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Analysis Of Employee Workload During Peak Season (Sugar Milling Season) And Impact On Operational Efficiency At PT Sinergi Gula Nusantara

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Abstract

Massive upstream oil and gas projects frequently require Contract Scope Changes (Perubahan Lingkup Kontrak/PLK). This study analyzes the technical evaluation decision-making process of the SKK Migas Project Acceleration Unit (UPP) in navigating bounded rationality under strict deadlines, focusing on the utilization of tacit knowledge. Employing a qualitative case study approach, data were collected through in-depth interviews with UPP and Internal Supervisory (PI) personnel, observations, and thematic analysis of four PLK meeting minutes from the Strategis X National Strategic Project. Findings reveal that UPP personnel avoid sub-optimal "satisficing" by leveraging tacit knowledge, manifested as analytical engineering intuition. Furthermore, effective evaluation relies heavily on cross-functional knowledge sharing and risk-based guidance from the PI division. The study concludes that successful PLK decision-making requires synergizing individual empirical analysis with strict adherence to SKK Migas Working Guidelines (PTK) 007 and 069, thereby ensuring megaproject integrity and state financial efficiency.

Keywords: Contract Scope Change (PLK), Bounded Rationality, Tacit Knowledge, Project Governance, SKK Migas.

INTRODUCTION

The sugar industry is a strategic agribusiness sector in Indonesia that plays a vital role in supporting national food security (Jamaludin et al., 2024). Effective human resource management in this sector is a key determinant of operational success, as it forms the primary foundation of organizational productivity (Dessler, 2020). In sugar mill

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operations, there is an annual period known as the peak milling season, characterized by intensive sugarcane harvesting and processing within a specific timeframe (Mayangsari et al., 2026). During this period, all company resources, particularly human resources, operate at maximum capacity to meet established production targets (Rahmadyah, 2021).

PT Sinergi Gula Nusantara (PT SGN), the largest sugar producer in Indonesia, is highly subject to the dynamics of this milling season (PT Sinergi Gula Nusantara, 2025). Employees across various divisions, especially those directly involved in milling operations, machine maintenance, quality control, and logistics experience a significant surge in workload (Rahmadyah, 2021). Workload is defined as the condition where job demands are perceived to exceed the physical and mental capacities of workers within a given timeframe (Munandar, 2014; Tarwaka & Bakri, 2010). Grounded in the Job Demands-Resources (JD-R) theory, excessive job demands (work overload) that are not balanced with adequate resources will inevitably lead to burnout, reduced employee well-being, and decreased performance (Bakker et al., 2014; Lesener et al., 2020; Schaufeli & Taris, 2014).

Conversely, operational efficiency is a key indicator of manufacturing success, defined as the organization's ability to optimize resource utilization to consistently produce output according to established capacities and standards (Heizer et al., 2020a). In the sugar industry, operational efficiency is primarily measured by extraction yield (rendement), machine downtime, and the punctuality of daily production target completion. Heizer et al. (2020a) emphasize that effective capacity planning and workforce management are dominant factors in maintaining operational efficiency, particularly in seasonal industries.

Previous literature indicates that high workloads in manufacturing and process industries significantly impact employee effectiveness and operational efficiency. Studies in industrial ergonomics and management reveal that excessive job demands correlate with decreased work performance, increased burnout, and diminished employee well-being (Lesener et al., 2020). Furthermore, Kim and Park (2022) demonstrated that high workloads during peak production periods in manufacturing contribute to increased human error, reduced productivity, and disrupted operational efficiency. These findings underscore the urgency of examining the relationship between employee workload and operational efficiency, specifically in the sugar industry, which has distinct seasonal production characteristics.

Based on empirical observations during an internship at PT SGN, several critical phenomena warrant further investigation. During the peak season, employee working

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hours significantly exceed normal operational limits. Excessive working hours without adequate recovery time negatively impact productivity and occupational health (Armstrong, 2021a; International Labour Organization, 2019). Continuous long working hours increase the risk of fatigue and reduced concentration, ultimately lowering long-term work efficiency. Concurrently, fluctuations in extraction yield, machine downtime, and daily target adherence were observed, indicating operational efficiency instability during the peak season (Heizer et al., 2020b).

While previous studies have linked workload to general manufacturing performance, there remains a scarcity of empirical evidence specifically addressing how seasonal peak workload dynamics directly affect specific operational metrics (yield and downtime) in the agro-industry. To bridge this scientific and practical gap, this study aims to provide evidence-based recommendations for company management to optimize workforce capacity and sustain operational efficiency during critical production periods.

OBJECTIVE

This study aims to analyze and describe the workload conditions of PT SGN employees during peak season, analyze the operational efficiency level of PT SGN during peak season, and analyze the influence of employee workload during peak season on operational efficiency at PT Sinergi Gula Nusantara. These objectives address the research questions regarding workload conditions, operational efficiency levels, and the impact of workload on operational efficiency during the peak milling season.

LITERATURE REVIEW

Theoretical Foundation

Workload encompasses quantitative (volume) and qualitative (difficulty) aspects (Hasibuan, 2017a). While optimal workload enhances motivation (Robbins & Judge, 2013), excessive workload causes fatigue and productivity decline. Peak season, such as the sugar milling season, forces rapid processing to maintain quality (Kurniawan & Purwono, 2018), creating HR and operational challenges that require schedule adjustments and temporary workforce additions (Sutrisno, 2019). Operational efficiency is the ability to maximize output while minimizing input through optimal resource management (Heizer & Render, 2014). In the sugar industry, high efficiency during milling is crucial to meet targets and reduce costs. Workload directly impacts this efficiency; well-managed workload enhances performance, while excessive workload causes errors (Kusuma & Wardoyo, 2024). Factors like production surges, workforce limitations, task

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complexity, and poor working conditions exacerbate these impacts if not properly managed (Hasibuan, 2017a; Robbins & Judge, 2013).

Previous Research

The Job Demands-Resources (JD-R) theory (Bakker et al., 2014) emphasizes balancing job demands and resources to prevent burnout. Schaufeli & Taris (2014) confirmed that imbalance between high demands and low resources predicts efficiency decline through health impairment and reduced motivation. Aligning with this, Kusuma & Wardoyo (2024) found that uneven workload distribution during peak production significantly decreases operational efficiency, reinforcing the need for effective workload management during intensive periods.

Basic Concepts

Building on the foundation above, this study focuses on two core concepts. First, employee workload, defined as the tasks to be completed within a timeframe, requiring balance between demands and capabilities (Hasibuan, 2017a). Second, operational efficiency, achieved through careful planning and process control to maximize output (Heizer & Render, 2014). In the context of the milling season, managing the former is a prerequisite for achieving the latter.

Relationship between Concepts

The relationship between workload and efficiency is direct. According to JD-R theory (Bakker et al., 2014), high demands during peak season must be offset by adequate resources (fair task distribution, training, scheduling) to prevent burnout. Without these resources, the imbalance negatively impacts efficiency. Kusuma & Wardoyo (2024) support this, showing that workload exceeding normal limits during intensive periods increases errors and decreases hourly output, making proactive workload management essential.

Framework Definition

This framework explains the relationship between employee workload and operational efficiency at PT SGN using the JD-R theory (Bakker et al., 2014). It illustrates how balancing quantitative and qualitative job demands with available resources prevents burnout and maintains efficiency during the intensive milling season.

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Conceptual Model

The model utilizes an Input-Process-Output approach. Input represents the high workload (task volume, difficulty, duration) during milling season. The process involves workload management strategies (flexible scheduling, training, technology, temporary workforce). Output reflects operational efficiency (productivity, quality, cost reduction). This linear relationship forms the basis for analyzing how managing the input through the process optimizes the output.

Framework Contextualization

Contextualized in PT SGN, the framework addresses the challenge of processing large sugarcane volumes within limited timeframes. Poor workload management risks downtime and low extraction yield. By applying strategies like flexible scheduling and temporary workforce additions, the company can balance demands and capacity. Understanding this relationship provides the basis for strategic recommendations to achieve production targets, reduce costs, and improve competitiveness.

METHODOLOGY

This study employs a descriptive qualitative approach with a case study strategy to understand employee workload during peak season at PT Sinergi Gula Nusantara (SGN) (Creswell, 2014; Yin, 2014). The qualitative approach enables comprehensive understanding of experiences and social processes during high operational intensity periods (Sugiyono, 2021). Conducted during the researcher's internship at PT SGN, a PTPN III subsidiary managing Indonesian sugar mills (Indrawanto et al., 2010), the research leveraged naturalistic observation of peak season dynamics when workload reaches its maximum (Kurniawan & Purwono, 2018; Sutrisno, 2019).

The unit of analysis comprised employees directly involved in mill operations during peak season, including operational staff and managers (Creswell, 2014; Yin, 2014). Primary data were obtained through participatory observation during the researcher's internship and in-depth semi-structured interviews with key informants, operational employees, supervisors, and managers (Moleong, 2017; Sugiyono, 2021). Secondary data from academic literature and company documents provided theoretical context (Hasibuan, 2017b; Bakker et al., 2014; Heizer & Render, 2014; Kusuma & Wardoyo, 2024).

Data analysis employed Miles et al.'s (2014) interactive model which data reduction through selection and transformation of raw data (Rijali, 2018), data display in

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descriptive narratives and matrices, and conclusion drawing with continuous verification. Validity was ensured through source and technique triangulation (Mekarisce, 2020), member checking with informants (Moleong, 2017), and extended observation periods (Sugiyono, 2021), ensuring credibility, transferability, dependability, and confirmability (Moleong, 2017).

RESULTS AND DISCUSSION

Respondent Profile

This qualitative study used purposive sampling to select three informants from PT Sinergi Gula Nusantara (SGN) representing administrative (R1), strategic-managerial (R2), and HRM operational (R3) perspectives (Creswell, 2014).

Table 1. Profile of Research Respondents

No	Code	Position/Division	Work Location	Milling Season Experience
	R1	Marketing and Customer Division Staff	PT SGN Head Office	2 milling seasons
	R2	Business Strategy Division Staff & Management System Mandate Team	PT SGN Head Office	>3 times (including experience at PG Gempolkrep as Assistant Manager)
	R3	HRM (Human Resource Management) Division Staff	PG Soedhono, Ngawi, East Java	4 milling seasons

The research was conducted during the peak milling season (May to December), characterized by 24-hour operational standby and significant workforce expansion. R3 explained: *"Kalau di luar giling, PG Soedhono ini karyawan tetapnya sekitar 250-an orang, Mas. Tapi begitu masuk musim giling, kita harus rekrut tenaga harian lepas bisa nambah 350 sampai 400 orang lagi. Jadi total yang harus kita kelola itu bisa 600-an lebih. Dari sisi administrasi SDM, otomatis beban kerja kita di bagian MSDM juga naik drastis."*

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Data were collected through semi-structured in-depth interviews (Fadhallah, 2021) and analyzed using Miles et al.'s (2014) interactive model.

Workload Conditions During Peak Season

Peak season triggers severe workload intensification across three dimensions. Quantitatively, work volume surges dramatically: daily document processing at HRM increased from 20-25 to 60-75 documents, while the total managed workforce exceeded 700, nearly tripling administrative workload (R3). Working hours extend significantly beyond formal schedules, with employees handling weekend shifts and maintaining 24-hour standby without proportional overtime compensation (R1, R2, R3). Qualitatively, task complexity increases as employees handle quality complaints, conduct extra supervision, and manage simultaneous multi-problems. R3 described *"Dalam satu hari masalahnya bisa macam-macam... MSDM itu kayak pemadam kebakaran masalah orang."*

Operational Efficiency During Peak Season

Operational efficiency is measured through production KPIs (sugar output, quality, downtime, losses) and HR metrics (≥95% attendance target, overtime rates, accident rates) (R2, R3). While service responsiveness remains intact (R1), data reveals a clear temporal decline: attendance rates drop from 96-98% in months 1-2 to 93-94% in month 3, then further to 90-91% by months 4-5. Concurrently, individual overtime increases from 20-25 to 35-40 hours monthly (R3). This pattern indicates gradual efficiency degradation as peak season progresses.

The Influence of Workload on Operational Efficiency

The primary mechanism linking workload to efficiency decline is cumulative fatigue. Prolonged hours and high demands cause physical exhaustion, emotional burnout, and demotivation (R1, R3). Fatigue directly impairs efficiency: human error (initially near zero) increases by months 3-4, while response times slow from 10-15 to 20-30 minutes (R3). Severe consequences include a 3-hour machine downtime caused by an operator falling asleep due to cumulative fatigue (R3). This creates a negative spiral where each 1% attendance drop increases individual workload by 5-7% (R3). Although moderation strategies exist (digitalization, SOPs, THL reserves), their effectiveness diminishes over time, proving insufficient by months 3-5. External factors (aging machinery, weather) compound these losses.

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Table 2. Data Encoding

No	Quotation (Verbatim)	Code	Theme
1	*"...kalau udah musim giling itu bakalan ada banyak pembeli. Soalnya kan gulanya masih fresh lah ya."* (Interview with R1, Marketing and Customer Staff)	Surge in number of buyers	Quantitative Workload
2	*"...aku di sini harus nyiapin dokumen yang berkaitan dengan pembelian saat itu juga, dan itu pun harus diterima pembeli sesegera mungkin karena kita kasih waktu tenggat untuk pembayaran maksimal 3 hari kerja."* (Interview with R1, Marketing and Customer Staff)	Document deadline pressure	Quantitative Workload
3	"...satu shift saya kalau di stasiun saya dulu atau di pabrik gula secara keseluruhan itu kita bisa menghandle atau menangani orang di bawah kita tuh ada 400 orangan Mas, satu kali shift Mas." (Interview with R2, Marketing and Customer Staff)	Large-scale management	Quantitative Workload
4	"Total yang harus kita kelola administrasinya 700 orang lebih. Workload naik hampir 3 kali lipat." (Interview with R3, HRM Staff PG Soedhono)	Surging administrative volume	Quantitative Workload
5	"Dokumen yang saya proses per hari naik jadi 60-75 dokumen per hari dari biasanya 20-25." (Interview with R3, HRM Staff PG Soedhono)	Documents increased 3-fold	Quantitative Workload

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6	"Jam kantor kita sampai jam 5, tapi pabrik kan operasionalnya 24 jam. Nah di luar itu kalau ada kerjaan dadakan kita harus tangani sesegera mungkin." (Interview with R1, Marketing and Customer Staff)	Work outside office hours	Extended Working Hours
7	"Ya libur pun juga kadang kita mau nggak mau harus bisa nge-handle." (Interview with R1, Marketing and Customer Staff)	Working on holidays	Extended Working Hours
8	"...kalau di saya kan sebagai asisten manajer kan saya ndak ada kata lembur Mas, artinya kami bertanggung jawab secara penuh ketika pabrik beroperasi 24 jam." (Interview with R2, Business Strategy Staff)	24-hour standby without overtime	Extended Working Hours
9	"Selama giling, saya jarang pulang sebelum jam 6-7 malam. Sabtu tetap masuk setengah hari. Libur penuh bisa dihitung jari." (Interview with R3, HRM Staff PG Soedhono)	Working hours exceed formal schedule	Extended Working Hours
10	"...ada beberapa pembeli yang menerima gula itu yang udah nggak bagus, jadi kan mau nggak mau kita harus tuker barang itu." (Interview with R1, Marketing and Customer Staff)	Handling quality complaints	Qualitative Workload

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11	"...ketika ada tebu yang kondisi kualitasnya ndak bagus, itu kita lakukan beberapa kali improvisasi. Itu yang kita masih butuh ekstra pengawasan." (Interview with R2, Business Strategy Staff)	Extra quality supervision	Qualitative Workload
12	"Dalam satu hari masalahnya bisa macam-macam... MSDM itu kayak pemadam kebakaran masalah orang." (Interview with R3, HRM Staff PG Soedhono)	Multiple simultaneous problems	Qualitative Workload
13	"Kalau giling sudah masuk bulan ke-3 ke-4, konflik antar karyawan mulai naik. Orang capek, emosi gampang terpancing." (Interview with R3, HRM Staff PG Soedhono)	Increased interpersonal conflicts	Qualitative Workload
14	"Ya kalau capek kita pasti ada lah, karena kadang di luar jam kantor kita masih harus ngurus kerjaan." (Interview with R1, Marketing and Customer Staff)	Physical fatigue	Cumulative Fatigue
15	"Ya kadang ngalamin malas, ngerasa monoton gini-gini aja." (Interview with R1, Marketing and Customer Staff)	Boredom and demotivation	Cumulative Fatigue
16	"...karena kalau udah burn out gitu ya coba cari selingan lah biar nggak pusing dan stres amat." (Interview with R1, Marketing and Customer Staff)	Burnout	Cumulative Fatigue

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17	"Yang paling terasa itu kelelahan emosional... Ada masa saya merasa overwhelmed, kayak masalahnya nggak pernah habis." (Interview with R3, HRM Staff PG Soedhono)	Emotional exhaustion	Cumulative Fatigue
18	"Ijin sakit naik 30-40% dibanding bulan pertama. Paling banyak ISPA dan muskuloskeletal." (Interview with R3, HRM Staff PG Soedhono)	Increased sick leave	Cumulative Fatigue
19	"Kecelakaan kerja tahun lalu 8 kasus. 7 di antaranya di bulan ke-3 ke atas, mayoritas karena kurang konsentrasi." (Interview with R3, HRM Staff PG Soedhono)	Temporally increased accidents	Cumulative Fatigue
20	"Kedisiplinan turun, keterlambatan naik, THL resign 10-15% sebelum kontrak habis." (Interview with R3, HRM Staff PG Soedhono)	Decline in discipline & turnover	Cumulative Fatigue
21	"...target utama kita di key performance indicator itu adalah produksi gula... KPI turunannya kualitas gula, jam berhenti pabrik, sama losses." (Interview with R2, Business Strategy Staff)	Tiered production KPIs	Operational Efficiency
22	"Dari MSDM kita pantau: tingkat kehadiran per shift target 95%, rasio jam lembur, kecelakaan kerja, dan fill rate posisi kritikal." (Interview with R2, Business Strategy Staff)	HR indicators for efficiency	Operational Efficiency

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23	"Sejauh ini kita nggak pernah telat menangani keluhan." (Interview with R1, Marketing and Customer Staff)	Service responsiveness maintained	Operational Efficiency
24	"Bulan pertama-kedua kehadiran 96-98%. Bulan ke-3 turun ke 93-94%. Bulan ke-4 ke-5 drop ke 90-91%." (Interview with R3, HRM Staff PG Soedhono)	Temporally declining efficiency	Operational Efficiency
25	"Jam lembur naik dari 20-25 jam per orang bulan pertama jadi 35-40 jam di bulan ke-4 ke-5." (Interview with R3, HRM Staff PG Soedhono)	Progressively increasing overtime	Operational Efficiency
26	"...perlahan-lahan kita sudah mulai memasuki era digitalisasi... pengendalian proses berbasis automatic control sehingga mengurangi faktor human error." (Interview with R2, Business Strategy Staff)	Digitalization reduces errors	Moderation Strategies
27	"...karyawan harus dibekali dengan SOP, untuk bisa jadi panduan bekerja lebih optimal dan efisien." (Interview with R2, Business Strategy Staff)	SOP as standardization	Moderation Strategies
28	"...memang kita sudah melakukan analisa beban kerja ya Mas, atau workload analysis." (Interview with R2, Business Strategy Staff)	Workforce planning	Moderation Strategies

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29	"...untuk layanan kita buatin beberapa grup WhatsApp berbeda dengan orang pabrik untuk pelunasan pembayaran, update stok data, agar fokus." (Interview with R1, Marketing and Customer Staff)	Structured communication	Moderation Strategies
30	"Kalau tenaga kerja tambahan ya selama ini kita ngandelin anak magang, baik mandiri maupun program Magenta." (Interview with R1, Marketing and Customer Staff)	Additional workforce (HO)	Moderation Strategies
31	"THL itu penyelamat kita selama giling... THL cadangan on-call 10-15% lebih sebagai jaring pengaman." (Interview with R3, HRM Staff PG Soedhono)	Additional workforce (factory)	Moderation Strategies
32	"Budaya gotong royong karyawan... saling bantu tanpa diminta." (Interview with R3, HRM Staff PG Soedhono)	Informal solidarity	Moderation Strategies
33	"Sistem 3 shift rotasi mingguan supaya shift malam nggak terus di orang yang sama." (Interview with R3, HRM Staff PG Soedhono)	Shift rotation	Moderation Strategies
34	"Di awal giling, human error hampir nol. Bulan ke-3 ke-4 mulai muncul. Response time melambat dari 10-15 menit jadi 20-30 menit." (Interview with R3, HRM Staff PG Soedhono)	Temporally increasing human error	Influence of Workload on Efficiency

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35	"Operator feeding rate ketiduran shift malam jam 3 pagi. Mesin overload, trip. Berhenti 3 jam. 540 ton tebu tertunda. Root cause: kelelahan akumulatif 5 bulan." (Interview with R3, HRM Staff PG Soedhono)	Downtime due to fatigue	Influence of Workload on Efficiency
36	"Setiap 1% kehadiran turun, beban per orang naik 5-7%... Itu spiral yang sulit diputus." (Interview with R3, HRM Staff PG Soedhono)	Negative spiral effect	Influence of Workload on Efficiency
37	"Kalau kehadiran di bawah 90%, posisi kritikal bisa kosong dan laju produksi harus diturunkan." (Interview with R3, HRM Staff PG Soedhono)	Decreasing production capacity	Influence of Workload on Efficiency
38	"Polanya kayak kurva bulan 1-2 stabil, bulan ke-3 mulai turun, bulan ke-5 ke atas makin curam. Berulang tiap tahun bukan anomali, tapi masalah sistemik." (Interview with R3, HRM Staff PG Soedhono)	Cumulative-temporal pattern	Influence of Workload on Efficiency
39	"Strategi itu membantu tapi ada batasnya. Efektivitasnya menurun seiring waktu. Cukup di bulan 1-2, kurang di 3-4, nggak cukup di bulan 5." (Interview with R3, HRM Staff PG Soedhono)	Limits of moderation effectiveness	Influence of Workload on Efficiency
40	"Karyawan yang langsung turun ke mesin bayarannya sama dengan yang di kantor. Itu bikin turnover THL tinggi dan motivasi turun." (Interview with R3, HRM Staff PG Soedhono)	Compensation injustice	Influence of Workload on Efficiency

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41	"...kita handle dengan komunikasi yang cepet lah, kita fast response baik sesama internal divisi pemasaran maupun antar divisi." (Interview with R1, Marketing and Customer Staff)	Fast response as coping	Moderation Strategies
42	"Cuaca berpengaruh besar... suplai tebu tersendat, pabrik jalan pelan." (Interview with R3, HRM Staff PG Soedhono)	External weather factors	External Factors
43	"Mesin-mesin di PG Soedhono sebagian sudah berumur puluhan tahun." (Interview with R3, HRM Staff PG Soedhono)	Aging machinery	External Factors
44	"...kuncinya itu ketika masuk tebu, kita harus tahu kualitas tebu yang digiling di pabrik gula kita." (Interview with R2, Business Strategy Staff)	Raw material quality	External Factors

DISCUSSION

Workload Intensification During Peak Season: A JD-R Theory Perspective

The findings reveal that employee workload at PT SGN during peak season increases significantly across multiple dimensions. Quantitative demands surge 2.5-3 times from normal conditions, with document processing increasing from 15-20 to 50-70 per day (R3), and managed workforce expanding from 250 to 600+ employees. Working hours extend beyond formal schedules, with employees frequently working weekends and maintaining 24-hour standby without proportional compensation. These findings align with the Job Demands-Resources (JD-R) theory (Bakker & Demerouti, 2007), which posits that high job demands, when not balanced with adequate resources, lead to health impairment. The data shows two simultaneous psychological processes operating. First, the health impairment process is evident through physical fatigue accumulation

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throughout the milling season, evidenced by sick leave increasing from 3-5 to 8-12 employees per day by month four (R3). Mental and emotional exhaustion manifests as monotony and demotivation (R1) and feelings of being overwhelmed (R3). Safety is compromised, with work accidents concentrated in months 3+, including an incident where a crane operator's fatigue-induced lack of focus caused a 2-hour production stoppage (R3).

Second, the motivational process provides buffering effects through job resources. The local *gotong-royong* (mutual assistance) culture at PG Soedhono serves as social capital strengthening workforce resilience (R3). Technology implementation (automatic control, fingerprint systems) reduces manual burden (R2, R3). Professional responsibility awareness drives individual persistence: *"kita harus sadar tanggung jawab"* (R1). A critical finding reveals temporal dynamics in JD-R balance. Unlike conventional JD-R applications, this study demonstrates that JD-R balance shifts systematically over time. In months 1-2, resources adequately compensate for demands, maintaining optimal efficiency. However, by month 3+, accumulated demands surpass available resource capacity, making the health impairment process dominant. This confirms Armstrong (2021) that excessive working hours without adequate recovery time progressively negatively impact productivity. The 5-6 month continuous exposure duration becomes a critical variable determining when the JD-R imbalance threshold is reached.

Operational Efficiency: Human Factors as Leading Indicators

Operational efficiency at PT SGN is monitored through integrated KPIs spanning production (sugar production volume, quality, downtime, losses), HR (≥95% shift attendance, overtime hours, accident rates, THL turnover), and customer service (complaint response time, document delivery punctuality). This aligns with Heizer et al. (2020a) defining operational efficiency as the organization's ability to optimize resource utilization for consistent output according to established standards. A unique finding reveals that HR indicators function as leading indicators preceding production efficiency decline. Attendance rates drop from 97-98% (months 1-2) to 89-91% (months 4-5) before significant downtime increases. R3's calculation shows that each 1% attendance decline potentially adds 10-15 minutes of idle time daily, totaling 5-7.5 hours of productive time loss monthly.

This suggests that HR metric monitoring can serve as an early warning system for operational efficiency threats. This finding extends Heizer et al.'s (2020a) framework by demonstrating that in seasonal sugar industry contexts, operational efficiency is not

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merely a function of technical factors (machinery, raw materials) but is significantly influenced by human factors. This supports Mangkunegara (2017) that work performance results from measurable quantity and quality outputs, meaning poorly managed workload directly impacts organizational output.

The Workload-Efficiency Relationship: An Integrative Temporal Model
Cumulative-Temporal Influence Pattern

Contrary to linear assumptions that high workload immediately reduces efficiency, this study reveals a cumulative-temporal influence pattern. During months 1-2, high workload coincides with optimal efficiency because employee energy remains fresh, initial motivation is high, and temporary workers (THL) are enthusiastic. Decline becomes noticeable in month 3 and significant in months 4-5. R3's empirical data from four milling seasons shows consistent patterns: *"Bulan pertama-kedua, semua indikator bagus... Tapi mulai bulan ke-3, grafik kehadiran mulai turun, laporan sakit naik... Di bulan ke-4 sampai ke-5, itu puncaknya."* This temporal pattern suggests that duration of exposure to high workload, not just intensity, determines efficiency impact.

The Negative Spiral Mechanism

A critical finding is the identification of a vicious cycle mechanism operating as follows: high workload leads to fatigue, which increases absenteeism, creating staff shortages that increase the burden on present workers, causing faster fatigue and more absenteeism in a self-reinforcing cycle. R3 quantifies this spiral, noting that each 1% decline in shift attendance from target adds an average of 10-15 minutes of idle time per day, which multiplied over 30 days monthly represents 5-7.5 hours of potential productive time loss. This non-linear, self-accelerating mechanism demonstrates that without timely intervention, conditions deteriorate exponentially. This finding extends previous research by Lesener et al. (2020) and Kim & Park (2022) by revealing the dynamic, cumulative nature of workload-efficiency relationships in seasonal industries.

Organizational Moderation Strategies and Their Limits

While high workload potentially reduces efficiency, organizational strategies function as buffers through multiple mechanisms. Digitalization and automatic control reduce manual performance dependency with high effectiveness in reducing human error. Workload analysis and THL planning attempt to match personnel to needs but achieve only moderate effectiveness due to persistent 10-15% gaps between

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requirements and availability. SOP and safety induction standardize actions and prevent incidents with moderate-to-high effectiveness. The local *gotong-royong* culture provides informal mutual support with high effectiveness as a unique social capital. THL cadangan on-call systems serve as safety nets for sudden vacancies with moderate effectiveness depending on availability and skill levels. Daily cross-department briefings enable rapid coordination and collective problem identification with high effectiveness. However, a critical finding reveals that strategy effectiveness is not constant throughout the milling season. In months 1-2, all strategies work optimally. By months 3-4, effectiveness weakens as SOP compliance declines and solidarity erodes from accumulated fatigue. By month 5+, existing strategies become insufficient, requiring reinforcement through additional interventions such as extra leave, incentives, and intensive rotation. This finding extends Bakker et al.'s (2014) JD-R theory by demonstrating that job resources have temporal limits in seasonal industries whose buffering capacity diminishes with prolonged exposure to high demands.

Functional and Level Variations

The workload-efficiency relationship varies significantly by organizational level and function. At the factory operational level (operators and shift workers), physical fatigue leads to human error, resulting in downtime and accidents, representing the most direct and measurable impact. At the head office administrative level (R1), mental fatigue creates potential delays leading to customer complaints, representing a more latent impact. At the strategic-managerial level (R2), supervision overload results in less strict oversight, affecting quality and compliance. At the factory HRM level (R3), administrative overload leads to suboptimal HR management and personnel shortages. This variation suggests that workload management interventions must be function-specific rather than one-size-fits-all, requiring tailored approaches for different organizational levels and roles.

Theoretical Implications

This study contributes to theory in four ways. First, it enriches the JD-R model with a temporal dimension by demonstrating systematic shifts in JD-R balance over time (balanced in months 1-2 to imbalanced in months 3+), providing important nuance for JD-R theory application in seasonal industries. Second, it identifies HR leading indicators by showing that HR metrics (attendance, sick leave, overtime) precede production efficiency decline, suggesting HR monitoring can function as an early warning system, a practical-theoretical contribution relevant to operations management. Third, it conceptualizes the

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spiral effect by identifying the vicious cycle (absenteeism → increased burden → fatigue → more absenteeism), demonstrating that the workload-efficiency relationship is non-linear and can experience negative acceleration without intervention. Fourth, it recognizes local social capital as an informal job resource by showing that PG Soedhono's local *gotong-royong* culture functions as an informal job resource, enriching the JD-R job resources typology, which typically focuses on formal organizational resources.

Practical Implications and Strategic Recommendations

Based on the findings, we propose seven evidence-based recommendations prioritized by urgency and impact. First, increase leave frequency to a minimum of one day per week on a rotating basis starting from month 2, as the critical fatigue point occurs at month 3 with attendance drop beginning in month 3 (R3), targeting factory management implementation. Second, implement an automated early warning system based on attendance and overtime data to address the absenteeism spiral effect (R3), recognizing that early detection is cheaper than remediation, requiring HRM and IT collaboration. Third, differentiate milling premiums by providing higher rates for night shifts, 100% attendance bonuses, and zero accident rewards, as flat premiums are perceived as unfair and demotivating (R3), requiring HRM and Finance coordination. Fourth, add 2-3 temporary HRM administrative staff during milling season, as the current 1:200 ratio is too high (R3) with 3 staff for 600+ employees being unsustainable, targeting PG management. Fifth, establish protected rest time policy for head office employees on weekends, as unlimited weekend work reduces recovery (R1), requiring head office management action. Sixth, conduct weekly brief health check-ups at factory clinics for high-risk positions to address significant sick leave increase without early detection (R3), requiring K3 and clinic coordination. Seventh, digitalize individual workload tracking to replace manual Excel systems, as manual recording consumes excessive HRM time (R3), requiring IT and HRM collaboration.

Synthesis

This study demonstrates that employee workload at PT SGN during peak season influences operational efficiency through a cumulative-temporal mechanism, mediated by organizational strategies, with variations based on job level and function. The integrative model reveals five key findings. First, workload increases 2.5-3 times from normal conditions across quantitative, temporal, and qualitative dimensions, with 5-6 month continuous exposure. Second, cumulative fatigue follows a temporal pattern progressing

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from light (months 1-2) to moderate with critical point (months 3-4) to severe (months 5+). Third, efficiency indicators show gradual decline following fatigue accumulation. Fourth, moderation strategies have temporal limits, being effective in months 1-2, weakening in months 3-4, and becoming insufficient by month 5+. Fifth, external factors including cane quality, weather, and THL availability moderate the workload-efficiency relationship. The key contribution reveals that in seasonal industries, duration of exposure to high workload is as critical as intensity, and that HR indicators can serve as early warning systems for operational efficiency threats, findings with significant theoretical and practical implications for seasonal industry management.

CONCLUSION

This study concludes that employee workload at PT Sinergi Gula Nusantara during peak season increases significantly across quantitative, temporal, and qualitative dimensions, reaching 2.5-3 times normal levels sustained over 5-6 months. The key finding reveals that workload influences operational efficiency through a cumulative-temporal mechanism rather than immediate linear effects. Efficiency remains optimal during months 1-2 despite high workload, but declines progressively from month 3 onwards as cumulative fatigue surpasses recovery capacity, reaching critical levels by months 4-5. Three critical mechanisms are identified.

First, HR indicators (attendance, sick leave, overtime) function as leading indicators that precede production efficiency decline, suggesting their potential as early warning systems for operational management. Second, a negative spiral mechanism operates where fatigue-induced absenteeism increases workload for present workers, accelerating further fatigue and absenteeism in exponential degradation each 1% attendance decline adds 5-7% individual burden. Third, organizational moderation strategies (digitalization, SOPs, workload analysis, local *gotong-royong* culture) demonstrate temporal limits, their buffering capacity diminishes with prolonged exposure, being effective in months 1-2 but insufficient by month 5+ without reinforcement. The theoretical contribution extends the Job Demands-Resources model by demonstrating that duration of exposure to high workload is as critical as intensity in seasonal industries, and that JD-R balance shifts systematically over time. Practically, these findings imply that proactive intervention based on HR indicator monitoring implemented before month 3 critical threshold is essential to prevent irreversible efficiency degradation. Without timely reinforcement of job resources and adequate recovery time, the negative spiral will accelerate operational decline regardless of initial mitigation strategies.

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