ABSTRAK

Sampah Bahan Berbahaya dan Beracun (B3) rumah tangga berpotensi menimbulkan dampak negatif terhadap lingkungan dan kesehatan apabila tidak dipilah dan dikelola dengan tepat. Salah satu tantangan dalam klasifikasi citra sampah B3 adalah mengurangi kesalahan klasifikasi yang mengategorikan sampah B3 sebagai non-B3, karena kesalahan klasifikasi yang mengategorikan sampah B3 sebagai non-B3 dapat menyebabkan penanganan sampah yang tidak tepat. Penelitian ini bertujuan membangun model klasifikasi citra sampah rumah tangga berbasis *transfer learning* menggunakan arsitektur EfficientNet-B0 dengan pendekatan mitigasi risiko untuk menekan kesalahan klasifikasi pada kelas B3. Penelitian menerapkan beberapa strategi, yaitu *fine-tuning* bertahap, *weighted Binary Cross Entropy* (*weighted* BCE), dan *class-aware attention*. Metodologi yang digunakan mengacu pada CRISP-DM hingga tahap *evaluation*. Pengujian dilakukan melalui lima skenario model menggunakan pendekatan *ablation study* untuk menganalisis kontribusi masing-masing strategi terhadap *accuracy*, *precision* B3, *recall* B3, *F1-score* B3, dan *false negative rate* (FNR) B3. Hasil penelitian menunjukkan bahwa model *class-aware attention* menghasilkan performa paling seimbang dengan *accuracy* sebesar 96,89%, *precision* B3 sebesar 96,48%, *recall* B3 sebesar 97,33%, *F1-score* sebesar 96,90%, serta FNR B3 terendah sebesar 2,67%. Hasil tersebut menunjukkan bahwa penerapan strategi mitigasi risiko efektif meningkatkan kemampuan model dalam mengidentifikasi sampah B3 sekaligus mengurangi kesalahan klasifikasi pada kelas tersebut.

Kata kunci: *class-aware attention*, *deep learning*, EfficientNet-B0, klasifikasi sampah, mitigasi risiko, sampah B3, *transfer learning*, *weighted* BCE.

ABSTRACT

Household Hazardous and Toxic Waste (B3) has the potential to cause negative impacts on the environment and human health if it is not properly sorted and managed. One of the challenges in B3 waste image classification is reducing misclassification errors that categorize B3 waste as non-B3, as such errors may lead to inappropriate waste handling. This study aims to develop a household waste image classification model based on transfer learning using the EfficientNet-B0 architecture with a risk mitigation approach to reduce classification errors in the B3 class. The research applies several strategies, including gradual fine-tuning, weighted Binary Cross Entropy (weighted BCE), and class-aware attention. The methodology follows the CRISP-DM framework up to the evaluation stage. Model testing was conducted through five model scenarios using an ablation study approach to analyze the contribution of each strategy based on accuracy, B3 precision, B3 recall, B3 F1-score, and B3 false negative rate (FNR). The results show that the class-aware attention model achieved the most balanced performance with an accuracy of 96.89%, B3 precision of 96.48%, B3 recall of 97.33%, F1-score of 96.90%, and the lowest B3 FNR of 2.67%. These results indicate that the implementation of risk mitigation strategies effectively improves the model's ability to identify B3 waste while reducing misclassification errors in the B3 class.

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Keywords: class-aware attention, deep learning, EfficientNet-B0, hazardous and toxic waste (B3), risk mitigation, transfer learning, waste classification, weighted BCE.