Terbit *online* pada laman web jurnal : https://jes-tm.org/index.php/jestm/index

Journal of Engineering Science and Technology Management

| ISSN (Online) 2828 -7886 |

Article

Facility Layout Redesign Using Systematic Layout Planning: A Case Study of a Vocational Motorcycle Workshop in Indonesia

Rizwan Yuanda[1], Aris Fiatno[2], Deddy Gusman[3], Lailatul Syifa tanjung[4], R. Joko Musridho[5]

[1,2,3,4,5]Department of Industrial Engineering, Faculty of Engineering, Universitas Pahlawan Tuanku Tambusai, Indonesia

[*]E-mail: yuandarizwan05@gmail.com

ARTICLE INFORMATION

Volume 4 Issue 2
Received: 12 September 2024
Accepted: 29 September 2024
Publish *Online*: 30 September 2024
Online: at https:JESTM.org/

Keywords

Affective Design;
Kansei Engineering;
Project-Based Learning;
Student-Centered Learning

ABSTRACT

Efficient facility layout plays a critical role in improving operational performance, learning effectiveness, and occupational comfort in vocational education workshops. This study examines the redesign of a motorcycle engineering and business workshop at a public vocational high school in Indonesia using the Systematic Layout Planning (SLP) method. The existing layout exhibited inefficient material flow, excessive travel distances, and poor spatial organization, leading to fatigue among students and reduced instructional productivity. A qualitative descriptive case-study approach was employed, supported by direct observation, process mapping, and activity relationship analysis. The SLP procedure was applied through the development of Operation Process Charts, Activity Relationship Charts (ARC), Activity Relationship Diagrams (ARD), and block layout alternatives. The proposed layout demonstrates a substantial reduction in inter-facility travel distance and improved logical sequencing of learning activities. The findings confirm that SLP is an effective and adaptable approach for optimizing educational workshop layouts, contributing to improved operational efficiency and a safer, more conducive learning environment.

1. BACKGROUND

1.1 Introduction

Vocational education institutions are designed to prepare learners for direct engagement with professional and industrial environments. In this context, workshops function as the core learning infrastructure where theoretical knowledge is translated into practical competence. The effectiveness of a vocational workshop is therefore closely related not only to the availability of equipment and tools, but also to how spatial arrangements support workflow, safety, supervision, and learning continuity. Previous studies emphasize that inadequately planned practice facilities can reduce instructional effectiveness and increase physical and cognitive load on learners (Edi et al., 2017; Saleh, 2020).

In practice, many vocational school workshops evolve without systematic spatial planning. Facility placement is often adjusted incrementally to accommodate new equipment or changing instructional needs, resulting in layouts that do not reflect the logical sequence of operational processes. Such conditions frequently lead to inefficient movement patterns, congestion, and unnecessary backtracking. Research in facility planning highlights that poor layout design contributes to increased fatigue, time inefficiency, and reduced productivity, particularly in environments that rely heavily on manual activities (Rizkiyanto, 2019).

The Motorcycle Engineering and Business Workshop at SMKN 1 Kuok illustrates these challenges. Field observations revealed that the existing layout did not adequately consider the flow of motorcycle service operations. Workstations, tools, and supporting facilities were arranged without clear attention to process order or functional relationships. As a result, students were required to move repeatedly across the workshop during practice sessions, which disrupted learning focus and reduced the effective use of instructional time. Similar conditions have been reported in vocational practice spaces where layout planning is not guided by formal facility design principles (Nurnaningsih, 2021).

From an industrial engineering perspective, facility layout design is a strategic decision that influences long-term operational efficiency, safety, and flexibility. A well-designed layout facilitates smooth material flow, minimizes non-value-added movement, and supports effective supervision. Conversely, poorly designed layouts may create bottlenecks, intersecting movement paths, and unsafe working conditions (Dewi et al., 2017). These principles, although widely applied in industrial settings, are not always systematically implemented in educational workshops.

Systematic Layout Planning (SLP) offers a structured approach to addressing layout problems by integrating quantitative analysis of material flow with qualitative evaluation of activity relationships. The method emphasizes the importance of proximity between interrelated activities and seeks to minimize unnecessary movement while maintaining functional coherence. Previous applications of SLP in manufacturing and service environments demonstrate its effectiveness in reducing travel distance and improving process efficiency (Elvira et al., 2021; Kautsar et al., 2021).

Despite its proven effectiveness in industrial contexts, the application of SLP within vocational education workshops remains limited. Educational workshops share operational characteristics with small-scale manufacturing systems, including sequential processes, shared resources, and human-centered operations. This similarity indicates that SLP has strong potential to improve workshop layout design in educational institutions, particularly those aiming to align learning environments with real industrial practices.

1.2 Research Purposes

Based on these considerations, this study applies the Systematic Layout Planning method to redesign the Motorcycle Engineering and Business Workshop at SMKN 1 Kuok. The objective is to develop a layout that reduces unnecessary movement, improves workflow continuity, and enhances the effectiveness of practical learning activities without altering the core instructional functions of the workshop. By grounding the redesign process in established facility planning theory and empirical observation, this research contributes to the practical improvement of vocational education infrastructure and extends the application of SLP beyond conventional industrial settings.

2 LITERATURE REVIEW

Facility layout planning has long been recognized as a fundamental component of industrial engineering, with direct implications for efficiency, safety, and productivity. In educational workshop environments, particularly within vocational schools, layout design plays an equally critical role by shaping how learning activities are conducted, supervised, and experienced. This section reviews relevant literature on facility layout planning, Systematic Layout Planning (SLP), and their application in both industrial and educational contexts.

2.1 Facility Layout Planning

Facility layout planning refers to the systematic arrangement of physical resources such as machines, equipment, workstations, and supporting facilities within a given space to support operational objectives. Wisudawati et al. (2022) describe facility layout as an integrated design process that aligns spatial configuration with workflow requirements and human activities. Similarly, Adiasa et al. (2020) emphasize that effective layout planning seeks to optimize material flow, information flow, and human movement to achieve operational efficiency.

In practice, a well-designed layout minimizes unnecessary movement, reduces handling time, and improves coordination between activities. Sofyan and Syarifuddin (2015) argue that layout planning is not merely a technical arrangement of machines, but a strategic decision that influences long-term operational performance. Inadequate layouts may result in congestion, bottlenecks, and inefficient use of space, all of which negatively affect productivity and safety.

Within vocational education settings, facility layout planning assumes additional pedagogical significance. Workshop layouts must accommodate learning objectives, instructor supervision, and student interaction while maintaining safety standards. Saleh (2020) highlights that poorly organized practice spaces hinder students' ability to perform tasks efficiently and disrupt the learning process. Therefore, layout planning in educational workshops must balance industrial efficiency with instructional needs.

2.2 Objectives and Principles of Facility Layout

The primary objective of facility layout planning is to support smooth and continuous workflow. Asdi et al. (2016) identify several key goals of layout design, including increasing output, reducing waiting time, minimizing material handling distance, and improving workplace safety. These objectives are achieved by arranging facilities in accordance with process sequences and functional relationships.

Fundamental principles of layout planning include minimizing travel distance, ensuring logical process flow, maximizing space utilization, and providing flexibility for future changes. Dewi et al. (2017) note that layout flexibility is particularly important in environments subject to evolving operational requirements. In vocational workshops, flexibility allows institutions to adapt to curriculum updates, changes in equipment, and variations in student numbers.

Another essential principle concerns occupational health and safety. Effective layouts reduce the risk of accidents by separating incompatible activities and providing clear movement paths. Rizkiyanto (2019) emphasizes that excessive movement and intersecting paths increase physical fatigue and safety risks, especially in manual work environments.

2.3 Systematic Layout Planning (SLP)

Systematic Layout Planning is a structured methodology developed to address complex layout problems through a step-by-step analytical process. According to Yulia and Cahyana (2022), SLP integrates quantitative analysis of material flow with qualitative assessment of activity relationships. The method emphasizes understanding how closely different activities should be located based on operational, informational, and environmental considerations.

SLP employs several analytical tools, including Operation Process Charts, Activity Relationship Charts (ARC), Activity Relationship Diagrams (ARD), and space requirement analysis. Wignjosoebroto (2016) explains that these tools enable planners to visualize workflow patterns and identify opportunities to reduce unnecessary movement. Unlike purely distance-based methods, SLP incorporates qualitative judgments that reflect practical operational needs.

The structured nature of SLP makes it suitable for environments where multiple activities share limited space. Sihombing et al. (2021) argue that SLP supports systematic decision-making by ensuring that layout alternatives are evaluated consistently based on predefined criteria.

2.4 Empirical Applications of SLP

Numerous empirical studies demonstrate the effectiveness of SLP in improving facility performance. Elvira et al. (2021) report that the application of SLP in a manufacturing facility resulted in significant reductions in material handling distance and operational cost. Similarly, Kautsar et al. (2021) found that SLP-based layout redesign reduced weekly material handling distance and improved production efficiency in a small-scale industry.

Although most SLP applications focus on industrial settings, several studies suggest its relevance to non-industrial environments. Yoesoef (n.d.) applied SLP in a mail processing center and reported improved space utilization and workflow separation. These findings indicate that SLP is adaptable to service-oriented and human-centered environments.

However, research applying SLP specifically to vocational education workshops remains limited. Existing studies often address workshop management from an administrative or pedagogical perspective, with less emphasis on systematic spatial planning. This gap highlights the need for empirical studies that adapt industrial layout methodologies to educational practice environments.

2.5 Research Positioning

Based on the reviewed literature, facility layout planning is a critical factor influencing operational efficiency and learning effectiveness in vocational workshops. Systematic Layout Planning offers a comprehensive framework that aligns spatial arrangement with process requirements and activity relationships. Despite its proven effectiveness in industrial and service contexts, its application in vocational education remains underexplored.

This study positions itself at the intersection of industrial engineering and vocational education by applying SLP to redesign a motorcycle engineering workshop. By grounding the redesign process in established layout planning theory and empirical observation, the research seeks to extend the application of SLP while addressing practical challenges faced by vocational education institutions.

3 METHODOLOGY

3.1 Research Design

This study employed a qualitative descriptive case-study design to examine and improve the facility layout of a vocational education workshop. The descriptive approach was selected to capture existing spatial conditions, operational activities, and workflow characteristics in their natural setting. Case-study methodology is appropriate for layout planning research because it allows in-depth analysis of a specific facility while maintaining contextual accuracy.

The research focused on developing an improved layout rather than testing hypotheses or measuring causal relationships. The redesign process was grounded in empirical observation and guided by the Systematic Layout Planning (SLP) framework, which integrates qualitative and quantitative considerations in facility layout design.

3.2 Research Site and Object

The research was conducted at the Motorcycle Engineering and Business Workshop of SMKN 1 Kuok, located in Kampar Regency, Riau Province, Indonesia. The workshop serves as a practical training facility for vocational students specializing in motorcycle maintenance and service. The object of the study comprised all physical facilities within the workshop, including workstations, equipment, storage areas, and supporting spaces involved in practical learning activities.

Figure 1 SMK N 1 Kuok

3.3 Data Types and Sources

Data used in this study consisted of primary and secondary data.

Primary data were obtained through direct observation of workshop activities, measurement of facility dimensions, identification of equipment locations, and documentation of student movement during practice sessions. Observations focused on operational sequences, interaction between workstations, and frequency of movement between activity areas.

Secondary data were collected from institutional documents, workshop layout drawings, photographs, and relevant literature. These data provided contextual information regarding workshop functions, space availability, and instructional requirements.

Tabel 1 Fasilitas Workshop Teknik dan Bisnis Sepeda Motor SMK N 1 Kuok

No.	Workshop Facility	Length (cm)	Width (cm)	Quantity
1	Welding Machine	29	22	1
2	Bench Vise	40	15	1
3	Toolbox	45	25	4
4	Air Compressor	88	40	1
5	Motorcycle	193	66	4
6	Bike Lift	190	60	4
7	Instructor's Desk	120	60	1
8	Workbench	200	100	1
9	Used Oil Container	30	35	1
10	Electrical Wiring Diagram Board	128	60	1
11	Special Tools Stand	19.7	12	2

3.4 Data Collection Techniques

Data collection was carried out through systematic observation, informal interviews with workshop instructors, and documentation review. Observations were conducted during active practice sessions to ensure that recorded movement patterns reflected actual learning conditions. Measurements of distances and space requirements were performed using standard measuring tools to ensure accuracy.

Process mapping techniques were applied to document the sequence of motorcycle service activities. An Operation Process Chart was developed to represent the flow of practical tasks, serving as the basis for subsequent layout analysis.

3.5 Layout Analysis Procedure Using SLP

The Systematic Layout Planning procedure was implemented through the following stages:

1. Analysis of operational processes using an Operation Process Chart to identify task sequences.
2. Identification of activity relationships and development of an Activity Relationship Chart (ARC) based on qualitative closeness ratings.
3. Transformation of ARC into an Activity Relationship Diagram (ARD) to visualize interdependencies between activities.

4. Determination of space requirements for each functional area.
5. Development of alternative block layouts consistent with spatial constraints.
6. Evaluation and selection of the most feasible layout based on workflow continuity and movement efficiency.

3.6 Data Analysis and Evaluation

Data analysis emphasized comparison between the existing layout and the proposed layout. Evaluation criteria included logical process flow, reduction of unnecessary movement, and functional coherence between activity areas. The selected layout alternative was the one that best satisfied these criteria while remaining feasible within the available space.

4 RESULTS AND DISCUSSION

4.1 Existing Layout Condition

The evaluation of the existing workshop layout indicates that the spatial arrangement of facilities did not reflect the logical sequence of motorcycle service operations. Several workstations that were functionally interconnected—such as diagnostic, repair, and testing areas—were positioned at considerable distances from one another. As a consequence, students were required to move repeatedly across the workshop during a single service task, resulting in frequent backtracking and intersecting movement paths.

Figure 2 *Existing Workshop Layout*

Figure 2 (Existing Workshop Layout) illustrates the initial spatial configuration of the Motorcycle Engineering and Business Workshop. The figure clearly shows the absence of structured zoning between core service areas, storage facilities, and supporting functions. The lack of spatial hierarchy caused congestion, particularly during peak practice sessions when multiple students operated simultaneously. This condition increased physical fatigue and reduced the effective duration of hands-on learning activities.

From an operational perspective, the existing layout generated non-value-added movement that did not contribute to task completion. Similar layout-related inefficiencies have been identified in manual and semi-manual work environments where facility planning is not systematically implemented (Rizkiyanto, 2019). In an educational context, such inefficiencies not only affect productivity but also disrupt learning focus and instructor supervision.

4.2 Analysis of Operational Processes

Operational activities within the workshop were analyzed using an Operation Process Chart to identify task sequences, decision points, and movement patterns during motorcycle servicing. The analysis revealed that several operational stages—particularly between diagnosis, repair, and functional testing—were separated spatially, leading to unnecessary travel distances.

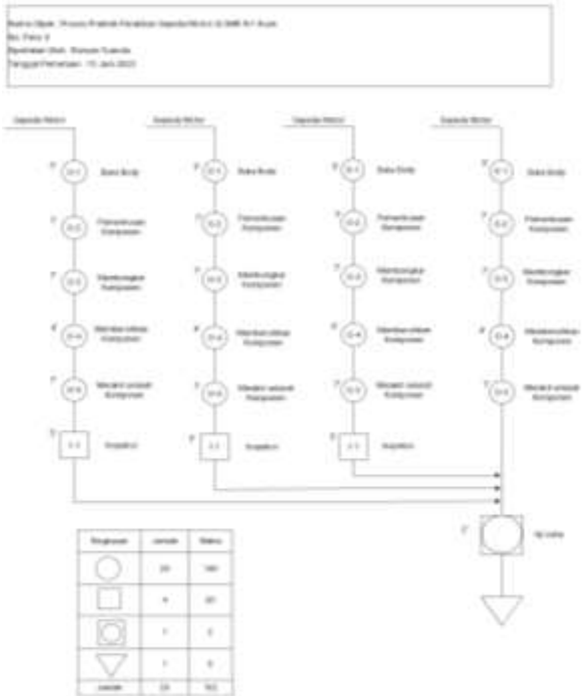

Figure 3 Peta Proses Operasi

Figure 3 (Operation Process Chart) presents the sequence of motorcycle service activities observed during practical sessions. The chart demonstrates that the process flow was logically structured at the task level; however, this logical sequence was not supported by the physical layout of the workshop. As a result, students were required to move back and forth between distant workstations to complete consecutive tasks.

The mismatch between process order and facility placement highlights a critical gap between operational logic and spatial design. This finding underscores the importance of aligning physical layout with process flow, particularly in environments where learning effectiveness depends on continuity and repetition of practical tasks.

4.3 Activity Relationship Analysis

To address spatial inefficiencies, activity relationships between workshop areas were evaluated using qualitative closeness ratings. The analysis considered functional dependency, frequency of interaction, safety requirements, and instructional supervision needs. Strong relationships were identified between diagnostic, repair, and testing activities, indicating the necessity of close spatial proximity.

Table 2. Activity Relationship Chart (ARC)

Activity Pair	Closeness Rating	Main Reason
Diagnosis – Repair	A	Sequential workflow
Repair – Testing	A	Process continuity
Storage – Service Area	X	Safety and cleanliness
Instructor Desk – Service Area	E	Supervision
Oil Waste Area – Service Area	X	Health and safety

Table 2 (Activity Relationship Chart) summarizes the qualitative closeness ratings between workshop activities. The table shows that core service functions exhibited high interdependence, while supporting activities such as storage and administrative functions required separation to minimize interference with practical work.

Based on the ARC results, an Activity Relationship Diagram was developed to visualize these interdependencies.

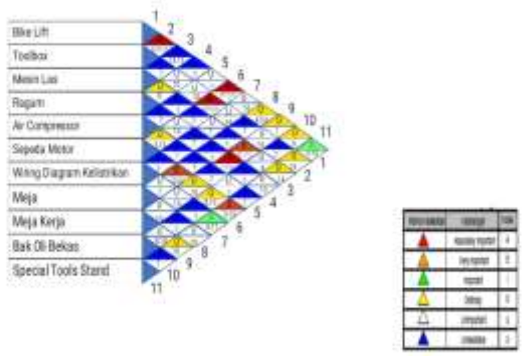

Figure 4 (Activity Relationship Diagram

Figure 4 (Activity Relationship Diagram) translates the qualitative relationship data into a spatial representation. The diagram emphasizes the need to cluster closely related service activities while maintaining clear boundaries between active work zones and supporting facilities. This visualization served as a critical reference for developing layout alternatives under the Systematic Layout Planning framework.

4.4 Proposed Layout Design Using SLP

Using the Activity Relationship Diagram and space requirement data, several alternative layouts were generated. Each alternative was evaluated based on workflow continuity, movement efficiency, and feasibility within the existing workshop space. The selected layout prioritized sequential arrangement of service activities and minimized intersecting movement paths.

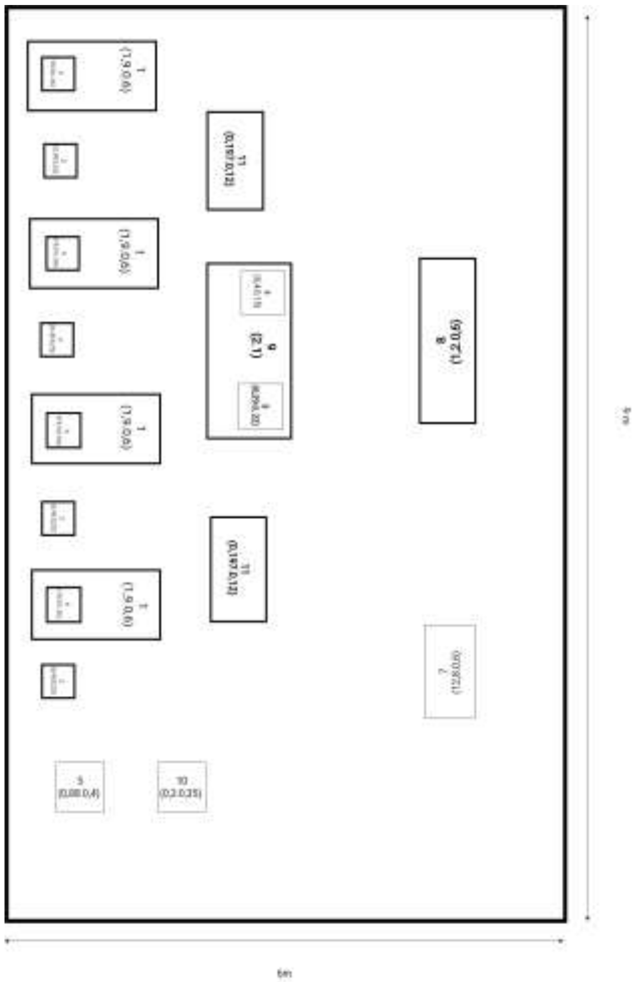

Figure 5 (Proposed Workshop Layout)

Figure 5 (Proposed Workshop Layout) presents the final layout configuration produced through the SLP procedure. Compared to the existing layout, the proposed design demonstrates clearer functional zoning, improved alignment with service processes, and enhanced visibility for instructor supervision. Diagnostic, repair, and testing areas are positioned in close proximity, allowing students to complete tasks with minimal unnecessary movement.

The redesigned layout also improves safety by reducing crossing paths and congestion. From a pedagogical perspective, the proposed arrangement supports smoother task transitions and sustained learning focus during practical sessions.

4.5 Comparison Between Existing and Proposed Layouts

A comparative evaluation was conducted to assess the effectiveness of the redesigned layout. The primary evaluation criterion was total travel distance during motorcycle service activities, as excessive movement was identified as a major source of inefficiency in the existing layout.

Table 3 (Comparison of Travel Distance Between Existing and Proposed Layouts)

No.	Product	Process Route	Material Handling Method	Travel Distance (m)
1	Motorcycle	A – B	Manual	3
2	Motorcycle	A – C	Manual	4
3	Motorcycle	A – D	Manual	5
4	Motorcycle	A – E	Manual	6
	Total			**18**

Table 3 (Comparison of Travel Distance Between Existing and Proposed Layouts) presents the reduction in movement distance achieved through the SLP-based redesign. The results indicate a substantial decrease in total travel distance, confirming that the proposed layout significantly improves operational efficiency.

Reduced movement distance contributes directly to lower physical fatigue, improved time utilization, and enhanced safety conditions. In a learning environment, these improvements translate into longer effective practice time and better instructional outcomes.

4.6 Discussion

The results demonstrate that Systematic Layout Planning is effective in addressing spatial inefficiencies within vocational education workshops. By integrating qualitative activity relationships with process flow analysis, the redesigned layout aligns physical space with operational and instructional requirements.

These findings are consistent with previous studies reporting efficiency improvements following SLP implementation in industrial contexts (Elvira et al., 2021; Kautsar et al., 2021). However, this study extends existing literature by confirming that SLP is equally applicable in educational workshop environments, where human movement, safety, and learning continuity are central considerations.

Improved spatial organization reduces physical strain on students, enhances instructor supervision, and supports smoother workflow during practical activities. The findings reinforce the importance of systematic facility planning as an integral component of vocational education infrastructure development, rather than a purely technical or secondary concern.

5 CONCLUSION

This study demonstrates that the application of Systematic Layout Planning provides a structured and effective approach for improving facility layout in vocational education workshops. The analysis of the existing layout revealed that facility placement did not adequately support the logical sequence of motorcycle service activities, resulting in unnecessary movement, congestion, and reduced effectiveness of practical learning sessions.

Through the systematic evaluation of operational processes and activity relationships, the proposed layout reorganizes workshop facilities based on functional interdependencies and workflow continuity. The redesigned layout reduces excessive travel distance between key service areas and establishes clearer functional zoning, allowing practical activities to be conducted more efficiently and safely. These improvements support smoother task transitions, better instructor supervision, and more focused student engagement during practice sessions.

The findings indicate that layout planning should be regarded as an integral component of vocational education infrastructure, rather than a secondary technical consideration. By aligning spatial design with operational and instructional requirements, vocational institutions can enhance both operational efficiency and learning quality. The results also confirm that Systematic Layout Planning, although widely applied in industrial settings, is equally relevant for educational workshop environments that share similar process-oriented characteristics.

Overall, this study contributes empirical evidence that systematic facility layout redesign can improve the effectiveness of vocational training environments. The approach presented in this research may serve as a practical reference for vocational schools seeking to optimize workshop layouts in alignment with real-world industrial practices.

References

Adiasa, I., Suarantalla, R., Rafi, M. S., & Hermanto, K. (2020). Perancangan Ulang Tata Letak Fasilitas Pabrik Di CV. Apindo Brother Sukses Menggunakan Metode Systematic Layout Planning (SLP). Performa: Media Ilmiah Teknik Industri, 19(2). https://doi.org/10.20961/performa.19.2.43467

Aji Pradana, S., Hasan, M. T., & Handayani, N. (2020). Perancangan Sistem Penjadwalan Produksi Kaos Sablon Dengan Metode Earliest Due Date Pada Usaha Konveksi Nolabel Sablon Langsa.

Asdi, Abdullah, I., & Pahira. (2016). Analisis Tata Letak Fasilitas Produksi Pada Proses Produksi Mie Telor UD Sumber Rezeki di Kota Makassar. 355–363.

Dewi, R. K., Choiri, M., & Eunike, A. (2017). Perancangan Tata Letak Fasilitas Menggunakan Metode Blocplan dan Analytic Hierarchy Process (AHP) (Studi Kasus: Koperasi Unit Desa Batu). Jurnal Rekayasa Dan Manajemen Sistem Industri, 2(3), 624–636.

Edi, S., Suharno, S., & Widiastuti, I. (2017). Pengembangan Standar Pelaksanaan Praktik Kerja Industri (Prakerin) Siswa Smk Program Keahlian Teknik Pemesinan Di Wilayah Surakarta. Jurnal Ilmiah Pendidikan Teknik Dan Kejuruan, 10(1), 22. https://doi.org/10.20961/jiptek.v10i1.14972

Elvira, L., Suhardi, B., & Astuti, R. D. (2021). Perancangan Ulang Tata Letak Fasilitas Menggunakan Metode Systematic Layout Planning Pada PT Pilar Kekar Plasindo. Tekinfo: Jurnal Ilmiah Teknik Industri Dan Informasi, 9(1), 34–46. https://doi.org/10.31001/tekinfo.v9i1.870

Fajri, A. (2021). Perancangan Tata Letak Gudang Dengan Metode Systematic Layout Planning. Ejournal.Uin-Suska.Ac.Id, 7(1), 2021. http://ejournal.uinsuska.ac.id/index.php/jti/article/view/10533

Kautsar, F., Zaman, M. Z., & Wiati, N. M. (2021). Analisis Dan Perancangan Ulang Tata Letak Fasilitas Produksi Dengan Metode Systematic Layout Planning. Journal of Industrial View, 3(2), 55–63. https://doi.org/10.26905/jiv.v3i2.6678

Khairani Sofyan, D., & Syarifuddin. (2015). Perancangan Ulang Tata Letak Fasilitas dengan Menggunakan Metode Konvensional Berbasis 5S (Seiri, Seiton, Seiso, Seiketsu dan Shitsuke). Jurnal Teknovasi, 02(2), 27–41.

Lubis, A. H. (2022). Usulan Perancangan Tata Letak Pabrik dengan Metode Systematic Layout Planning di CV Suka Bersama. Universitas Medan Area.

Muslim, D., & Ilmaniati, A. (2018). Perbaikan Tata Letak Fasilitas Terhadap Optimalisasi Jarak dan Ongkos Material Handling Dengan Pendekatan Systematic layout planning (SLP) di PT Transplant. Jurnal.Unsur.Ac.Id. vol 2(1): 45–52. https://jurnal.unsur.ac.id/jmtsi/article/view/327.

Oki Rizkiyanto, Ratih Setyaningrum, J. (2019). Usulan Perbaikan Tata Letak Ruang Perkantoran Fakultas Teknik Menggunakan Metode CORELAP (Computerized Relationship Layout Planning). Seminar Nasional Teknik Industri Universitas Gadjah Mada, 2016, 60–64.

Oksa Rizaldy Wiratama, A., Susetyo*, J., & Adelina Simanjuntak, R. (2021). Usulan Penataan Ulang Tata Letak Fasilitas Dengan Metode Systematic Layout Planning (SLP) dan Class Based Storage. Jurnal Teknologi, 15(1), 68–76. https://doi.org/10.34151/jurtek.v15i1.3964

Oktaviana, A., & Seto, B. (2017). Perancangan tata letak mesin produksi untuk mengurangi biaya material handling pada industri logam. Gaung Informatika, 10(3), 163–173.

Putra, A., & Muslimin, M. (2021). Tata Letak untuk Meningkatkan Efisiensi Pada Perusahaan Furniture XYZ Dengan Metode ARC (Activity Relationship Chart) Dan ARD (Activity Relationship Diagram... Ejournal-Unipra.Com. vol (3). https://ejournal-unipra.com/index.php/jer/article/view/182

Putra, B. I., & Jakaria, R. B. (2020). Buku Ajar Analisa dan Perancangan Sistem Kerja.

Putri, R. E., & Ismanto, W. (2019). Pengaruh Perancangan Ulang Tata Letak Fasilitas Di Area Operasional Kerja Berbasis 5S Untuk Pengajuan Modal Usaha. Jurnal Dimensi, 8(1), 71–89. https://doi.org/10.33373/dms.v8i1.1824

Saleh, Y. S. (2020). Manajemen Sarana Dan Prasarana Di Sekolah Menengah Kejuruan Amaliyah Sekadau. Jurnal Al-Amin – Kajian Pendidikan Dan Sosial Kemasyarakatan, 5(1), 14–37.

Sihombing, E. I. N. T., Manik, Y., & Siboro, B. A. H. (2021). Perancangan Tata Letak Fasilitas Pada Rumah Produksi Taman Eden 100. JISI: Jurnal Integrasi Sistem Industri, 8(2), 77. https://doi.org/10.24853/jisi.8.2.77-86

Sulistyo, A., & Hargiyarto, P. (2019). Pengembangan Tata Letak Bengkel dan Program Praktik Fabrikasi Logam di SMK N 1 Seyegan. Jurnal Dinamika Vokasional Teknik Mesin, 4(1), 18–23. https://doi.org/10.21831/dinamika.v4i1.24277

Simatupang, J. (2020). Relayout Lantai Produksi PT. Gunung Selamat Lestari Dengan Metode SLP dan CORELAP. Jurnal.Unprimdn.Ac.Id. http://jurnal.unprimdn.ac.id/index.php/juriti/article/view/1314

Wisudawati, T., Agusti, F., Utomo, W. P., & Wicaksono, F. (2022). Pendampingan Dalam Penataan Letak Fasilitas Di UMKM Fuji Rotan Trangsan Gatak Sukoharjo. Fordicate, 1(2), 141–149. https://doi.org/10.35957/fordicate.v1i2.2408

Yoesoef, R. A. (n.d.). (Mail Post Center) Pt Pos Indonesia , Semarang Menggunakan Systematic Layout Planning Dan Class Based Storage.

Yulia, N. T., & Cahyana, A. S. (2022). Facility Relayout Using Systematic Layout Planning and Blocplan Methods to Minimize Material Handling Distance Relayout Fasilitas Menggunakan Metode Systematic Layout Planning dan Blocplan Guna Meminimasi Jarak Material Handling. Procedia of Engineering and Life Science, 2(2).