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MRP-JIT Material Planning Model to Minimize Delay Risk in SDP Panel Production

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Abstrak
PT Kimindo Jaya Indonesia merupakan perusahaan manufaktur panel listrik yang menerapkan sistem Make-to-Order dalam proses produksinya. Salah satu permasalahan utama yang dihadapi perusahaan adalah keterlambatan material pada produksi Sub Distribution Panel (SDP), karena beberapa komponen kritis belum tersedia sesuai jadwal perakitan. Penelitian ini bertujuan untuk mengembangkan model perencanaan material terintegrasi Material Requirement Planning dan Just-in-Time (MRP-JIT) untuk meminimalkan risiko keterlambatan pada produksi panel SDP. Penelitian ini menggunakan pendekatan deskriptif kuantitatif dengan data produksi periode Januari sampai Juni 2025. Data yang digunakan meliputi jumlah produksi, Bill of Materials, persediaan awal, safety stock, scheduled receipt, lead time pemasok, jadwal perakitan, dan data historis keterlambatan material. Pengolahan data dilakukan melalui perhitungan gross requirement, net requirement, Lot-for-Lot, planned order receipt, planned order release, dan sinkronisasi kedatangan material berbasis JIT. Kondisi aktual menunjukkan 10 kasus keterlambatan material dengan total keterlambatan 43 hari dan rata-rata 4,3 hari per kasus. Model yang diusulkan menjadwalkan pemesanan berdasarkan lead time pemasok dan menargetkan kedatangan material satu sampai dua hari sebelum perakitan. Hasil penelitian menunjukkan bahwa model MRP-JIT dapat mendukung perubahan pola pengadaan dari pembelian reaktif menjadi perencanaan material preventif.

Kata Kunci : Just-in-Time, Keterlambatan material, Make-to-Order, Material Requirement Planning, Sub Distribution Panel

Abstract
PT Kimindo Jaya Indonesia is an electrical panel manufacturing company that applies a Make-to-Order production system. One of the main problems faced by the company is material delay in Sub Distribution Panel (SDP) production, because several critical components are not available according to the assembly schedule. This study aims to develop an integrated Material Requirement Planning and Just-in-Time (MRP-JIT) material planning model to minimize delay risk in SDP panel production. This research used a descriptive quantitative approach with production data from January to June 2025. The data included production quantity, Bill of Materials, initial inventory, safety stock, scheduled receipts, supplier lead time, assembly schedule, and historical material delay data. Data processing was conducted through gross requirement calculation, net requirement calculation, Lot-for-Lot sizing, planned order receipt, planned order release, and JIT-based material arrival synchronization. The actual condition showed 10 material delay cases, with a total delay of 43 days and an average delay of 4.3 days per case. The proposed model scheduled material orders based on supplier lead time and targeted material arrivals one to two days before assembly. The results indicate that the MRP-JIT model can support the shift from reactive purchasing to preventive material planning.

Keywords : *Just-in-Time, Make-to-Order, Material delay, Material Requirement Planning, Sub Distribution Panel*

1. Introduction.

Project-based manufacturing requires companies to produce customized products while maintaining reliable delivery schedules. In this environment, the Make-to-Order (MTO) system is widely applied because production activities start after customer orders are confirmed. This system provides flexibility in product specifications and order quantities, but it also increases the complexity of production scheduling, material procurement, and supply chain coordination, especially when demand changes across planning periods (Lienardo & Jin, 2020). In electrical panel manufacturing, this challenge becomes more critical because production activities depend on the availability of various electrical components that must be prepared according to project schedules (Septriani et al., 2021).

Sub Distribution Panel (SDP) production is one example of project-based manufacturing that requires accurate material planning. An SDP panel consists of several critical components, such as panel boxes, Molded Case Circuit Breakers (MCCBs), Miniature Circuit Breakers (MCBs), magnetic contactors, relays, overload relays, NYAF cables, busbars, indicator lamps, and digital meters. The unavailability of one critical component can interrupt assembly preparation, component installation, wiring, functional testing, and final completion. Therefore, inaccurate material planning may increase the risk of stock-outs, urgent purchasing, production rescheduling, and project delays (Utami Rahmawati et al., 2022; Kamila & Momon, 2024).

Previous studies have shown that Material Requirement Planning (MRP) can support material planning by converting production demand into detailed component requirements. MRP uses the master production schedule, Bill of Materials (BOM), inventory records, scheduled receipts, safety stock, and supplier lead time to determine gross requirements, net requirements, planned order receipts, and planned order releases (Utami Rahmawati et al., 2022). Several studies have applied MRP in different production and project environments, including raw material inventory control (An-nisa et al., 2024), high-rise building material planning (Awati & Dita Putra, 2024), lot-sizing evaluation in construction material logistics (Simanjuntak & Mardiaman, 2025), dock construction material planning (Syofrial, 2021), and production planning in food manufacturing (Br Ginting et al., 2024). These studies indicate that MRP can improve material requirement accuracy and reduce the risk of material shortages.

In addition to quantity planning, material arrival timing is also important. MRP can determine what materials are required and when orders should be released, but it does not automatically ensure that materials arrive close to the actual time of use. If materials arrive too early, inventory and storage requirements may increase. If materials arrive late, production activities can be disrupted. The Just-in-Time (JIT) approach can complement MRP by synchronizing material arrivals with the production schedule, reducing unnecessary inventory, and supporting continuous production flow (Tren et al., 2025; Jannah et al., 2025). Other studies on JIT also show that timely material delivery can improve inventory efficiency, but its effectiveness depends on supplier reliability, delivery consistency, and demand stability (Wan et al., 2025; Indrawan et al., 2025).

Recent research has started to discuss the integration of material requirement planning and delivery synchronization. Hybrid MRP-JIT systems have been studied under demand uncertainty to improve the relationship between requirement calculation and material arrival timing (Utomo et al., 2020). Mixed procurement optimization for MRP and JIT also shows that both approaches can be combined to support procurement decision-making by balancing quantity accuracy and delivery synchronization (Farhang Zad et al., 2024). These findings indicate that MRP and JIT have complementary roles in material planning. MRP provides the basis for calculating material quantities and order release dates, while JIT focuses on aligning material arrivals with production needs.

However, most previous studies still discuss MRP and JIT separately. MRP studies generally emphasize inventory control, lot-sizing decisions, and raw material requirement calculations, while JIT studies mainly discuss inventory reduction and timely delivery. Research that integrates MRP and JIT in Make-to-Order electrical panel production remains limited, even though this industry has specific characteristics, such as fluctuating project demand, multilevel BOM structures, multiple critical components, and supplier lead time uncertainty (Indra Jaya et al., 2025). This condition creates a research gap in the development of a material planning model that combines quantity accuracy from MRP with arrival synchronization from JIT in SDP panel production.

PT Kimindo Jaya Indonesia is an electrical contractor and panel manufacturer that produces SDP units based on customer orders. Company records from January to June 2025 showed that SDP production fluctuated from month to month and material delays occurred repeatedly during the observation period. The monthly production volume and material delay condition are presented in Table 1.

Table 1. SDP production volume and material delays from January to June 2025

Month	SDP production (units)	Delay cases	Total delays (days)	Average delay (days/case)
January	11	2	7	3.5
February	8	2	9	4.5
March	6	2	9	4.5
April	12	1	5	5.0
May	10	2	9	4.5
June	12	1	4	4.0
Total/Average	59	10	43	4.3

Source: PT Kimindo Jaya Indonesia, 2025, processed by the author.

Table 1 shows that SDP production reached 59 units during the January to June 2025 period, with monthly production ranging from 6 to 12 units. During the same period, the company recorded 10 material delay cases, with a cumulative delay of 43 days and an average delay of 4.3 days per case. These data indicate that material delay was not an incidental issue, but a recurring operational problem. The fluctuation of production volume affected material requirements, while the delayed arrival of critical components affected the continuity of the assembly process.

The current procurement condition shows that the company still needs a more structured material planning model. Purchase orders are often issued when material requirements have become urgent, while supplier lead times vary according to component availability (Robbani et al., 2023). As a result, procurement decisions are not always synchronized with the assembly schedule. This condition indicates that the problem is not only related to the number of materials required, but also to the timing of order release and material arrival.

The novelty of this study lies in the development of an integrated MRP-JIT material planning model for SDP panel production in a Make-to-Order electrical panel manufacturing environment. In this model, MRP is used to calculate material requirements, determine planned order receipts, and establish planned order releases based on BOM, inventory position, safety stock, scheduled receipts, and supplier lead time. JIT is then used to synchronize material arrivals by setting target arrival dates one to two days before the scheduled assembly process. Therefore, the proposed model is expected to shift procurement from reactive purchasing to preventive material planning (Indra Jaya et al., 2025).

Based on the identified problem and research gap, this study aims to develop an integrated MRP-JIT material planning model to minimize delay risk in SDP panel production at PT Kimindo Jaya Indonesia. Specifically, this study examines SDP production fluctuations, analyzes material delay conditions, determines material requirements and order release timing using MRP, and synchronizes material arrivals with the assembly schedule using the JIT approach.

2. Materials and Methods

2.1 Research Materials and Data

This study used a descriptive quantitative approach with a case study design. The research was conducted at PT Kimindo Jaya Indonesia, an electrical contractor and panel manufacturer located in Bekasi, Indonesia. The object of this study was the material planning process for Sub Distribution Panel (SDP) production under a Make-to-Order system. The planning horizon covered January to June 2025.

Because this study was conducted in an industrial engineering and production planning context, the materials used in this research refer to production data, company records, and critical SDP components rather than chemical materials or laboratory equipment. The main data consisted of monthly SDP production quantities, Bill of Materials (BOM), initial inventory, safety stock, scheduled receipts, supplier lead times, assembly schedules, and historical material delay data.

Primary data were obtained through direct observation of SDP production activities and interviews with personnel from production, purchasing, and warehouse departments. Secondary data were obtained from company records related to production planning, inventory, procurement, and material delays.

The analysis focused on ten critical materials that directly affected SDP production continuity. These materials were panel box, MCCB, MCB, magnetic contactor, relay, overload relay, NYAF cable 0.75 mm, busbar, indicator lamp, and digital meter. These materials were selected because the absence of one component could interrupt assembly preparation, component installation, wiring, functional testing, or final completion. The material planning parameters used in the MRP calculation are presented in Table 2.

Table 2. Material planning parameters for SDP production

Material	Requirement per SDP	BOM level	Initial inventory	Safety stock	Scheduled receipt	Lead time
Panel box	1 unit	1	1 unit	2 units	0	6 days
MCCB	2 units	1	2 units	4 units	0	5 days
MCB	10 units	1	4 units	20 units	0	4 days
Magnetic contactor	2 units	1	3 units	4 units	0	5 days
Relay	3 units	1	4 units	6 units	0	4 days
Overload relay	2 units	1	2 units	4 units	0	5 days
NYAF cable 0.75 mm	10 meters	2	20 meters	20 meters	0	3 days
Busbar	2 units	2	3 units	4 units	0	5 days
Indicator lamp	4 units	2	6 units	8 units	0	3 days
Digital meter	1 unit	1	2 units	2 units	0	6 days

Source: PT Kimindo Jaya Indonesia, 2025, processed by the author.

Table 2 shows that each SDP unit required different material quantities based on the BOM structure. MCBs and NYAF cable 0.75 mm had the highest usage because each SDP unit required 10 MCB units and 10 meters of NYAF cable. Panel box and digital meter had lower usage quantities, with one unit required for each SDP panel, but both materials remained critical because they had the longest supplier lead time of 6 days. Supplier lead time ranged from 3 to 6 days, which affected the planned order release date for each material. Therefore, materials with longer lead times had to be ordered earlier to ensure availability before assembly.

2.2 Research Procedure

The research procedure was arranged to identify the material delay problem, collect the required data, calculate material requirements, and develop the proposed MRP-JIT material planning model. The research flow is shown in Figure 1.

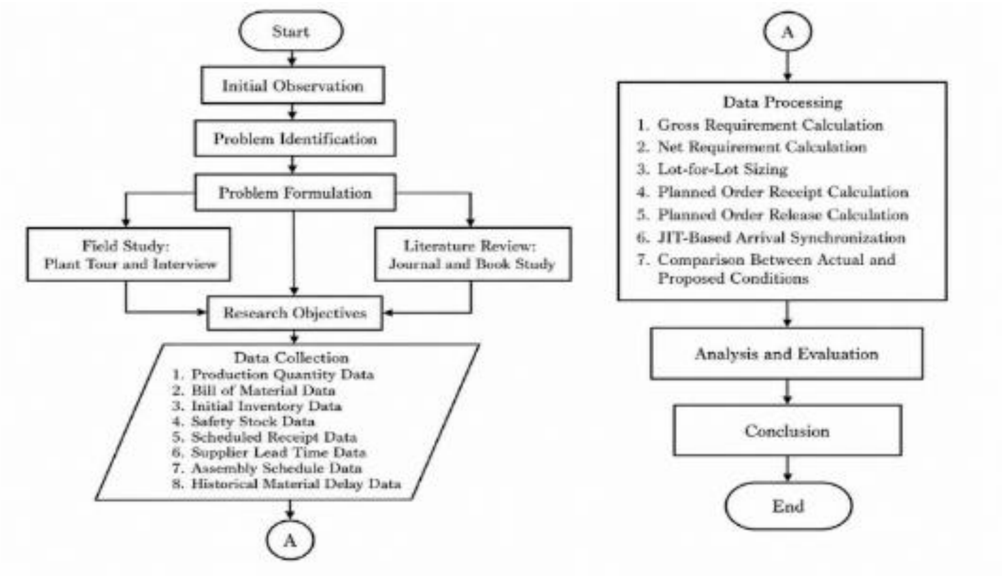

Figure 1.Research flow of the MRP-JIT material planning model

Figure 1 shows the stages used to develop the MRP-JIT material planning model. The study began with initial observation, problem identification, and problem formulation. Field study and literature review were then conducted to support the research objectives. After that, production quantity, BOM, inventory, safety stock, scheduled receipt, supplier lead time, assembly schedule, and historical material delay data were collected. The collected data were processed through MRP calculations and JIT-based arrival synchronization. The final stage compared the actual procurement condition with the proposed MRP-JIT model to evaluate its potential effectiveness.

2.3 MRP-JIT Calculation Method

Material Requirement Planning (MRP) was used to convert the SDP production schedule into detailed material requirements by considering the BOM, inventory position, safety stock, scheduled receipts, and supplier lead time. The main outputs of MRP were gross requirements, net requirements, planned order receipts, and planned order releases. MRP was selected because it can support material planning accuracy and reduce the risk of material shortages in production and project-based environments (Kusumadini & Nirawati, 2025; Narasimha et al., 2024)

The Just-in-Time (JIT) approach was used to synchronize material arrivals with the assembly schedule. In this study, JIT did not replace MRP but complemented it by setting target material arrival dates one to two days before assembly. The integration of MRP and JIT was used to combine quantity accuracy from MRP with arrival synchronization from JIT, which is important in Make-to-Order production with fluctuating demand and supplier lead time variation (Farhang Zad et al., 2024).

The gross requirement for each material was calculated using Equation (1).

$$GRi,t = Pt \times Qi \tag{1}$$

Where GRi, t is the gross requirement of material i in period t, Pt is the number of SDP units scheduled in period t, and Qi is the quantity of material i required for one SDP unit.

The net requirement was calculated by considering gross requirement, safety stock, available inventory, and scheduled receipt. The net requirement equation is shown in Equation (2).

$$NRi,t = \max(0, GRi,t + SSi - OHi,t-1 - SRi,t) \tag{2}$$

Where NRi, t is the net requirement of material i in period t, SSi is the safety stock of material i, OHi, t-1 is the available inventory before period t, and SRi, t is the scheduled receipt of material i in period t.

This study used the Lot-for-Lot technique because SDP production was based on confirmed customer orders and monthly requirements fluctuated. Under this technique, the planned order receipt was equal to the calculated net requirement, as shown in Equation (3).

$$PORci,t = NRi,t \tag{3}$$

Where PORci, t is the planned order receipt of material i in period t, and NRi, t is the net requirement of material i in period t.

The planned order release was determined by shifting the target material arrival date backward according to supplier lead time. The planned order release equation is shown in Equation (4).

$$PORLi,t = TADt - Li \tag{4}$$

Where PORLi, t is the planned order release date of material i in period t, TADt is the target material arrival date in period t, and Li is the lead time of material i.

After the MRP schedule was obtained, the JIT approach was used to synchronize material arrival with the assembly schedule. JIT emphasizes material arrival close to the time of use to reduce unnecessary inventory and support continuous production flow (Utomo et al., 2020). The target material arrival date was set one to two days before assembly, as shown in Equation (5).

$$TADt = ADt - B \tag{5}$$

Where TADt is the target material arrival date in period t, ADt is the scheduled assembly date in period t, and B is the arrival buffer of one to two days. This buffer was used to check material quantity, inspect physical condition, and prepare components before assembly started.

2.4 Evaluation Method

The proposed MRP-JIT model was evaluated by comparing the actual procurement condition with the proposed planning result. The comparison included the number of delay cases, total delay duration, average delay, order timing basis, and material arrival position relative to the assembly schedule. The average delay was calculated using Equation (6).

$$DL = \frac{\sum_{j=1}^{n} DLj}{n} \tag{6}$$

Where DL is the average delay per case, DLj is the delay duration of case j, and n is the total number of delay cases.

This study did not use inferential statistical testing because it did not compare experimental groups or test causal relationships statistically. The evaluation focused on whether the proposed MRP-JIT model could generate measurable material requirements, planned order release dates based on supplier lead time, and target material arrivals before assembly. The result of zero scheduled delay in the proposed model was interpreted as a planning-based result. It did not indicate that material delays had been fully eliminated in actual operations, because the model had not yet been fully implemented in the company's daily procurement system.

3. Results and Discussion.

3.1 Material Delay Root Cause Analysis.

The actual condition showed that material delays occurred repeatedly during the January to June 2025 observation period. As shown in Table 1, PT Kimindo Jaya Indonesia recorded 10 material delay cases, with a total delay of 43 days and an average delay of 4.3 days per case. This condition indicates that material delay was not an incidental problem, but a recurring operational issue that affected the continuity of SDP panel production. Since the SDP production process consists of sequential activities, the absence of one critical material could delay assembly preparation, component installation, wiring, functional testing, and final completion.

To identify the causes of material delays more systematically, a fishbone diagram was developed. The diagram grouped the causes into six main factors, namely methods, people, measurement, materials, system/tools, and environment. The fishbone diagram is shown in Figure 2.

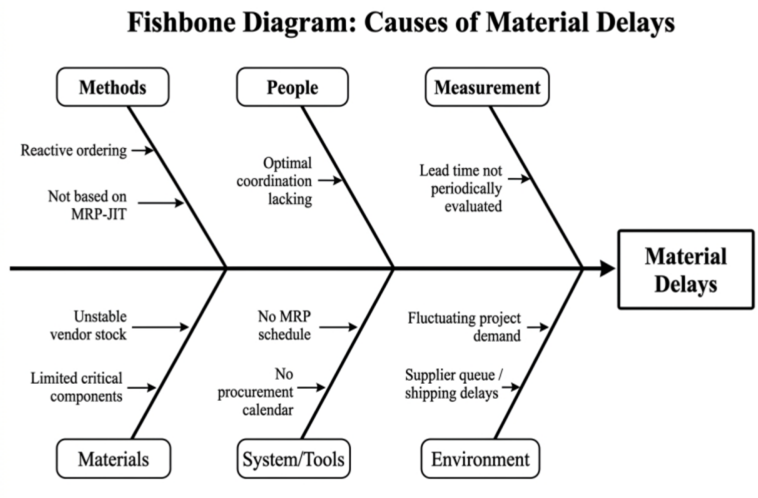

Figure 2. Fishbone diagram of material delay causes

Figure 2 shows that the material delay problem was influenced by both internal planning weaknesses and external supply uncertainty. From the methods factor, procurement was still reactive because material orders were often issued when requirements had become urgent. This condition made the company less able to anticipate supplier lead time. From the people factor, coordination between production, purchasing, and warehouse departments was not yet optimal, which affected the accuracy of material requirement communication and order timing.

From the measurement factor, supplier lead time was not evaluated regularly. As a result, procurement decisions were not always supported by updated delivery performance data. From the materials factor, unstable vendor stock and limited availability of critical components increased the risk of late material arrival. From the system/tools factor, the company did not yet have a structured MRP schedule or procurement calendar linked to the assembly plan. From the environment factor, fluctuating project demand, supplier queues, and delivery delays also contributed to material unavailability. These findings show that the company needs a structured planning model that can calculate material requirements, determine order release timing, and synchronize material arrivals with the assembly schedule.

3.2 Gross Material Requirement Results

The MRP calculation began by converting the SDP production schedule into gross material requirements based on the BOM quantity of each component. During the January to June 2025 period, the company produced 59 SDP units. Therefore, the gross requirement of each material depended on the quantity required to produce one SDP panel. The gross material requirements are presented in Table 3.

Table 3. Gross material requirements for SDP production from January to June 2025

Material	Requirement per SDP	Total SDP production	Gross requirement
Panel box	1 unit	59 units	59 units
MCCB	2 units	59 units	118 units
MCB	10 units	59 units	590 units
Magnetic contactor	2 units	59 units	118 units
Relay	3 units	59 units	177 units
Overload relay	2 units	59 units	118 units
NYAF cable 0.75 mm	10 meters	59 units	590 meters
Busbar	2 units	59 units	118 units
Indicator lamp	4 units	59 units	236 units
Digital meter	1 unit	59 units	59 units

Source: PT Kimindo Jaya Indonesia, 2025, processed by the author.

Table 3 shows that MCBs and NYAF cable 0.75 mm had the highest gross requirements. This occurred because each SDP unit required 10 MCB units and 10 meters of NYAF cable. Therefore, the total gross requirement reached 590 MCB units and 590 meters of NYAF cable during the six-month planning period. Indicator lamps also had a relatively high requirement, with 236 units, because each SDP unit required four indicator lamps. Relays required 177 units, while MCCBs, magnetic contactors, overload relays, and busbars required 118 units each.

Although panel boxes and digital meters had lower gross requirements, with 59 units each, both materials remained critical because each SDP panel required one unit, and both had the longest supplier lead time. This finding shows that material planning should not only focus on high-volume materials, but also on low-volume critical materials that can stop the next production stage when unavailable. This result supports previous studies stating that MRP can improve material requirement accuracy by converting production demand into structured component requirements (Kamila & Momon, 2024).

3.3 MRP-JIT Order Release and Material Arrival Schedule

After gross requirements and net requirements were calculated, the next step was to determine planned order releases and synchronize material arrivals with the assembly schedule. The planned order release was determined by moving backward from the target material arrival date according to supplier lead time. The JIT approach was then used to set material arrivals one to two days before assembly (Indra Jaya et al., 2025). The MRP-JIT order release and material arrival schedule is presented in Table 4.

Table 4. Gross material requirements for SDP production from January to June 2025

Month	SDP production	Assembly start date	Target material arrival	Order release range	Buffer before assembly
January	11 units	10 January 2025	9 January 2025	3 to 6 January 2025	1 day
February	8 units	12 February 2025	11 February 2025	5 to 8 February 2025	1 day
March	6 units	11 March 2025	10 March 2025	4 to 7 March 2025	1 day
April	12 units	14 April 2025	12 April 2025	6 to 9 April 2025	2 days
May	10 units	13 May 2025	12 May 2025	6 to 9 May 2025	1 day
June	12 units	16 June 2025	14 June 2025	8 to 11 June 2025	2 days

Source: PT Kimindo Jaya Indonesia, 2025, processed by the author.

Table 4 shows that the order release range changed according to the target material arrival date and supplier lead time. Materials with a 6-day lead time, such as panel boxes and digital meters, had to be ordered earlier than materials with shorter lead times. Materials with a 5-day lead time, such as MCCBs, magnetic contactors, overload relays, and busbars, were released after that. MCBs and relays with a 4-day lead time were ordered closer to the target arrival date, while NYAF cable 0.75 mm and indicator lamps with a 3-day lead time could be ordered last.

April provides a clear example of the MRP-JIT synchronization process. In April, the company planned to produce 12 SDP units and start assembly on 14 April 2025. The target material arrival date was set on 12 April 2025. Therefore, materials with a 6-day lead time had to be ordered on 6 April 2025, materials with a 5-day lead time had to be ordered on 7 April 2025, materials with a 4-day lead time had to be ordered on 8 April 2025, and materials with a 3-day lead time had to be ordered on 9 April 2025.

This schedule shows that MRP and JIT played complementary roles in the proposed model. MRP determined the material quantities and order release timing, while JIT synchronized material arrivals with the assembly schedule. The one-to-two-day buffer was used to check material quantity, inspect physical condition, and prepare components before assembly. This arrangement is more realistic than requiring materials to arrive exactly on the assembly day because electrical panel production still needs material checking before use. The finding is consistent with previous studies showing that JIT can support timely delivery and reduce unnecessary inventory, but its implementation must consider supplier reliability and delivery uncertainty (Pahinggis & Sucita, 2022; Farhang Zad et al., 2024; Utomo et al., 2020).

3.4 Comparison Between Actual and Proposed Conditions

The comparison between the actual procurement condition and the proposed MRP-JIT model was conducted to evaluate the potential improvement generated by the proposed planning model. The comparison included delay cases, total delay duration, average delay, arrival condition, order timing basis, and planning synchronization. The comparison is presented in Table 5.

Table 5. Comparison between actual condition and proposed MRP-JIT model

Indicator	Actual condition	Proposed MRP-JIT model	Interpretation
Number of analyzed materials	10 materials	10 materials	All critical materials were included in the planning model
Material delay cases	10 cases	0 scheduled cases	Delay risk can be reduced through planned order release
Total material delay	43 days	0 scheduled days	The model has the potential to reduce 43 delay days
Average delay	4.3 days/case	0 scheduled days	Average delay risk can be reduced
Delay or arrival condition	Late by 3 to 6 days	Arrives 1 to 2 days before assembly	Material availability changes from late to ready before production
Basis of order timing	Not structured	Based on 3 to 6 days of supplier lead time	Order timing becomes more measurable
Synchronized planning period	No synchronized schedule	6 months	All planning periods have target arrivals before assembly

Source: PT Kimindo Jaya Indonesia, 2025, processed by the author.

Table 5 shows that the actual procurement condition was still reactive. In the actual condition, the company recorded 10 material delay cases, with a total delay of 43 days and an average delay of 4.3 days per case. In contrast, the proposed MRP-JIT model scheduled all critical materials to arrive one to two days before assembly. This result indicates that the proposed model can reduce material delay risk by linking production demand, BOM quantity, inventory position, safety stock, supplier lead time, planned order release, and target material arrival.

The proposed model provides a more preventive procurement mechanism compared with the actual condition. In the actual system, purchase orders were often issued after material requirements became urgent. This created a higher risk of stock-outs and production delays because the company depended on supplier availability at the time of need. In the proposed model, order release dates were calculated before assembly based on supplier lead time. Therefore, materials with longer lead times could be ordered earlier, while materials with shorter lead times could be ordered closer to the target arrival date.

The findings support previous studies stating that MRP can improve planning accuracy and reduce shortage risk by converting production schedules into detailed material requirements (Utami et al., 2024; Kamila & Momon, 2024; Simanjuntak & Mardiaman, 2025). The findings also support JIT studies, which emphasize timely material delivery to reduce unnecessary inventory and maintain production flow (Jannah et al., 2025; Alni et al., 2024). In addition, the integration of MRP and JIT can support procurement planning by combining material requirement accuracy with delivery synchronization (Farhang Zad et al., 2024; Utomo et al., 2020). However, this study extends previous findings by applying the integrated MRP-JIT model in a Make-to-Order electrical panel production context.

The practical contribution of this model is that PT Kimindo Jaya Indonesia can use the MRP-JIT schedule as a procurement guideline. The company can determine what materials are needed, how many materials must be ordered, when orders must be released, and when materials should arrive before assembly. This planning mechanism can help reduce urgent purchasing and improve coordination between production, purchasing, warehouse, and suppliers.

However, the result must be interpreted carefully. The results represent a planning-based scheduling scenario derived from historical production data, not an actual implementation outcome in the company's operational system. It only shows that the proposed schedule was designed to prevent delays if order release dates, supplier lead times, and delivery commitments are followed. This study also did not include detailed ordering cost, holding cost, and shortage cost calculations. Therefore, the result represents a planning-based improvement, not a confirmed implementation outcome. Future implementation is needed to validate the actual effect of the MRP-JIT model on company operations.

4. Conclusion

This study developed an integrated MRP-JIT material planning model to minimize delay risk in SDP panel production at PT Kimindo Jaya Indonesia. The actual condition showed that 59 SDP units were produced during the January to June 2025 period, with 10 material delay cases and a total delay of 43 days, resulting in an average delay of 4.3 days per case. This condition indicates that material delays were recurring and had a direct impact on production continuity in Make-to-Order electrical panel manufacturing.

The proposed model integrates Material Requirement Planning (MRP) and Just-in-Time (JIT) to improve material planning accuracy and delivery synchronization. MRP is used to determine material requirements, planned order receipts, and planned order releases based on Bill of Materials, inventory position, safety stock, and supplier lead time. Meanwhile, JIT is applied to synchronize material arrivals by setting delivery schedules 1–2 days before the assembly process to ensure readiness before production starts.

Material delivery in the proposed model is synchronized using a backward scheduling approach based on the production schedule and supplier lead time. Orders are released earlier to ensure that materials arrive 1–2 days before assembly begins. Coordination is carried out between production planning, purchasing, and suppliers through confirmed delivery schedules. If delays still occur, the company must apply mitigation actions such as expedited procurement, utilization of safety stock, substitution with alternative suppliers, or adjustment of the assembly schedule based on material criticality. This mechanism ensures that production continuity can still be maintained even when deviations from the planned schedule occur.

The confidence level of the proposed MRP-JIT model is considered moderate to high. The model is effective under the condition that supplier lead times remain stable, production schedules are accurate, and coordination between departments is well maintained. However, its performance still depends on external factors such as supplier reliability and demand variability. Therefore, the expected improvement should be interpreted as conditional rather than absolute operational certainty.

The results of this study represent a planning-based simulation using historical production data rather than an actual implementation in the company's operational system. Therefore, the effectiveness of the proposed model is assessed based on its logical consistency in integrating material requirement planning, order release timing, and delivery synchronization, rather than empirical performance in real operational conditions.

Future studies are recommended to validate the proposed model through full implementation in industrial settings and to incorporate additional factors such as ordering cost, holding cost, shortage cost, supplier performance variability, and integration with digital procurement or ERP systems.

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