

ABSTRAK

Proses bongkar kargo *pulp* di PT. Maritim Sinar Utama (MSU) memiliki peran strategis dalam rantai logistik, namun masih menghadapi ketidakseimbangan beban kerja antarstasiun yang menyebabkan *idle time*, antrian proses, serta keterlambatan bongkar hingga 44% dari total kapal yang ditangani. Kondisi ini turut memicu peningkatan biaya operasional, termasuk sewa dermaga, sewa alat berat, lembur TKBM, serta potensi *demurrage* yang dapat mencapai USD 13.000–15.000 per hari. Permasalahan tersebut menunjukkan perlunya pendekatan analitis yang mampu memetakan aliran kerja secara objektif dan mengidentifikasi sumber ketidakefisienan.

Penelitian ini bertujuan untuk (1) menganalisis kondisi aktual keseimbangan lini pada proses bongkar muat *pulp* berdasarkan hasil pengukuran waktu kerja di lapangan, serta (2) menerapkan metode *line balancing* untuk mengevaluasi tingkat efisiensi dan merumuskan rekomendasi peningkatan produktivitas. Pendekatan penelitian bersifat deskriptif kuantitatif, menggunakan *stopwatch time study* dan *work sampling* untuk memperoleh *observed time*, *normal time*, dan *standard time*, yang kemudian dipetakan ke dalam *precedence diagram*. Analisis keseimbangan lini dilakukan menggunakan metode heuristik *Kilbridge–Wester* (K–W) dengan dukungan aturan *Least Number of Following Tasks* (LNFT) untuk pengelompokan elemen kerja ke dalam stasiun secara sistematis.

Hasil penelitian menunjukkan bahwa pada metode *Truck Lossing* (TL), *cycle time* aktual sebesar 285 detik per siklus lebih tinggi dibanding *takt time* target 202 detik, sehingga kapasitas maksimal hanya sekitar 88 *lift* per *shift*, berada jauh di bawah kebutuhan 125 *lift*. Pada metode *Kade Lossing* (KL), *cycle time* sebesar 268 detik juga belum memenuhi ritme kerja ideal. Penerapan *line balancing* menghasilkan konfigurasi dua stasiun kerja yang lebih proporsional untuk masing-masing metode, dengan peningkatan *line efficiency* serta penurunan *balance delay* dan *smoothness index*, menandakan beban kerja yang lebih merata antarstasiun.

Secara keseluruhan, penelitian ini mengonfirmasikan bahwa ketidakseimbangan lini merupakan penyebab utama inefisiensi waktu bongkar *pulp* di PT. MSU. Penerapan metode heuristik *line balancing* terbukti efektif dalam mengidentifikasi *bottleneck*, mengurangi *idle time*, serta meningkatkan keselarasan alur kerja. Temuan ini memberikan dasar ilmiah yang kuat bagi perbaikan operasional, termasuk potensi peningkatan *throughput* bongkar per *shift* dan penurunan biaya tambahan akibat *over* durasi.

Kata Kunci: *Stevedoring Pulp, Truck Lossing (TL), Kade Lossing (KL), Line Balancing, Kilbridge Wester*

ABSTRACT

The pulp cargo stevedoring process at PT. Maritim Sinar Utama (MSU) plays a strategic role in the company's logistics operations, yet it continues to experience workload imbalances across workstations. These imbalances generate idle time, process queues, and unloading delays affecting up to 44% of the barges handled. Such conditions further escalate operational costs, including berth rental, equipment rental, labor overtime, and potential demurrage charges reaching USD 13,000–15,000 per day. This situation underscores the need for an analytical approach capable of mapping workflow conditions objectively and identifying sources of inefficiency.

This study aims to (1) analyze the actual line balance conditions in the pulp unloading process based on field time-study measurements, and (2) apply line balancing techniques to assess efficiency levels and formulate productivity improvement recommendations. A descriptive-quantitative methodology was employed using stopwatch time study and work sampling to obtain observed time, normal time, and standard time, which were subsequently structured into a precedence diagram. Line balancing analysis was conducted using the Kilbridge–Wester (K–W) heuristic supported by the Least Number of Following Tasks (LNFT) rule to systematically assign task elements into workstations.

The findings show that under the Truck Lossing (TL) method, the actual cycle time of 285 seconds per cycle exceeds the takt time target of 202 seconds, limiting the achievable capacity to approximately 88 lifts per shift—well below the required 125 lifts. Under the Kade Lossing (KL) method, the actual cycle time of 268 seconds likewise fails to meet the ideal production rhythm. The application of line balancing produced a two-workstation configuration for each method, yielding improved line efficiency and reduced balance delay and smoothness index values, indicating a more proportional distribution of workload.

Overall, the study confirms that line imbalance is the primary source of inefficiency in the pulp unloading operations at PT. MSU. The use of heuristic line balancing proved effective in identifying bottlenecks, reducing idle time, and enhancing workflow alignment. These findings provide a strong empirical basis for operational improvements, particularly in increasing unloading throughput per shift and minimizing additional costs resulting from over-duration.

Keywords: *Stevedoring Pulp, Truck Lossing (TL), Kade Lossing (KL), Line Balancing, Kilbridge–Wester.*