

INTISARI

Industri manufaktur memerlukan fasilitas yang mendukung kelancaran produksi. Salah satu aspek penting dalam efisiensi operasional adalah perencanaan tata letak fasilitas atau *Facility Layout Problem* (FLP) yang bertujuan mengurangi biaya penanganan material. Salah satu jenis FLP yang umum diterapkan adalah *Multi Row Layout Problem* (MRLP), yaitu penempatan departemen pada lebih dari dua baris untuk meminimalkan jarak perpindahan material. Namun, dalam praktiknya, penempatan fasilitas sering terkendala elemen *fixed position* seperti area bongkar muat, ruang kontrol, dan peralatan, yang menciptakan *unavailable area* atau area yang tidak dapat digunakan. Selain itu, aspek keselamatan kerja juga perlu diperhatikan karena berkaitan langsung dengan perlindungan tenaga kerja dan kelancaran operasional. Sayangnya, kedua aspek tersebut masih jarang dipertimbangkan secara eksplisit dalam penelitian terdahulu. Oleh karena itu, integrasi *unavailable area* dan keselamatan ke dalam model MRLP menjadi penting untuk dikaji lebih lanjut.

Penelitian ini mengembangkan model matematika MRLP dengan mempertimbangkan *unavailable area* dan faktor keselamatan. Model yang digunakan diklasifikasikan sebagai *Mixed Integer Nonlinear Programming* (MINLP) karena melibatkan variabel keputusan yang bersifat kontinu maupun bilangan bulat serta batasan yang bersifat nonlinear. Untuk menyelesaikan model ini secara optimal, digunakan metode eksak dengan bantuan solver Gurobi Optimizer, yang mampu mengevaluasi solusi secara menyeluruh berdasarkan fungsi objektif dan batasan yang ada.

Model yang dikembangkan berhasil menghasilkan solusi optimal yang memenuhi seluruh batasan serta telah lulus uji verifikasi dan *numerical study*. Hal ini membuktikan bahwa model mampu menangani kompleksitas MRLP dengan pertimbangan *unavailable area* dan aspek keselamatan. Namun, tingkat kompleksitas model menyebabkan waktu komputasi yang relatif lama sehingga perlu adanya pendekatan lanjutan atau metode alternatif untuk meningkatkan efisiensi penyelesaian di masa mendatang.

Kata kunci: *Facility Layout Problem (FLP)*, *Multi Row Layout Problem (MRLP)*, *fixed position*, *unavailable area*, keselamatan kerja, *Mixed Integer Nonlinear Programming (MINLP)*, Gurobi Optimizer

ABSTRACT

Manufacturing industries require facilities that support smooth production processes. One of the key aspects of operational efficiency is facility layout planning, known as the Facility Layout Problem (FLP), which aims to reduce the cost of material handling. A commonly applied type of FLP is the Multi Row Layout Problem (MRLP), which involves placing departments in more than two rows with the main objective of minimizing material movement distance. In practice, however, facility placement is often constrained by fixed position elements such as loading areas, control rooms, and equipment spaces, creating unavailable areas that cannot be used for facility placement. Additionally, workplace safety is another important factor to consider, as it is directly related to worker protection and smooth operations. Unfortunately, these two aspects—unavailable areas and safety—have rarely been explicitly addressed in previous studies. Therefore, integrating both into the MRLP model is essential for further investigation.

This study develops a mathematical model of MRLP that incorporates unavailable areas and safety factors. The model is classified as a Mixed Integer Nonlinear Programming (MINLP) model because it involves decision variables that are both continuous and integer, with nonlinear constraints. To solve the model optimally, an exact method is used with the help of the Gurobi Optimizer, which can evaluate solutions comprehensively based on the objective function and defined constraints.

The developed model successfully produces optimal solutions that satisfy all constraints and has passed verification and numerical studies. This demonstrates the model's capability to handle the complexity of MRLP while considering safety and unavailable area aspects. However, the high complexity of the model results in relatively long computation times, indicating the need for further research into alternative approaches or methods to improve computational efficiency in the future.

Keywords: Facility Layout Problem, Multi Row Layout Problem (MRLP), fixed position, unavailable area, safety factor, Mixed Integer Nonlinear Programming (MINLP)