Tibuana
Journal of applied Industrial Engineering-University of PGRI Adi Buana

p-ISSN 2622-2027
e-ISSN 2622-2035

Applying Production Capacity Planning Analysis to Enhance Operational Efficiency in the Garment Industry

Cindy Novalia Dwi Pratama[1], Evi Yuliawati[2]
[1,2]Industrial Engineering Department, Faculty of Industrial Technology, Institut Teknologi Adhi Tama Surabaya, Jl Arif Rahman Hakim No 100, Surabaya, 60117, Indonesia

eviyulia103@itats.ac.id

***Abstract*—Rira Clothing Convection is a business engaged in the convection of Muslim clothes for girls. The demand to continually adjust to the development of fashion trends regularly demonstrates the company's awareness of the importance of adapting to an ever-changing market. The existence of these fluctuations certainly affects the production process, which includes the target number of clothes that must be produced, the determination of the number and schedule for ordering raw materials, the production process time, the number of machines needed, and others. The purpose of this study is to minimize the cost of raw material inventory with the Material Requirement Planning (MRP) Method and plan the optimal production capacity so that production runs effectively and efficiently with the Capacity Requirement Planning (CRP) Method. The results of the study showed that the calculation of the minimum inventory used the Material Requirement Planning (MRP) method with the Economic Order Quantity (EOQ) technique. The total inventory cost for the main raw materials is Diamond Crepe fabric with four orders of 427.5 meters/order and Rayon Stretch fabric with three orders of 745.5 meters/order of Rp 1,400,000. The optimal production capacity planning is the number of working days at the pattern making, cutting, and sewing stations, as many as four days in five periods and 4.5 days in one period, while in the bundling, packing, and finishing stations as many as four days in six periods.**

***Index Terms*—Capacity Planning; Garment Industry; MRP; CRP**

I. INTRODUCTION

The industrial sector in Indonesia is experiencing significant growth, and products are becoming increasingly complex, leading to heightened competition within the industry. This trend is evidenced by the diverse range of products marketed by various companies (Ulfah et al., 2018). To navigate this competitive landscape, it is crucial to focus on consumer loyalty. Companies that provide high-quality services and products and meet demand in a timely manner are more likely to achieve consumer loyalty. The key to a company's success lies in understanding consumer desires. When a company accurately identifies and meets consumer needs with the right products at the right time, it can enhance overall customer satisfaction. Timely understanding of consumer needs also enables companies to maintain optimal product inventory, ensuring smooth production and distribution processes without undesirable shortages or surpluses. Metrics such as timeliness and optimal product inventory are vital in evaluating the efficiency and success of an industry (Syam et al., 2022).

In this context, it is essential to manage all company resources effectively, particularly within the production process, to maintain a competitive position. A well-executed production process requires thorough planning and control to avoid obstacles that could disrupt the production flow and hinder the ability to meet customer demand adequately (Purnomo, 2019). Proper planning and control of production are necessary not only to avoid impediments but also to ensure that the inputs and outputs of the business are well-managed. These inputs include efficient costs and raw materials, as well as an effective workforce.

The production process at Rira Clothing Convention is primarily manual, utilizing several machines such as sewing machines. In garment production, it is crucial to consider market demand to meet consumer needs and remain competitive. However, Rira Clothing Convention frequently faces challenges due to fluctuating market demand, especially in the months leading up to significant Islamic holidays like Idul Fitri, when demand surges dramatically compared to other months, making it difficult to predict demand

p-ISSN 2622-2027
e-ISSN 2622-2035

accurately. These fluctuations inevitably affect the production process, including targets for the number of garments to be produced, determining the quantity and schedule of raw material orders, production time, the number of machines required, and other factors. The following is the data on demand for girls' Muslim clothing at Rira Clothing Convention over the past two years (Yuliawati et al., 2023).

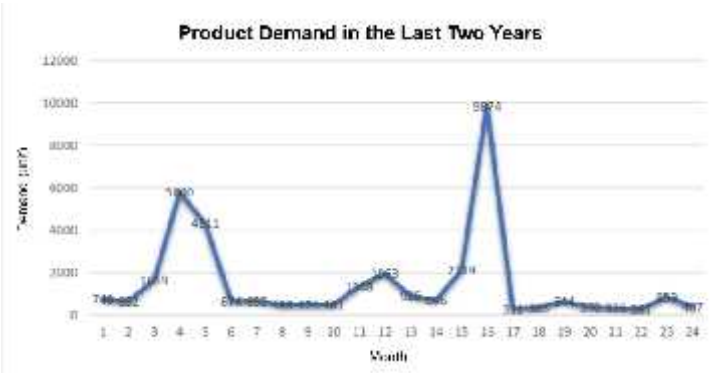

Figure 1: Demand Data for Girls' Muslim Clothing in 2021 to 2022

Raw material inventory is crucial for the company. A shortage of inventory can disrupt the production process and hinder the ability to meet customer demand. Conversely, excess inventory increases storage costs, risk of damage or obsolescence, and can impede the production flow (Gulo et al., 2023). One method that can be applied to effectively plan raw material inventory is Material Requirement Planning (MRP), which allows companies to predict raw material needs more accurately (Daroini & Himawan, 2022).

Material Requirement Planning (MRP) is a systematic method for scheduling the raw materials required in the production process, considering inventory costs within a single cycle. The primary objective of MRP is to determine and establish the quantity and procurement of raw materials based on the Bill of Materials (BOM) and projected demand forecasts as outlined in the Master Production Schedule (MPS). MRP ensures that raw materials are received precisely when needed for the production process (Ibrahim et al., 2018).

Both capacity shortages and surpluses in a company can have severe consequences. A capacity shortage can disrupt production and delivery processes, resulting in delays and even failure to meet production targets. This can damage the company's reputation as customer trust in its ability to meet their needs is compromised. Conversely, excess capacity also poses significant risks by increasing production costs and resulting in low resource utilization, making it difficult for products to remain competitive in the market. Additionally, excess capacity can lead to decreased profits and loss of market share due to intense competition (Makhmudah et al., 2022).

Capacity Requirement Planning (CRP) is a method that can be applied for planning production capacity needs based on the established production plan. CRP helps companies ensure that the required production capacity is available at the right time to meet the production schedule (Putriani & Rahmalita, 2023). CRP is an advanced planning and control process that follows Material Requirement Planning (MRP) and is concerned with the availability of production capacity. The objective of CRP analysis is to balance the demand with the available processing capacity (Yasmin Firiza, 2020). By using both MRP and CRP methods, this study aims to optimize the production process so that Rira Clothing Convection can meet customer demand in line with market needs, thereby sustaining its business in the garment industry.

Based on the aforementioned background, it is evident that production planning and control are necessary for the girls' Muslim clothing at Rira Clothing Convention. This research will involve creating a Master Production Schedule (MPS) based on the forecasting results, followed by data processing using the Material Requirement Planning (MRP) method and the Capacity Requirement Planning (CRP) method. This study is crucial to ensure that the production process operates optimally, with the expectation that planning and control of raw materials and

p-ISSN 2622-2027
e-ISSN 2622-2035

production capacity will be effectively managed.

II. METHOD

A. Design, Location, and Research Period

The object of this research is the production process at Rira Clothing Convention, located at Jl. Rungkut Barata VI No.18, Rungkut Menanggal, Gunung Anyar District, Surabaya, East Java. The focus of this study is to plan and control the raw material inventory and production capacity for the One Set model of girls' Muslim clothing required by Rira Clothing Convention. The data processing stage is carried out based on the sequential steps in the research methodology. The processing steps begin with forecasting the demand for the One Set model of girls' Muslim clothing, determining the Master Production Schedule (MPS), planning raw material requirements using the Material Requirement Planning (MRP) method, calculating inventory costs, and concluding with planning production capacity using the Capacity Requirement Planning (CRP) method.

B. Forecasting

Demand forecasting is conducted to estimate the number of requests for the upcoming period. The forecasting methods used are moving average, exponential smoothing, and multiplicative decomposition (seasonal) with the assistance of POM-QM software. Each forecasting method has an error measurement. The forecasting method with the smallest error measurement will be used as the basis for the master production schedule.

C. Bill Of Material (BOM)

The table contents should be typed in single spacing, 8-point size, Times New Roman.

The Bill of Material (BOM) lists all components required to create a product or assembly (Ginting et al., 2019). BOM plays a crucial role in coordinating and managing the supply chain and production processes. It details how the components are arranged or assembled to form the final product, providing clear instructions to operators or workers on how to assemble or combine these components during the production process.

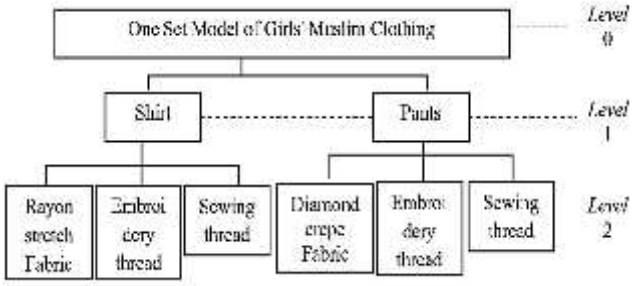

Figure 2: Bill Of Materials (BOM) for One Set Model of Girls' Muslim Clothing

D. Material Requirement Planning (MRP)

The basic components of Material Requirement Planning (MRP) consist of the Master Production Schedule (MPS), product structure over time, and inventory data (Kahfi et al., 2020). The information from the master production schedule provides other relevant details such as demand quantity, inventory status, and the timing for ordering materials or assembling necessary components. There are four stages or steps involved in the MRP preparation: netting (net requirements), lotting, offsetting (planned order release), and exploding (Handoko & Puspitasari, 2021).

Table 1 MRP Calculation Tables

Lead Time:	Time Periods				
	1	2	3	4	5
GR					
SR					
POH					
NR					
POR					
PORel					

p-ISSN 2622-2027
e-ISSN 2622-2035

In the calculation of MRP, two techniques are used: the Lot For Lot (LFL) technique and the Economic Order Quantity (EOQ) technique. In the Lot For Lot method, the lot size or order quantity is set so that the inventory ordered matches exactly the net requirements for that period. The fundamental principle of EOQ is to find the point where the total inventory holding cost and setup cost are at their lowest.

$$Q = \sqrt{\frac{2DS}{H}} \quad (1)$$

E. Capacity Requirement Planning (CRP)

Capacity Requirement Planning (CRP) is a method for planning capacity needs, focusing on managing and regulating the use of equipment, machinery, labor, and other resources required in the detailed process. The steps in Capacity Requirement Planning (CRP) include calculating the capacity of work centers, determining the load, and balancing capacity and load. Capacity planning can be performed through analysis and reporting using the CRP method as follows (Sandy Wicaksono & Siti Mundari, 2022): Receiving information related to Planned Order Release from MRP.

1. Receiving information related to Standard Time per unit and Standard Setup Time per lot size.
   Operation Time = Run Time + Set Up Time (2)
2. Calculating the capacity at each work center
   Available Capacity Time = Number of working hours x Utilization x Efficiency (3)
   $$\text{Utilization} = \frac{\text{Actual working hours}}{\text{/A w h}} \times 100\% \quad (4)$$
   $$\text{Efficiency} = \frac{\text{Standard working hours}}{\text{/Available working hours}} \quad (5)$$

III. RESULTS AND DISCUSSIONS

A. Forecasting Results

The following are the comparison results of the three forecasting methods.

Table 2 Comparison of Data Processing Results using POM-QM Software

Error Measurement	Forecasting Methods		
	Moving Average	Exponential Smoothing	Multiplicative Decomposition (Seasonal)
MAD	166.9	143.937	87.017
MSE	55.829,65	40.704,03	17.548,81
MAPE	264.172	223.046	229.448
Standard Error	180.00%	155.36%	118.57%

Based on the table above, it is shown that the method with the smallest error measurement is the Multiplicative Decomposition (Seasonal) method, with a Mean Absolute Deviation (MAD) of 87.017, Mean Squared Error (MSE) of 17,548.81, Mean Absolute Percentage Error (MAPE) of 229.448, and a standard error of 118.57%. Therefore, this method is used to forecast demand for subsequent periods and determine the master production schedule.

Table 3 Master Production Schedule (MPS)

No	Period	Forecasting Results	JIP
1.	13	16.841	17
2.	14	50.97	51
3.	15	14.695	15
4.	16	20.211	21
5.	17	9.775	10
6.	18	9.457	10
7.	19	22.051	23
8.	20	140.395	141
9.	21	132.722	133
10.	22	321.945	322

p-ISSN 2622-2027
e-ISSN 2622-2035

No	Period	Forecasting Results	JIP
11.	23	51.61	52
12.	24	33.081	34
13.	25	60.943	61
14.	26	331.76	332

B. MRP Calculation Results

MRP calculations using the Lot For Lot technique and the EOQ technique show results as in the following tabl

Table 4 MRP for Rayon Stretch Fabric using LFL Technique

Lead Time: 1 Month	Period														
Rayon Stretch Fabric (Meter)	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
GR		17	51	15	21	10	10	23	141	133	322	52	34	61	332
SR															
POH		0	0	0	0	0	0	0	0	0	0	0	0	0	0
NR		17	51	15	21	10	10	23	141	133	322	52	34	61	332
PORec		17	51	15	21	10	10	23	141	133	322	52	34	61	332
PoRel	17	51	15	21	10	10	23	141	133	322	52	34	61	332	

Table 5 MRP for Diamond Crepe Fabric using LFL Technique

Lead Time: 1 Month	Period														
Diamond Crepe Fabric (Meter)	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
GR		25.5	76.5	22.5	31.5	15	15	34.5	211.5	199.5	483	78	51	91.5	498
SR															
POH		0	0	0	0	0	0	0	0	0	0	0	0	0	0
NR		25.5	76.5	22.5	31.5	15	15	34.5	211.5	199.5	483	78	51	91.5	498
PORec		25.5	76.5	22.5	31.5	15	15	34.5	211.5	199.5	483	78	51	91.5	498
PoRel	25.5	76.5	22.5	31.5	15	15	34.5	211.5	199.5	483	78	51	91.5	498	

Table 6 MRP for Rayon Stretch Fabric using EOQ Technique

Lead Time: 1 Month	Period														
Rayon Stretch Fabric (Meter)	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
GR		215	0	0	0	0	0	0	215	0	215	215	0	215	215
SR															
POH		0	212.5	212.5	212.5	212.5	212.5	212.5	212.5	425	425	210	422.5	422.5	207.5
NR		215	0	0	0	0	0	0	2.5	0	0	5			7.5
PORec		427.5							427.5			427.5			427.5
PoRel	427.5							427.5			427.5			427.5	

p-ISSN 2622-2027
e-ISSN 2622-2035

Table 7 MRP for Diamond Crepe Fabric using EOQ Technique

Lead Time: 1 Month	Period														
Diamond Crepe Fabric	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
GR		322.5	0	0	0	0	0	0	322.5	0	322.5	322.5	0	322.5	322.5
SR															
POH		0	423	423	423	423	423	423	423	100.5	100.5	523	200.5	200.5	623.5
NR		322.5	0	0	0	0	0	0	0	0	222.5	0	0	122	
PORec		745.5									745.5			745.5	
PoRel	745.5									745.5			745.5		

Table 8 Inventory Cost using LFL and EOQ Technique

No.	Technique	Raw Materials	Ordering Cost (Rp)	Holding Cost (Rp)	Total Inventory Cost (Rp)
1.	LFL Technique	Rayon Stretch Fabric	700.000	9.380	709.380
		Diamond Crepe Fabric	700.000	4.620	704.620
TOTAL			1.400.000	14.000	1.414.000
2.	EOQ Technique	Rayon Stretch Fabric	200.000	2.680	202.680
		Diamond Crepe Fabric	150.000	990	150.990
TOTAL			350.000	3.670	353.670

The inventory costs associated with using the Lot For Lot (LFL) technique amount to Rp 1,414,000, with ordering costs of Rp 1,400,000 and holding costs of Rp 14,000. In contrast, the inventory costs associated with using the Economic Order Quantity (EOQ) technique amount to Rp 353,670, with ordering costs of Rp 350,000 and holding costs of Rp 3,670. The comparison between the two techniques indicates that the inventory costs with the EOQ technique are lower than those with the LFL technique. Therefore, planning raw material orders using the EOQ technique is recommended to minimize the inventory costs incurred.

C. CRP Calculation Results

The Capacity Requirement Planning (CRP) calculation is performed to balance the load with the available capacity, ensuring that the production process runs optimally. The CRP results indicate that the pattern-making station (WC 1), cutting station (WC 2), and sewing station have the same excess and shortage of capacity. Whereas, the bundling station (WC 3) has the same capacity balance as the finishing and packing station (WC 5).

Table 9 CRP WC 1,2, and 4

Description	Period						Total
WC 1, 2, and 4	12	19	21	22	24	25	
Available Time (Minutes)	12.480	12.480	12.480	12.480	12.480	12.480	74.880
Utilization Rate	0.98	0.98	0.98	0.98	0.98	0.98	5.88
Efficiency Rate	1	1	1	1	1	1	6

p-ISSN 2622-2027
e-ISSN 2622-2035

Description	Period						Total
WC 1, 2, and 4	12	19	21	22	24	25	
Available Capacity	12.231	12.231	12.231	12.231	12.231	12.231	73.386
Actual Demand	1.720	1.720	1.720	1.720	1.720	1.720	10.320
Excess/Shortage	10.511	10.511	10.511	10.511	10.511	10.511	63.066

Table 10 CRP WC CRP WC 3 and WC 5

Description	Period						Total
WC 3 dan 5	12	19	21	22	24	25	
Available Time (Minutes)	12.480	12.480	12.480	12.480	12.480	12.480	74.880
Utilization Rate	0.99	0.99	0.99	0.99	0.99	0.99	5.94
Efficiency Rate	1	1	1	1	1	1	6
Available Capacity	12.356	12.356	12.356	12.356	12.356	12.356	74.136
Actual Demand	1.720	1.720	1.720	1.720	1.720	1.720	10.320
Excess/Shortage	10.636	10.636	10.636	10.636	10.636	10.636	63.816

The table above indicates that balancing the capacity and load across all workstations is necessary to make the production system more effective and efficient. Balancing is achieved for Work Centers (WC) 1, 2, and 4 by changing the working days from 26 days (8 hours/day) to 4 days across all periods, except for period 21, which requires 4.5 days. For Work Centers 3 and 5, balancing results in 4 days across all periods.

Table 11 CRP Adjustment for WC 1, 2, and 4

Description	Period						Total
WC 1, 2, and 4	12	19	21	22	24	25	
Available Time (Minutes)	1.920	1.680	1.920	1.680	1.680	1.680	10.560
Utilization Rate	0.98	0.98	0.98	0.98	0.98	0.98	5.88
Efficiency Rate	1	1	1	1	1	1	6
Available Capacity	1.882	1.647	1.882	1.647	1.647	1.647	10.352
Actual Demand	1.720	1.720	1.720	1.720	1.720	1.720	10.320
Excess/Shortage	162	-73	162	-73	-73	-73	32

Table 12
CRP Adjustment for WC 3 and 5

Description	Period						Total
WC 3 dan 5	12	19	21	22	24	25	
Available Time (Minutes)	1.920	1.920	1.920	1.920	1.920	1.920	11.520
Utilization Rate	0.99	0.99	0.99	0.99	0.99	0.99	5.88
Efficiency Rate	1	1	1	1	1	1	6
Available Capacity	1.901	1.664	1.901	1.664	1.664	1.664	10.458
Actual Demand	1.720	1.720	1.720	1.720	1.720	1.720	10.320
Excess/Shortage	181	-56	181	-56	-56	-56	138

IV. CONCLUSIONS

The raw material ordering plan for the One Set model of children's Muslim clothing at Rira Clothing Convection is carried out using the EOQ technique within the MRP method. Rayon Stretch raw material is ordered four times at 427.5 meters per order, and Diamond Crepe raw material is ordered three times at 745.5 meters per order.

p-ISSN 2622-2027
e-ISSN 2622-2035

Thus, the total ordering cost for both raw materials is Rp 1,400,000, and the total holding cost is Rp 14,000, resulting in a total inventory cost of Rp 1,414,000.

Using the Capacity Requirement Planning method, optimal production capacity planning for the One Set model of children's Muslim clothing at Rira Clothing Convection is as follows: 4 working days (8 hours/day) at all Work Centers 1 (pattern-making), 2 (cutting), 3 (bundling), 4 (sewing), 5 (packing and finishing) in period 12 and period 21, which requires 3.5 days or 3 days (8 hours/day) plus 1 day (4 hours/day) in period 19, 22, 24 and 25.

REFERENCES

Daroini, M. A., & Himawan, A. F. I. (2022). Analisis Pengendalian Persediaan Bahan Baku Songkok ZNR dengan Menggunakan Metode Material Requirement Planning (MRP). *Jurnal Mahasiswa Manajemen*, *2*(02), 155. https://doi.org/10.30587/mahasiswamanajemen.v2i02.3035

Ginting, E. F., Ibnutama, K., & Suryanata, M. G. (2019). Implementasi DES (Data Encryption Standard) Untuk Penyandian Data Bill Of Material pada Divisi Produksi PT.Siantar Top, Tbk. *Jurnal SAINTIKOM (Jurnal Sains Manajemen Informatika Dan Komputer)*, *18*(2), 161. https://doi.org/10.53513/jis.v18i2.155

Gulo, S. E., Hura, A., Mendrofa, M. S. D., & Lase, D. (2023). Analisis Penerapan Metode Material Requirement Planning (MRP) Dalam Perencanaan Persediaan Bahan Baku Pada Produksi Kue di Wery Bakery. *INNOVATIVE: Journal Of Social Science Research*, *3*(5), 5729–5739. https://doi.org/10.31004/innovative.v3i4.4190

Handoko, A., & Puspitasari, N. B. (2021). Perencanaan Persediaan Bahan Baku Menggunakan Metode Material Requirement Planning (MRP) Pada PT Pardic Jaya Chemicals. *Jurnal Seminar Nasional Teknologi Industri Berkelanjutan I (SENASTITAN I)*, 386–393.

Ibrahim, M., Fawzy, A., & Ngudi, W. T. (2018). Pengendalian Persediaan Bahan Baku Alumunium Rod Wire Untuk Pembuatan Kabel Menggunakan Metode Forecasting dan Material Requirement Planning (MRP) di PT. SCC. *Jurnal Teknik Industri*, *2*(2), 33–37.

Kahfi, A., Sumartono, B., & Arianto, B. (2020). Analisis Perencanaan Bahan Baku Perakitan Lemari dengan Metode Material Requirement Planning (MRP) pada Bengkel Furniture. *Jurnal Teknik Industri*, *9*(1), 39–57.

Makhmudah, S., Pratama, R. A., Kurnia, H., Zakaria, N. F., & S, A. N. (2022). Perancangan Sistem Kerja di Berbagai Industri Manufaktur: Kajian Literature Review. *Jurnal Teknik Industri*, *3*(02), 83–92.

Purnomo, Y. A. (2019). *PENGENDALIAN PERSEDIAAN BAHAN BAKU DENGAN METODE EOQ BACKORDER PADA UD SEKAWAN PUTRA*. 1–10.

Putriani, & Rahmalita, L. (2023). PERENCANAAN KAPASITAS PRODUKSI DENGAN METODE CAPACITY REQUIREMENT PLANNING (CRP). *New England Journal of Medicine*, *372*(2), 2499–2508.

Sandy Wicaksono, & Siti Mundari. (2022). Perencanaan Kapasitas Produksi Untuk Memenuhi Permintaan Konsumen Pada Home Industri Sandal. *Prosiding Senakama*, *1*(September), 121–134.

Syam, A. A., Siregar, Z. H., & Harahap, U. N. (2022). Perencanaan kapasitas dan waktu produksi menggunakan metode Capacity Requirement Planning (CRP) pada industri tahu tempe. *Jurnal VORTEKS*, *3*(1), 174–181. https://doi.org/10.54123/vorteks.v3i1.152

Ulfah, S. N. M., Zalynda, P. M., & Kurniasih, D. (2018). Perencanaan Kebutuhan Bahan Baku dengan Menggunakan Metode Material Requirement Planning (MRP) di PT. Bonli Cipta Sejahtera. In *Galang Tanjung* (Issue 2504).

Yasmin Firiza, S. (2020). Analisis Perencanaan Pengendalian Produk Hairdryer Carolina 450 Watt Dengan Menggunakan Metode Capacity Requirement Planning (Crp). *In Talenta Conference Series: Energy and Engineering (EE)*, *3*(2), 337–343.

p-ISSN 2622-2027
e-ISSN 2622-2035

https://doi.org/10.32734/ee.v3i2.1012

Yuliawati, E., Widjajanti, W. W., Mirzayanti, Y. W., & Syamsuri, S. (2023). Pendampingan Pemanfaatan Teknologi Digital pada Pengelolaan Pemasaran dan Implementasi Ergonomi sebagai Upaya Meningkatkan Kinerja Ekonomi Digital di Rira Clothing Konveksi. *JPP IPTEK (Jurnal Pengabdian Dan Penerapan IPTEK)*, *7*(2), 119–128. https://doi.org/10.31284/j.jpp-iptek.2023.v7i2.5017