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Analisis Socio-Technical pada Rencana Proyek Relokasi Depo Lokomotif (Studi Kasus di Yogyakarta)
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ABSTRAK

Rencana relokasi Depo Lokomotif Yogyakarta ke Area Stasiun Patukan merupakan konsekuensi dari penerapan konsep *Transit Oriented Development* (TOD) di Stasiun Yogyakarta. Rencana ini menimbulkan dampak *socio-technical* bagi pengguna kereta api serta operasional perkeretaapian. Kajian relokasi fasilitas perkeretaapian di Indonesia dari perspektif socio-technical masih terbatas dan belum ditemukan penelitian yang mengintegrasikan persepsi pengguna kereta api dengan *Agent-Based Modeling* (ABM) untuk mengevaluasi dampak relokasi fasilitas kereta api. Penelitian ini bertujuan mengisi kesenjangan tersebut dengan menyusun kerangka pikir interaksi *socio-technical*, mengidentifikasi dampak redistribusi kendaraan akibat rencana pembukaan Pintu Utara dan identifikasi dampak langsiran lokomotif terhadap kepadatan lalu lintas di perlintasan sebidang, serta merumuskan strategi relokasi yang optimal dan berkelanjutan.

Penelitian menggunakan dua pendekatan metode yaitu survei terhadap 112 pengguna kereta api di Stasiun Yogyakarta menggunakan Kuesioner Persepsi dan Aksesibilitas yang telah diuji validitas dan reliabilitasnya, serta menggunakan data sekunder berupa Kajian Kinerja Lalu Lintas Dinas Perhubungan Kota Yogyakarta, data jumlah penumpang dan jadwal kereta api berdasarkan GAPEKA 2025 milik PT Kereta Api Indonesia (Persero). Data tersebut menjadi basis dari dua model *Agent-Based Modeling* berbasis NetLogo yang dibangun mengikuti *ODD Protocol*, serta melalui proses kalibrasi, verifikasi, dan validasi model. Dua model yang disimulasikan yaitu: (1) model redistribusi kendaraan akibat rencana pembukaan Pintu Utara, dan (2) model dampak langsiran lokomotif terhadap kepadatan lalu lintas pada lima perlintasan sebidang di petak Stasiun Yogyakarta–Patukan. Setiap skenario disimulasikan sebanyak 30 kali replikasi dan telah diuji sensitivitas.

Hasil menunjukkan bahwa dari tiga skenario pembukaan Pintu Utara Stasiun, Skenario 3 (pembukaan Pintu Utara untuk penumpang KA Bandara YIA dan *Commuter Line*) menyebabkan redistribusi kendaraan terbesar dan konsisten dengan penurunan volume di Pintu Selatan sebanyak 23,21% - 24,50%, dan Parkir Selatan sebanyak 22,67% - 29,76%. Kenaikan secara proporsional juga terjadi di Pintu Utara, Parkir Utara, dan Jalan Gowongan Kidul. Uji sensitivitas membuktikan bahwa model responsif terhadap kenaikan volume penumpang. Di sisi lain, simulasi dampak langsiran lokomotif pasca relokasi membuktikan adanya peningkatan frekuensi langsiran yang berdampak pada peningkatan panjang antrean kendaraan di perlintasan sebidang, khususnya di Jalan Tata Bumi Selatan dan Jalan Soragan. Penelitian ini merumuskan strategi yang optimal berupa penerapan Skenario 3 disertai mitigasi teknis di sisi utara stasiun, serta pengelolaan jadwal langsiran yang terintegrasi antara Dinas Perhubungan Yogyakarta dengan PT Kereta Api Indonesia (Persero). Penelitian ini juga berkontribusi dalam mengusulkan kerangka evaluasi *socio-technical* berbasis metode *Agent-Based Modeling* yang dapat direplikasi pada kasus relokasi fasilitas perkeretaapian lainnya.

Kata kunci: *Depo Lokomotif Yogyakarta, Transit Oriented Development (TOD), Relokasi Fasilitas, Analisis Socio-Technical, Agent-Based Modeling (ABM)*

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ABSTRACT

The plan to relocate the Yogyakarta Locomotive Depot to the Patukan Station area is a consequence of implementing the Transit-Oriented Development (TOD) concept at Yogyakarta Station. This plan entails socio-technical impacts for both train users and railway operations. Studies on the relocation of railway facilities in Indonesia from a socio-technical perspective remain limited, and research integrating train users' perceptions with Agent-Based Modeling (ABM) to evaluate the impacts of such relocations is scarce. This research aims to bridge this gap by developing a socio-technical interaction conceptual framework, identifying the impacts of vehicle redistribution resulting from the planned opening of the North Entrance and the effects of locomotive shunting on traffic congestion at level crossings, and formulating an optimal and sustainable relocation strategy.

The study employed two methodological approaches: a survey of 112 train users at Yogyakarta Station using a Perception and Accessibility Questionnaire (with verified validity and reliability), and the use of secondary data specifically, a traffic performance study by the Yogyakarta City Transportation Agency, along with passenger volume and train schedule data (GAPEKA 2025) from PT Kereta Api Indonesia (Persero). These data served as the foundation for two NetLogo-based Agent-Based Models developed in accordance with the ODD Protocol, which subsequently underwent calibration, verification, and validation. The two simulated models were: (1) a vehicle redistribution model resulting from the planned opening of the North Entrance, and (2) a model assessing the impact of locomotive shunting operations on traffic congestion at five level crossings along the Yogyakarta Station–Patukan railway segment. Each scenario was simulated through 30 replications and subjected to sensitivity analysis.

The results indicate that among the three scenarios for opening the station's North Entrance, Scenario 3 opening the North Entrance to both YIA Airport Train and Commuter Line passengers resulted the most significant vehicle redistribution. This scenario consistently led to volume reductions of 23.21%–24.50% at the South Entrance and 22.67%–29.76% at the South Parking area. Proportional increases were observed at the North Entrance, North Parking area, and Jalan Gowongan Kidul. Sensitivity testing confirmed the model's responsiveness to increases in passenger volume. Simulations regarding post-relocation locomotive shunting operations revealed an increase in shunting frequency, which in turn increased the frequency of vehicle queues at level crossings, particularly on Jalan Tata Bumi Selatan and Jalan Soragan. The study formulates an optimal strategy comprising the implementation of Scenario 3, accompanied by technical mitigation measures on the station's north side and a shunting schedule managed through integrated coordination between the Yogyakarta Transportation Agency and PT Kereta Api Indonesia (Persero). Additionally, the research proposes a socio-technical evaluation framework based on Agent-Based Modeling that can be replicated for other railway facility relocation projects.

***Keywords**: Yogyakarta Locomotive Depot, Transit Oriented Development (TOD), Facility Relocation, Socio-Technical Analysis, Agent-Based Modeling (ABM)*