ABSTRAK

Proses seleksi pemain dalam *Football Manager 2024* memerlukan pertimbangan atas berbagai atribut teknis dan finansial yang kompleks. Sistem rekomendasi bawaan gim belum sepenuhnya mampu mengakomodasi kebutuhan taktis pelatih secara spesifik. Untuk itu, diterapkan pendekatan berbasis data dengan menggabungkan metode *content-based filtering* dan klasterisasi menggunakan algoritma *K-Means* dan *Gaussian Mixture Model* (GMM). Dataset yang digunakan mencakup 5.290 pemain dengan atribut teknis, fisik, mental, nilai transfer, dan gaji. Reduksi dimensi dilakukan menggunakan *Principal Component Analysis* (*PCA*) untuk menyederhanakan representasi data.

Model *K-Means* menghasilkan struktur klasterisasi yang lebih baik dengan nilai *silhouette score* tertinggi sebesar 0,875. Sementara itu, *GMM* mencatat skor tertinggi hanya sebesar 0,498. Meskipun demikian, sistem rekomendasi berbasis *GMM* menunjukkan hasil yang lebih unggul dalam konteks relevansi terhadap batas nilai transfer dan gaji. Nilai rata-rata *precision, recall, f1-score* dan *NDCG* pada *GMM* mencapai 0,929 untuk skor *precision*, *recall* sebesar 0,662, *f1-Score* sebesar 0,731, dan *NDCG* sebesar 0,975, lebih baik dibandingkan *K-Means* yang masing-masing memperoleh *precision* 0,813, *recall* 0,603, *f1-Score* 0,656, dan *NDCG* 0,839. Selain itu, skor *precision*, *recall*, *F1-score*, dan *NDCG* pada *GMM* juga lebih tinggi dan stabil di berbagai kombinasi parameter.

Perbandingan hasil menunjukkan bahwa nilai *silhouette score* yang lebih tinggi pada *K-Means* tidak menghasilkan rekomendasi yang lebih baik dibandingkan *GMM. K-Means* menghasilkan klaster yang lebih terpisah dengan baik menurut pengukuran *silhouette score*, tetapi *GMM* menghasilkan rekomendasi dengan kualitas yang lebih tinggi berdasarkan seluruh metrik evaluasi.

Kata Kunci: *K-Means, Gaussian Mixture Model,* Sistem Rekomendasi, *Football Manager 2024*, *Content-Based Filtering.*

ABSTRACT

The player selection process in Football Manager 2024 requires consideration of various complex technical and financial attributes. The game's built-in recommendation system is not yet fully capable of accommodating the coach's specific tactical needs. Therefore, a data-driven approach was implemented by combining content-based filtering and clustering methods using the K-Means and Gaussian Mixture Model (GMM) algorithms. The dataset used includes 5,290 players with technical, physical, mental, transfer value, and salary attributes. Dimensionality reduction was performed using Principal Component Analysis (PCA) to simplify the data representation.

The K-Means model produced a better clustering structure with the highest silhouette score of 0.875. Meanwhile, GMM recorded its highest score at 0.498. Nevertheless, the GMM-based recommendation system showed superior results in terms of relevance to transfer value and salary limits. The average precision, recall, F1-score, and NDCG on GMM reached 0.929 for precision, 0.662 for recall, 0.731 for F1-score, and 0.975 for NDCG — outperforming K-Means, which achieved precision of 0.813, recall of 0.603, F1-score of 0.656, and NDCG of 0.839. In addition, the precision, recall, F1-score, and NDCG scores of GMM were also higher and more stable across various parameter combinations.

The comparison shows that the higher silhouette score of K-Means does not result in better recommendations compared to GMM. K-Means produced better-separated clusters according to the silhouette score measurement, but GMM generated higher-quality recommendations based on all evaluation metrics.

Keyword: K-Means, Gaussian Mixture Model, Recommender System, Football Manager 2024, Content-Based Filtering.