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Strategi Penguatan Industri Pengolahan Indonesia Melalui Integrasi Analisis Markov Chain dan Pestel
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INTISARI

Industri pengolahan di Indonesia mengalami dinamika pertumbuhan dan pergeseran struktur antar subsektor yang tidak merata. Pendekatan berbasis indikator statis dinilai belum mampu menangkap kompleksitas tersebut, sehingga penelitian ini menggunakan pendekatan berbasis sistem untuk menganalisis dinamika struktural 16 subsektor industri pengolahan selama periode 2011–2025 melalui integrasi model *Markov Chain*, Tipologi Klassen, dan analisis PESTEL. Model *Markov Chain* digunakan untuk mengestimasi probabilitas transisi dan distribusi *steady state* dalam mengidentifikasi pola persistensi jangka panjang. Hasil analisis menunjukkan bahwa model bersifat *robust*, yang dibuktikan melalui analisis perturbasi dengan skenario perubahan probabilitas sebesar ±5% dan ±10%. Hal ini menunjukkan bahwa model stabil dan reliabel dalam merepresentasikan dinamika subsektor. Berdasarkan Tipologi Klassen, sebanyak 12,5% subsektor tergolong maju dan tumbuh pesat, 18,75% memiliki kontribusi tinggi namun tertekan, 43,75% tergolong potensial, dan 25% merupakan subsektor tertinggal. Temuan ini menunjukkan bahwa transformasi industri pengolahan Indonesia cenderung didominasi oleh persistensi struktural dibandingkan mobilitas yang cepat. Analisis PESTEL dilakukan berdasarkan diskusi dan pembobotan bersama Kementerian Perindustrian Republik Indonesia, dengan menggunakan subsektor yang dipilih sebagai contoh dari masing-masing kuadran, yaitu industri kimia, farmasi, dan obat tradisional (Kuadran II), industri logam dasar (Kuadran III), serta industri kulit dan alas kaki (Kuadran IV). Hasilnya menunjukkan bahwa industri logam dasar memiliki kondisi eksternal paling kuat (3,80), diikuti industri kimia, farmasi, dan obat tradisional (3,40), serta industri kulit dan alas kaki (2,70). Temuan ini memberikan dasar kuantitatif dan strategis bagi perumusan kebijakan industri nasional.

Kata kunci: Industri Pengolahan, *Markov Chain*, Tipologi Klassen, PESTEL, Analisis Perturbasi

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ABSTRACT

The manufacturing industry in Indonesia experiences dynamic growth and uneven structural shifts across subsectors. Static indicator-based approaches are considered insufficient to capture this complexity; therefore, this study adopts a systems-based approach to analyze the structural dynamics of 16 manufacturing subsectors over the period 2011–2025 by integrating the Markov Chain model, Klassen typology, and PESTEL analysis. The Markov Chain model is employed to estimate transition probabilities and steady-state distributions in order to identify long-term persistence patterns. The results indicate that the model is robust, as demonstrated by perturbation analysis under ±5% and ±10% probability change scenarios, which show no significant impact on the steady-state distribution. This confirms that the model is stable and reliable in representing subsector dynamics. Based on Klassen typology, 12.5% of subsectors are classified as advanced and fast-growing, 18.75% as high contribution but under pressure, 43.75% as potential subsectors, and 25% as underdeveloped. These findings suggest that the transformation of Indonesia's manufacturing sector is dominated by structural persistence rather than rapid mobility. The PESTEL analysis is conducted based on discussions and weighted assessments with the Ministry of Industry of the Republic of Indonesia, using selected subsectors as examples from each quadrant: the chemical, pharmaceutical, and traditional medicine industry (Quadrant II), the basic metal industry (Quadrant III), and the leather and footwear industry (Quadrant IV). The results show that the basic metal industry has the strongest external condition (3.80), followed by the chemical, pharmaceutical, and traditional medicine industry (3.40), and the leather and footwear industry (2.70). These findings provide a quantitative and strategic basis for national industrial policy formulation.

Keywords: *Manufacturing Industry, Markov Chain, Klassen Typology, PESTEL, Perturbation Analys*