UNIVERSITI TEKNOLOGI MARA

PARAMETRIC STUDY ON MECHANICAL SEPARATION SYSTEM FOR TRASH REMOVAL FROM FRESH FRUIT BUNCHES (FFB) CONSIGNMENT IN PALM OIL MILLS

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ABSTRACT

This study addresses the persistent issue of trash contamination in fresh fruit bunch (FFB) consignments delivered to palm oil mills, which negatively impacts the oil extraction rate (OER) and the quality of crude palm oil (CPO). Trash, comprising sand, soil, stones, and vegetative matter, has been found to increase the free fatty acid (FFA) content and degrade the deterioration of bleachability index (DOBI) of CPO. These quality issues reduce the market value of the oil and limit its application potential. To solve this problem, a mechanical separation system (MSS) prototype was developed. The MSS, designed as a vibrating screen with gap sizes of 15, 30, and 45 mm, was tested for its effectiveness in removing trash from FFB consignments under both dry and wet conditions. Statistical analyses, including ANOVA and paired t-tests, confirmed the significant impact of gap size and environmental conditions on separation efficiency. Among the tested configurations, the 30 mm gap size provided the optimal balance between efficient trash removal and minimal loose fruit loss, thereby maximising overall milling performance. In addition, the MSS showed a strong positive correlation between trash removal and OER improvement, with 1.019% increase in OER observed following the implementation of the system. This study highlights the importance of efficient trash removal and separation in improving CPO quality, increasing OER, and promoting sustainable practices within the palm oil industry. Future research should focus on the economic feasibility analysis of large-scale MSS adoption, integration of automated monitoring systems, and comprehensive assessment of the downstream impacts of trash removal on refining and bleaching processes.

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CHAPTER 1
INTRODUCTION

1.1 Research Background

Malaysia is one of the world's leading producers of crude palm oil (CPO), contributing about 40% of the global supply [1,2]. The industry has experienced substantial growth, marked by the continuous expansion of plantation areas [3]. Furthermore, the number of palm oil mills increased substantially from 352 in 2001 to 453 in 2017, with significant growth occurring in East Malaysia [4]. However, this expansion has also raised critical challenges in maintaining processing efficiency and product quality. Malaysian palm oil mills process fresh fruit bunches (FFB) to extract CPO and palm kernel (PK). The annual CPO production is 18 million tons from 5.90 million hectares of cultivated land [5]. These two products contribute significantly to the country's economy.

The primary challenge lies in ensuring consistent FFB quality. The Malaysian Palm Oil Board (MPOB) has implemented grading standards to safeguard product quality [6], including penalties for substandard consignments. According to the MPOB grading standard manual, FFBs are categorized as either good or poor. A good bunch refers to ripe FFB, with high-quality oil content, whereas poor FFBs include underripe, rotten, empty, dirty, or old bunches, as well as dura types and bunches with long stalks. Unripe bunches are rejected and removed from FFB consignments.

The current quality assessment relies heavily on manual inspection by mill workers (Figure 1.1), who manually segregate unripe or rotten bunches and remove foreign materials [7]. This labour-intensive methodology is inefficient and prone to inconsistencies. As shown in Figure 1.2, trash is often embedded within the FFB consignment and mixed with loose fruit as well as non-palm oil matter. This condition requires additional workers to segregate trash from FFB consignments.