hesterly, 2023). Thus, maintenance management is not merely a technical activity but also an integral part of organizational strategy.

The C-130HS Hercules aircraft is a vital asset of the Indonesian Air Force, holding a strategic role in various military operations, logistics missions, and national as well as international humanitarian tasks. The multifunctional capabilities of this aircraft demand a high level of operational readiness and a reliable maintenance system. In various tactical and emergency missions, the effectiveness of maintenance directly influences the speed and success of operational execution. Therefore, maintenance management of the C-130HS Hercules has broad strategic implications for the nation's defense capability.

However, the C-130HS fleet, which has been in operation for more than three decades, faces serious challenges due to performance degradation and system obsolescence. From a managerial perspective, managing aging aircraft requires maintenance strategies capable of addressing budget limitations, spare-parts availability, and constrained technician capacity. These issues create their own complexity in efforts to maintain operational efficiency and mission effectiveness (Halim, 2025). In this regard, management must be able to design and implement adaptive and sustainable maintenance policies.

In practice, the conventional maintenance system commonly used in military environments is the time-based maintenance (TBM) approach, which refers to maintenance carried out based on specific time intervals or flight-hour cycles without considering the actual condition of components. This system is relatively easy to implement but has weaknesses, as it may lead to inefficient maintenance activities in terms of both cost and time. Conversely, the Reliability-Centered Maintenance (RCM) approach is a reliability-based maintenance method that focuses on system functions, failure modes, and the operational impact of those failures (Moubray, 2022). RCM is designed to identify the most effective maintenance activities to preserve system performance and safety by considering risks and the prioritization of critical functions.

Up to the present, the maintenance system for the C-130HS Hercules aircraft within Air Squadron 31 at Halim Perdanakusuma Air Base is still dominated by the time-based maintenance approach. Maintenance schedules are determined based on flight hours or calendar age, regardless of the actual condition or potential failure of specific components. Although this approach has been used for many years and provides certainty in maintenance scheduling, it is less adaptive to the dynamic condition of the aircraft—particularly for fleets that have entered the aging phase. This situation creates a risk of unexpected failures and leads to the inefficient use of resources by performing maintenance that may not actually be required

Most existing RCM studies are still dominated by technical approaches from the perspective of mechanical engineering and reliability engineering. There has been relatively little research discussing RCM from a managerial standpoint, particularly within the context of military organizations. Therefore, this study seeks to fill that gap by examining how RCM-based maintenance strategies can be integrated into the management system, decision-making processes, technical human-resource management, and organizational policies within Air Squadron 31 at Halim Perdanakusuma Air Base.

2. Literature Review

1. Strategic Management

Strategic management is an integrative field of management that combines analysis, formulation, and implementation to improve organizational performance and achieve competitive advantage. According to Rothaermel (2021), its primary goal is to deploy and allocate resources effectively while managing various stakeholders to respond to external environmental challenges. In the context of military organizations, performance orientation is not solely measured in terms of economic gains, but rather by the effectiveness of mission accomplishment, the efficiency of national budget utilization, the level of operational readiness, and the assurance of national defense and security.

The strategic dimension within military organizations is a multidimensional framework that integrates national defense policy objectives with real operational capabilities in the field. This encompasses a broad spectrum, ranging from force planning, defense logistics and supply-chain management, to weapon-system maintenance and modernization strategies to ensure combat readiness (Freedman, 2015). The synergistic integration of all these elements is a prerequisite for achieving operational superiority and strategic effectiveness.

The strategic dimension within military organizations represents a multidimensional framework that aligns national defense policy objectives with actual operational capabilities in the field. This framework spans a wide spectrum of areas, including force planning, defense logistics and supply-chain management, as well as weapon-system maintenance and modernization strategies to ensure sustained combat readiness (Freedman, 2015). The synergistic integration of these elements is essential for achieving operational superiority and strategic effectiveness.

In the context of military organizations, the maintenance system for defense equipment such as aircraft fleets is a concrete example of an organizational capability. If this system is merely reactive and unstructured, it may still hold value (by keeping aircraft operational), but it will not be rare or difficult to imitate, and therefore cannot serve as a source of strategic advantage. Conversely, the implementation of advanced and proactive maintenance strategies, such as Reliability-Centered Maintenance (RCM), can transform maintenance capability into a strategic asset. A well-integrated RCM system creates operational efficiency and superior combat readiness, making it a capability that is rare, difficult for others to imitate, and organized to maximize defense value (Rothaermel, 2021).

2. Operational and Maintenance Management

Operational management is a field of management that focuses on managing resources to design, produce, and deliver goods or services. Its purpose is to ensure that the transformation process from inputs to outputs runs effectively and efficiently while meeting stakeholder expectations (Slack & Brandon-Jones, 2022). Within the military context, this operational function translates into process management that ensures mission readiness, logistical effectiveness, as well as the availability and reliability of primary weapon systems (alutsista).

Within the framework of modern physical asset management, the maintenance function plays a strategic role in ensuring the reliability, availability, and safety of assets throughout their life cycle. Maintenance has evolved from merely corrective actions (repairing failures) into a proactive and predictive function that forms an integral part of operational strategies aimed at achieving superior organizational performance (Dhillon, 2002). This is particularly crucial in the context of high-value assets with potentially fatal failure risks, such as military aircraft.

3. Conventional Maintenance System (Time-Based Maintenance)

Time-Based Maintenance (TBM), or time-based maintenance, is one of the earliest and most commonly used approaches in industrial maintenance systems. This strategy emphasizes performing maintenance actions periodically based on specific time intervals, operating cycles, or mileage, under the assumption that components will gradually degrade over time (Mobley, 2002). Accordingly, maintenance is carried out before failure occurs in order to prevent undesirable breakdowns.

The TBM approach offers several advantages, particularly in terms of ease of implementation and planning. Fixed and measurable maintenance schedules facilitate the management of manpower, logistics, and spare-parts procurement. In addition, due to its systematic nature, TBM also supports consistent documentation and reporting for audit or inspection processes (Dhillon, 2002).

3. Research Methods

This study employs a qualitative approach with a case study design to gain an in-depth understanding of the implementation of Reliability-Centered Maintenance (RCM) strategies on the C-130HS Hercules aircraft. This approach was selected because it allows for the exploration of complex technical and managerial phenomena within a real operational environment (Yin, 2018). Data analysis was conducted descriptively and qualitatively by integrating the technical methods of RCM and Failure Mode and Effect Analysis (FMEA) to identify critical failure modes, assess their risk levels, and formulate appropriate maintenance strategies based on the RCM decision logic. Data validity was strengthened through triangulation in the form of interviews with senior technicians and maintenance managers, as well as verification of technical documents such as the MPD and AMM.

The research was conducted at Air Squadron 31, Halim Perdanakusuma Air Base, Jakarta, which serves as the operational unit operating the C-130HS Hercules heavy transport aircraft of the Indonesian Air Force. This location was chosen due to its operational complexity, which is relevant to the application of RCM to an aging aircraft fleet. Data collection took place from August to December 2025, covering the stages of planning, field observations, in-depth interviews, technical analysis, and result validation. All research activities were carried out within the actual operational maintenance context to ensure the relevance and accuracy of the findings.

The research data were obtained from both primary and secondary sources. Primary data were gathered through semi-structured interviews, observations of maintenance activities in the hangar, and Focus Group Discussion (FGD) sessions with senior technicians and maintenance planners for completing the FMEA worksheets and RCM decision tree. Meanwhile, secondary data were collected from maintenance logbooks, work cards, A/B/C/D-check inspection schedules, Technical Orders, and system fault reports over the past three years. The research instruments used included interview guides, observation sheets, FMEA worksheets, and RCM decision tree forms, all of which were designed to produce in-depth qualitative data along with structured quantification as the basis for formulating systematic and adaptive RCM-based maintenance strategy recommendations.

4. Results and Discussions

1. Current Condition of the Maintenance Management System for the C-130HS Aircraft

The current maintenance management system for the C-130HS aircraft refers to an official, structured, and hierarchical guideline as outlined in the document ‘Aircraft and

Component Maintenance Instruction Details.' To understand the workflow and the maintenance philosophy applied, it is important to explain the definition of each key element within the guideline. The guideline is divided into several main columns, including the Maintenance Schedule, which lists the types of inspections and their intervals; the Maintenance Executor, which details the responsible unit for each maintenance level, ranging from light-level maintenance at the Air Squadron (SKD), intermediate-level maintenance at the Technical Squadron (SKT), to heavy-level maintenance at the Maintenance Depot (DEPO); the Koharmatau Reference Code, which serves as the work-order or standard-procedure reference number issued by the Air Force Materiel Maintenance Command; and the Remarks column, which provides additional information to clarify the execution of maintenance tasks.

RINCIAN PEDOMAN PEMELIHARAAN PESAWAT TERBANG DAN KOMPONEN

NAMA BARANG TYPE	BUATAN PABRIK	JADWAL PEMELIHARAAN	PELAKSANA PEMELIHARAAN				BENTUK KOHARMATAU	KETERANGAN
			SKD	SKT	DEPO	KONT		
PESAWAT TERBANG C-130B KC-130B C-130H C-130H-30 L-100-30	LOCKHEED AERONAUTICAL SYSTEM COMPANY (LASC), USA	a. Daily Inspection/Turn Arround Inspection.	31,32, **33**				**25001**	
		b. Paket Inspeksi Progresive (PIP), dilaksanakan setiap 50 jam terbang.	31,32, **33**				**25001**	Terdiri dari 24 Paket (THI dilebur Dalam paket-paket PI)
		c. Three Years Inspection (TYI), setiap 3000 jam terbang/ 3 tahun setelah SIP.		021,022, **044**			**25001**	
		d. Structural Integrity Program (SIP), setiap 6000 jam terbang atau 6 tahun.			10		**25001**	
		e. Special Inspection **(SI)**.	31,32, **33**	021,022, **044**	10, 20, 30		**25001**	Dilaksanakan pada : kondisi khusus
		f. Penggantian/Pemeliharaan Komponen.	31,32 **33**	021, 022, **044**	10, 20, 30		**25002**	Sesuai Rincian pada BP3A

Gambar 1 : Detailed Guidelines for Aircraft and Component Maintenance

Based on the structure of the guideline shown in Figure 4.3, it can be analyzed that the maintenance management system applied to the C-130H fleet in Air Squadron 31 is grounded in a preventive maintenance strategy using a Time-Based Maintenance (TBM) approach. This means that most maintenance schedules and actions are determined according to pre-established intervals, whether based on accumulated flight hours or calendar time, irrespective of the actual condition of the components at that moment

In addition to these scheduled inspections, the existing system also accommodates Special Inspections (SI), which are carried out under specific conditions, as well as Component Replacement/Maintenance whose schedules refer to supplementary technical documents (BP3A). The implementation of maintenance is divided according to capability levels, in which Air Squadron 31 is responsible for light-level maintenance such as Daily Inspections and PIP, while heavier inspections such as TYI and SIP are performed by the Technical Squadron (SKT) and the Maintenance Depot (Depo). Although this structured system provides scheduling certainty, it serves as the basis for analysis in this study to evaluate its effectiveness and compare it with a more dynamic approach such as Reliability-Centered Maintenance (RCM).

Tabel 1. Damage Summary for the Period January 2024 – May 2025

SYSTEM	**Kerusakan**		**MTBF (hari)**
	Frek	**%**	
ENGINE	49	89.09	11.17
COCPIT	2	3.64	273.75
PROPELLER	2	3.64	273.75
NOSE AREA	1	1.82	547.50
WHEEL WELL AREA	1	1.82	547.50
TOTAL	**55**	**100.00**	

The overall damage recap presented in Table 1 shows a highly significant concentration of issues within one primary system. It was identified that the ENGINE system is the largest contributor to failures, with 49 out of 55 incidents, accounting for 89.09% of all aircraft failures. This high frequency is reflected in the very low Mean Time Between Failures (MTBF), which is only 11.17 days. These data indicate that, from a maintenance management perspective, efforts to improve operational readiness and overall fleet efficiency must prioritize enhancing the reliability of the engine system.

Tabel 2. Engine System Failure Summary for the Period January 2024 – May 2025

ITEM	Kerusakan		MTBF (hari)
	Frek	%	
TD AMPLIFIER	15	30.61	37
TD VALVE	12	24.49	46
NUT OIL PUMP	4	8.16	137
FCU	4	8.16	137
SSS	3	6.12	183
MAIN OIL PUMP	3	6.12	183
FILTER	2	4.08	274
NUT EDP	2	4.08	274
MAGNETIC DRAIN PLUG	2	4.08	274
NUT CHECK VALVE	2	4.08	274
TOTAL	**49**	**100.00**	

Furthermore, Table 2 provides a deeper breakdown of the sources of failures within the engine system, and the results further reinforce the argument for applying an RCM analysis. The data show that failures are not evenly distributed but are instead concentrated in two specific components within the Temperature Datum (TD) system, namely the TD AMPLIFIER (30.61%) and the TD VALVE (24.49%). Together, these two components account for more than 55% of all engine system failures. The chronic frequency of failures at these critical points demonstrates that the current time-based maintenance approach is not sufficiently effective in preventing them. Therefore, this condition serves as the primary justification for implementing a Reliability-Centered Maintenance (RCM) approach focused on the engine system, in order to develop a smarter and more adaptive maintenance strategy tailored to its most dominant failure modes.

2. Results of the Reliability-Centered Maintenance (RCM) Analysis

The results of the FMEA analysis make it possible to compare the level of risk across the main sub-assemblies of the C-130HS engine. Based on the comparison of RPN values, the Power Section clearly exhibits the highest aggregate risk. This is evidenced by several components within this section whose RPN values far exceed the highest values found in other sub-assemblies, such as the TD Amplifier (RPN = 450) and the TD Control Valve (RPN = 315). In contrast, the Reduction Gear and Torquemeter Assembly show more moderate risk levels, with their highest RPN values recorded for the Engine Driven Pump (RPN = 216) and the Torque Pick-Up (RPN = 192), respectively. These findings indicate that although each engine section contains potential failure points that must be managed, the Power Section represents the most critical area and therefore requires top priority in the development of a reliability-based maintenance strategy.

The results of the RCM Logic Tree analysis effectively translate the quantitative risk data from the FMEA into actionable qualitative maintenance strategies. The key finding from this analysis is that Scheduled Tasks are the most dominant and logical classification of actions for the majority of high-risk failure modes. Although the recommended tasks fall under the same category, the underlying justifications vary depending on the consequences of failure. For the TD Amplifier and TD Control Valve, scheduled tasks (in the form of calibration) were selected due to their very high failure frequency and significant operational impact. Conversely, for components such as the Fuel Pump and Engine Driven Pump, scheduled tasks (in the form of replacement or restoration) are mandatory because they are driven by safety-critical consequences that cannot be tolerated.

On the other hand, for the TD Amplifier—which frequently experiences calibration issues the technicians agreed that waiting for a failure to occur is not an optimal option. Therefore, scheduled calibration is recommended as a more proactive and efficient preventive action to ensure that the component continues to perform optimally without having to wait for a failure. With this approach, every decision made to address a failure mode is based on actual technical experience in the field, integrated with relevant theoretical principles. The results of these discussions were then summarized in a table presenting the jointly agreed-upon maintenance recommendations.

Tabel 3. Hasil RCM *Logic Tree*

Item	RPN	Dampak Keselamatan	Dampak Operasional	Deteksi Dini	Dampak Ekonomi	Rekomendasi Klasifikasi Tugas
TD Amplifier	450	Rendah	Sangat Tinggi; instabilitas mesin dapat membatalkan misi.	Sulit; degradasi terjadi secara bertahap.	Tinggi; biaya pencegahan lebih ekonomis.	*Scheduled Task* (Kalibrasi Terjadwal)
TD Control Valve	315	Rendah	Sangat Tinggi; kegagalan fungsi langsung mengganggu performa.	Sulit; pergeseran kalibrasi tidak mudah terdeteksi.	Tinggi; mencegah kegagalan operasional lebih efektif.	*Scheduled Task* (Kalibrasi Terjadwal)
Fuel Pump	280	Sangat Tinggi; kegagalan total dapat menyebabkan engine flameout.	Sangat Tinggi	Mungkin; degradasi dapat dideteksi melalui CBM.	Sangat Tinggi; biaya kegagalan di udara sangat besar.	*Scheduled Task* (Penggantian Terjadwal/TBO)
Engine Driven Pump	216	Tinggi; kegagalan dapat mempengaruhi sistem hidrolik utama.	Tinggi	Sulit; kegagalan internal tidak menunjukkan gejala awal.	Tinggi; mencegah kerusakan sekunder lebih efektif.	*Scheduled Task* (Penggantian Terjadwal)
Ignition Exciter	210	Tinggi; krusial untuk kemampuan relight di udara (fungsi keselamatan).	Tinggi	Sulit; kegagalan bersifat tersembunyi (hidden) hingga dibutuhkan.	Sedang – Tinggi	*Failure Finding Task & Scheduled Task*
Tacho Generator	200	Sedang; sinyal RPM yang salah mempengaruhi sinkronisasi dan kontrol.	Tinggi	Sulit; komponen dapat gagal berfungsi secara tiba-tiba.	Sedang	*Scheduled Task* (Pengecekan/Penggantian)
Torque Pick Up	192	Sedang; sinyal torsi yang salah	Tinggi	Sulit; kegagalan	Sedang	a. Scheduled Task (Pengecekan/Pengg

	mengganggu manajemen tenaga.	sensor sering terjadi tanpa peringatan.	antian)

In addition, the analysis identified the specific need for a Failure-Finding Task for the Ignition Exciter, whose primary risk stems from hidden failures associated with its protection function (relight capability). Thus, the RCM Logic Tree not only confirms the necessity of proactive maintenance actions but also provides a strong logical basis for selecting the most appropriate task type according to the unique risk profile of each failure mode. This becomes the foundation for developing a more intelligent and efficient maintenance program. The results obtained from the RCM Logic Tree analysis would not provide practical value without concrete steps for implementation. Therefore, the final stage of this study involved integrating the recommended maintenance tasks into the existing hierarchical inspection schedule of the C-130HS aircraft, namely the A/B/C/D-Checks. This integration process was carried out through discussions and direct confirmation with technicians during Focus Group Discussion (FGD) sessions to ensure that the proposed recommendations are realistic and can be implemented without disrupting aircraft operational continuity

Table 4. RCM Decision Worksheet

Item & Failure Mode	Consequence Evaluation				FB	Proposed Task	Proposed Interval (Check Level)	Integration Package
	H	S	E	O				
TD Amplifier - Out of calibration	N	N	N	Y	12	Scheduled Restoration (Calibration)	B-Check	Higher-Level PIP / Special Task
TD Control Valve - Out of calibration	N	N	N	Y	12	Scheduled Restoration (Calibration)	B-Check	Higher-Level PIP / Special Task
Fuel Pump - Low/No pressure output	N	Y	N	Y	8	CBM / Scheduled Discard	C-Check	TYI
Engine Driven Pump - Low/No pressure	N	Y	N	Y	9	Scheduled Discard (Replacement)	C-Check	TYI
Ignition Exciter - No/Weak output	Y	Y	N	Y	17	Failure-Finding Task (Op. Check)	A-Check	PIP
Tacho Generator - No/Erratic signal	N	N	N	Y	12	Scheduled Discard (Replacement)	C-Check	TYI
Torque Pick Up - No signal/Erratic signal	N	N	N	Y	12	Scheduled Discard (Replacement)	C-Check	TYI
AC Generator - Fails to produce power	N	N	N	Y	12	Scheduled Discard (Overhaul)	D-Check	SIP
Gear Box Oil Pump - Low/No pressure	Y	Y	N	Y	17	Failure-Finding Task (Pressure Check)	B-Check	Higher-Level PIP
G/B Oil Press Transmitter - Erroneous	N	N	N	Y	12	Scheduled Restoration (Calibration)	B-Check	Higher-Level PIP
Speed Sensitive Switch - Switch failure	N	N	N	Y	12	Scheduled Discard (Replaceme	C-Check	TYI

Item & Failure Mode	Consequence Evaluation				FB	Proposed Task	Proposed Interval (Check Level)	Integration Package
	H	S	E	O				
						nt)		
Oil Cooler Assy - Leak / Clogging	N	N	Y	Y	12	Scheduled Restoration (Cleaning/Test)	C-Check	TYI
Fuel Enrichment Valve - Fails open/closed	N	N	N	Y	12	Scheduled Restoration (Functional Test)	B-Check	Higher-Level PIP
P/S Oil Press Transmitter - Erroneous	N	N	N	Y	12	Scheduled Restoration (Calibration)	B-Check	Higher-Level PIP
Power Section Pump - Low/No pressure	Y	Y	N	Y	17	Failure-Finding Task (Pressure Check)	B-Check	Higher-Level PIP
Speed Sensitive Valve - Fails to actuate	N	N	N	Y	12	Scheduled Restoration (Functional Test)	B-Check	Higher-Level PIP
Starter Control Valve - Fails open/closed	N	N	N	Y	12	Scheduled Restoration (Functional Test)	A-Check	PIP
Fuel Heater And Strainer - Clogging/Failure	N	N	N	Y	12	Scheduled Restoration (Cleaning/Test)	B-Check	Higher-Level PIP
Oil Cooler Actuator Flap - Fails to modulate	N	N	N	Y	12	Scheduled Restoration (Lubrication/Test)	A-Check	PIP
Oil Quantity Transmitter - Erroneous	N	N	N	Y	12	Scheduled Restoration (Calibration)	B-Check	Higher-Level PIP
L/H & R/H Distribution Box - Bus failure	Y	N	N	Y	20	Failure-Finding Task (Resistance Test)	C-Check	TYI
Fuel Control Unit - FCU failure	N	Y	N	Y	9	Scheduled Discard (Overhaul)	D-Check	SIP
Ignition Relay - Fails to energize	Y	N	N	Y	20	Failure-Finding Task (Continuity Test)	B-Check	Higher-Level PIP
Anti Icing Solenoid - Fails open/closed	N	N	N	Y	12	Scheduled Restoration (Functional Test)	A-Check	PIP
Engine Starter - Fails to engage/cut out	N	N	N	Y	12	Scheduled Discard (Overhaul)	C-Check	TYI
Ice Detector - Fails to detect ice	Y	Y	N	Y	17	Failure-Finding Task (BIT Check)	A-Check	PIP
Low Pressure Fuel Filter - Clogging	N	N	N	Y	12	Scheduled Discard	A-Check	PIP

Item & Failure Mode	Consequence Evaluation				FB	Proposed Task	Proposed Interval (Check Level)	Integration Package
	H	S	E	O				
						(Replacement)		
Oil Tank - Crack / Leak	N	N	Y	Y	12	Scheduled Restoration (NDT Inspection)	C-Check	TYI
Control Coordinator - isalignment	N	N	N	Y	12	Scheduled Restoration (Rigging Check)	A-Check	PIP
Geneva Lock - Fails to engage/disengage	N	N	N	Y	12	Scheduled Restoration (Functional Test)	B-Check	Higher-Level PIP
Accesoris Housing - Crack / Seal leak	N	N	Y	Y	12	Scheduled Restoration (NDT Inspection)	C-Check	TYI
Parallelling Press Switch - Fails to actuate	N	N	N	Y	12	Scheduled Restoration (Functional Test)	B-Check	Higher-Level PIP
Parallelling Valve - Sticking / Leak	N	N	N	Y	12	Scheduled Restoration (Cleaning/Test)	C-Check	TYI
Engine Relay Box - Relay contact failure	Y	N	N	Y	20	Failure-Finding Task (Resistance Test)	B-Check	Higher-Level PIP
Fuel Flow Transmitter - Erroneous reading	N	N	N	Y	12	Scheduled Restoration (Calibration)	B-Check	Higher-Level PIP

The results in the RCM Decision Worksheet present a framework for integrating reliability-based maintenance tasks into the existing hierarchical maintenance schedule. The main principle of this integration is to match the frequency and complexity of the Proposed Tasks with the most efficient inspection level (Proposed Interval/Check Level) and maintenance package (Integration Package).

The implementation of RCM is not intended to replace the existing time-based maintenance system, but rather to serve as a more logical methodological evolution. In other words, RCM strengthens the already structured maintenance framework such as PIP, TYI, and SIP without eliminating it. The maintenance schedule remains the primary framework, but the content of each task is refined through reliability analysis. The fundamental difference between TBM and RCM lies in their analytical focus. TBM is oriented toward the question *'when should maintenance be performed?'*, where time intervals act as the primary trigger. In contrast, RCM emphasizes *'why must a failure be prevented, and what is the most effective way to do so?'* Thus, RCM focuses on understanding system functions, identifying failure modes, and managing the consequences of those failures to ensure that system functionality is preserved.

The implementation of RCM described in this study can be viewed not only as a technical solution but also in relation to several management theory frameworks. The integration process of RCM appears to align with key principles in Strategic Management particularly the Resource-Based View (RBV) as well as Operational Management. This alignment indicates that the application of RCM has the potential to become more than merely a procedural improvement; it may function as a strategic step that enhances organizational capabilities and performance. From a Strategic Management perspective, the Resource-Based View (RBV) posits that an organization’s competitive advantage can be derived from internal capabilities that are valuable, rare, and difficult to imitate (VRIO) (Barney & Hesterly, 2023). Conventional maintenance systems based on TBM, although essential, are typically considered standard industry practice and do not inherently provide any distinctive advantage, since they can be implemented by any organization.

By implementing RCM, Air Squadron 31 has the potential to develop its maintenance function into a more reliable internal capability. An RCM-based maintenance system becomes difficult to imitate because it relies not only on technical manuals but is also built upon the contextual knowledge of personnel (through FMEA), data-analysis capability, and an organizational culture that is proactive toward risks. The development of this capability ultimately supports the achievement of higher levels of operational readiness, which within the context of a military organization constitutes one of its primary strategic objectives.

The implementation of RCM has the potential to improve fleet reliability by reducing the frequency of unexpected failures in the critical components that have been identified. It can also enhance the quality of maintenance outcomes, as each task is specifically designed to address the root causes of failure. From a cost perspective, RCM can promote efficiency by helping reduce over-maintenance (unnecessary maintenance actions) and the costs associated with under-maintenance, such as emergency repairs and downtime (Alsyouf et al., 2023). Thus, RCM can be viewed as a managerial approach that supports the achievement of operational objectives. The findings of this study are consistent with and represent an extension of previous research in the field of reliability-based maintenance. In general, the effectiveness of RCM in optimizing maintenance schedules has been demonstrated by various studies. For example, research by A. Zhou et al. (2024) found that RCM-based policies were able to increase total operational time in civilian aircraft fleets through the optimization of D-check cycles. This is relevant to the findings of the present study, in which the integration of RCM tasks into TYI and SIP packages likewise aims to achieve similar efficiencies.

5. Conclusion

The findings of this study show that the current maintenance management system for the C-130HS aircraft in Air Squadron 31 remains predominantly dependent on a rigid time-based maintenance (TBM) approach embedded in hierarchical intervals such as PIP, TYI, and SIP. While this system provides scheduling certainty, it has proven insufficient in addressing the actual risks of an aging fleet, as evidenced by the high frequency of failures in the engine system particularly in the Temperature Datum components (TD Amplifier and TD Valve). The study further demonstrates that Reliability-Centered Maintenance (RCM) can be systematically integrated into the existing framework without replacing it. Through a structured process involving FMEA for objective risk identification, the RCM Logic Tree for determining the most effective maintenance tasks, and the RCM Decision Worksheet for incorporating these tasks into the established inspection schedule, RCM offers a practical and adaptive enhancement to improve reliability and operational readiness of the C-130HS fleet.

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