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Pengembangan Digitasi Deduct Value dan Corrected Deduct Value serta Prediksi Kondisi Perkerasan dalam Airport Pavement Management System pada Runway 07L-25R Bandar Udara Internasional Soekarno-Hatta
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INTISARI

Airport Pavement Management System (APMS) di Bandar Udara Internasional Soekarno-Hatta masih bersifat deskriptif dan belum menyediakan prediksi kondisi perkerasan sebagaimana direkomendasikan FAA dan diwajibkan PR-DJPU 3 Tahun 2026. Selain itu, perhitungan *Pavement Condition Index* (PCI) manual bergantung pada pembacaan kurva *Deduct Value* (DV) dan *Corrected Deduct Value* (CDV) ASTM D5340-12 yang memakan waktu dan subjektif. Permasalahan penelitian meliputi kesesuaian APMS eksisting terhadap acuan, validitas model digitasi kurva DV dan CDV, dan model prediksi kondisi *Runway* 07L-25R. Tujuan penelitian adalah mengevaluasi APMS eksisting serta mengembangkan dan menguji validitas kedua model.

Penelitian menggunakan dokumen APMS serta data PCI 360 *sample unit* tahun 2020-2023 dan 2025. APMS dievaluasi dengan *gap analysis* berlapis terhadap FAA, PR-DJPU 3 Tahun 2026, dan ICAO. Sebanyak 41 kurva DV dan kurva CDV untuk lima nilai q didigitasi dengan OriginPro, diregresi dengan persamaan polinomial dan *piecewise polynomial*, diimplementasikan dalam prototipe *Microsoft Excel*, lalu divalidasi terhadap perhitungan manual dan PAVER. Model *Markov chain* disusun sebagai Model I (transisi tahunan 2020-2023) dan Model II (transisi dua tahunan 2023-2025), kemudian divalidasi dengan *2-fold cross-validation* berdasarkan *sample unit* terhadap kondisi aktual 2025.

Enam dari sepuluh kriteria FAA telah sesuai, dua sesuai sebagian, dan dua belum sesuai. Ketiga acuan evaluasi APMS menunjukkan kesenjangan utama pada fungsi *performance prediction*. Prototipe menghasilkan PCI *runway* 79,86 dibandingkan 80,29 dari PAVER, dengan selisih setiap *sample unit* kurang dari 2 poin dan kesesuaian kategori 96,9%. Probabilitas transisi Model I tidak stabil antarperiode, sedangkan Model II menghasilkan MAE 24,83 *sample unit*, lebih kecil daripada Model I (34,88) dan prediksi tanpa perubahan (57,00), serta memproyeksikan PCI turun dari 80,58 pada 2025 menjadi 62,35 pada 2035. Disimpulkan bahwa model digitasi valid dan efektif menggantikan pembacaan kurva manual, sedangkan Model II valid secara lintas *sample unit* meskipun masih memerlukan validasi temporal prospektif. Kedua model diintegrasikan dalam prototipe untuk melengkapi fungsi *performance prediction* pada APMS.

Kata kunci: *Airport Pavement Management System*, *Pavement Condition Index*, digitasi *deduct value*, *Markov chain*, *Runway* 07L-25R Bandar Udara Internasional Soekarno-Hatta

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ABSTRACT

The existing Airport Pavement Management System (APMS) at Soekarno-Hatta International Airport remains descriptive and does not provide pavement condition predictions, as recommended by the Federal Aviation Administration (FAA) and required under PR-DJPU Regulation No. 3 of 2026. In addition, manual Pavement Condition Index (PCI) calculation relies on interpreting the Deduct Value (DV) and Corrected Deduct Value (CDV) curves in ASTM D5340-12, which is time-consuming and subjective. This study evaluates the existing APMS and develops and validates DV/CDV curve digitization and pavement condition prediction models for Runway 07L-25R.

The study uses APMS documents and PCI data from 360 sample units for 2020–2023 and 2025. A layered gap analysis evaluates APMS compliance with FAA guidance, PR-DJPU Regulation No. 3 of 2026, and ICAO references. Forty-one DV curves and CDV curves for five q values were digitized using OriginPro, fitted with polynomial and piecewise polynomial equations, implemented in a Microsoft Excel prototype, and validated against manual calculations and PAVER. Two Markov chain models were developed: Model I, based on annual transitions from 2020 to 2023, and Model II, based on two-year transitions from 2023 to 2025. Both models were validated using 2-fold cross-validation by sample unit against actual 2025 conditions.

Six of the ten FAA criteria were met, two were partially met, and two were not met. All three APMS evaluation frameworks identified performance prediction as the principal gap. The prototype yielded a runway PCI of 79.86, compared with 80.29 from PAVER, with differences of less than two PCI points for every sample unit and 96.9% category agreement. Model I exhibited unstable transition probabilities across periods, whereas Model II achieved a mean absolute error (MAE) of 24.83 sample units, lower than Model I (34.88) and the no-change baseline (57.00), and projected PCI to decline from 80.58 in 2025 to 62.35 in 2035. The digitization model was considered valid and effective as an alternative to manual curve interpretation. Model II was valid across sample units, although prospective temporal validation remains necessary. Both models were integrated into the prototype to support performance prediction within APMS.

***Keywords**: Airport Pavement Management System, Pavement Condition Index, deduct value digitization, Markov chain, Runway 07L-25R Soekarno-Hatta International Airport*