CHAPTER 4
RESNET-50 FOR WASTE IDENTIFICATION

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4.1 INTRODUCTION

The problem of waste management has become increasingly important in recent years due to the damage that waste causes to ecosystems and biodiversity. Human population growth, urbanisation, and consumption of consumer goods have led to a drastic increase in waste generated worldwide (Aulia et al., 2021). Its negative environmental impacts, including water and air pollution, reduction of natural habitats, and climate change, make effective waste management an urgent priority.

A 2016 World Bank report projects that global urban solid waste production will increase to around 3.4 billion tons annually by 2050. The World Bank report also shows that of the total municipal solid waste production of about 2.01 billion tons annually, at least 33% of it needs to be managed correctly, which can cause significant environmental damage (Kaza et al., 2018). Other official sources, such as the United Nations (UN), have also identified a substantial increase in global waste production. Indonesia is one of the countries with high levels of waste production. Data from the Indonesian Ministry of Environment and Forestry shows that in 2020, Indonesia produced more than 64 million tons of solid waste. This number reflects serious problems in waste management in Indonesia, including challenges in separating organic

and recyclable waste. Waste can cause pollution, spread disease, and harm wildlife (Yafi & Utaminingrum, 2022). To address these issues, it is essential to raise awareness, promote eco-friendly lifestyles, and develop innovative solutions for waste management. Coordinating global efforts to reduce and manage waste properly is also necessary.

Waste that is disposed of without proper sorting can lead to several problems. It is essential to separate organic waste from recyclable waste when managing waste. Organic waste includes food scraps, yard waste, and other materials that can be composted or digested. Recyclable waste contains materials that can be reprocessed into new products, such as paper, plastic, metal, and glass. Accurate and efficient separation between these two types of waste is an essential step in the waste management process, as it reduces waste ending up in landfills, increases recycling potential, and reduces environmental impact (Girsang et al., 2023). Efficient sorting is crucial for maximising recycling potential and achieving sustainability goals.

Increasing consumption leads to more complex waste streams with various materials and categories. Manual sorting needs to adapt to this evolving landscape. Computing technology and artificial intelligence (AI) have provided potential solutions to improve waste management. Advanced countries such as Austria, Germany, New Zealand, the United States, the United Kingdom, Japan, Singapore, Switzerland, South Korea, and Canada use AI to manage waste because it is efficient and can maximise resources (Fang et al., 2023). With the help of machine learning (ML) algorithms and computer vision, automated systems can be used to accurately identify and separate organic and recyclable waste (Ramsurrun et al., 2021). As such, this technology opens up opportunities to address the problem of inefficient or inaccurate separation that often occurs in traditional waste management facilities. Furthermore, AI can analyse vast amounts of waste data to identify trends, optimise sorting processes, and inform policy decisions, leading to a more sustainable and efficient waste management system.

One recent computer vision development uses deep learning (DL) models like ResNet-50. ResNet-50 is a highly advanced model in image

classification tasks (Suherman et al., 2023). Its profound ability to understand complex visual characteristics in images has excellent potential in identifying organic and recyclable waste. ResNet-50 can be used to develop more accurate and efficient waste separation systems, which can help us manage waste more sustainably.

This research focuses on the use of the ResNet-50 model in the identification of organic and recyclable waste. The report will utilise a dataset comprising around 22,000 waste images sourced from the Kaggle platform. This dataset includes various waste types often found in daily waste management. This study endeavours to create an accurate and efficient waste identification system applicable to waste management facilities, aiming to enhance waste management practices. Transfer learning techniques are employed, utilising the ResNet-50 model pre-trained on external datasets as the foundation. Moreover, model parameter tuning is conducted to enhance performance in waste identification tasks. Various tools and libraries, such as Flask and Numpy, are applied to facilitate model deployment and interactive testing.

4.2 RELATED WORKS

Organic and recyclable waste can be classified using transfer learning methods with various architectures such as ResNet-50, VGG-16, Inception (GoogLeNet), MobileNet, DenseNet, and Xception. One of the transfer learning architectures that can work well for image classification problems is ResNet-50. Several studies on waste classification using ResNet-50 have shown significant progress in understanding and solving waste management problems. Some previous studies have adopted a robust ResNet-50 architecture to improve the accuracy of waste classification. Research by Stephen et al. (2019) using transfer learning models with several architectures such as VGG 16, Mobilenet V1, Inception V3, and Resnet 50 to identify the types of plastic, glass, and iron waste proved that the model with ResNet-50 gave the best prediction results compared to other architectures. In addition,