Optimization of Raw Material Supply Scheduling to Maximize Storage Utilization at Company X

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ABSTRAK

Studi ini berfokus pada pengoptimalan penjadwalan pasokan bahan baku di Perusahaan X, sebuah bisnis di industri makanan dan minuman, untuk memaksimalkan pemanfaatan penyimpanan. Perusahaan X menghadapi tantangan dalam menyeimbangkan permintaan bahan baku dengan kapasitas penyimpanan yang terbatas, yang menyebabkan masalah seperti kekurangan stok atau kelebihan stok. Praktik manajemen inventaris saat ini terbukti tidak efektif dalam memenuhi permintaan konsumen secara efisien. Penelitian ini menggunakan metodologi kuantitatif, dengan fokus pada analisis data numerik untuk mengatasi tujuan penelitian. Melalui pendekatan ini, data yang dapat diukur dikumpulkan dan diperiksa untuk memberikan wawasan yang jelas tentang pola, hubungan, dan tren. Metode kuantitatif memastikan objektivitas dan ketepatan, menjadikannya ideal untuk mengevaluasi faktor-faktor seperti jadwal pasokan bahan baku, kapasitas penyimpanan, dan fluktuasi permintaan, sehingga mendukung pengambilan keputusan berdasarkan data. Melalui analisis data penjualan dan kebutuhan bahan baku, penelitian ini bertujuan untuk mengembangkan strategi penjadwalan yang lebih efektif yang menyelaraskan pasokan dengan permintaan sambil mengoptimalkan ruang penyimpanan. Temuan studi ini menawarkan solusi potensial untuk meningkatkan efisiensi operasional, mengurangi pemborosan, dan meningkatkan kinerja rantai pasokan secara keseluruhan. Dengan menerapkan penjadwalan pasokan yang dioptimalkan, Perusahaan X dapat memastikan operasi yang lebih lancar dan memenuhi kebutuhan konsumen dengan lebih baik, sehingga memaksimalkan nilai di seluruh rantai pasokan.

Kata kunci: Penjadwalan Pasokan; Bahan Baku; Optimasi; Pemanfaatan Penyimpanan; Manajemen Inventaris.

ABSTRACT

This study focuses on optimizing the raw material supply scheduling at Company X, a business in the food and beverage industry, to maximize storage utilization. Company X faces challenges in balancing raw material demand with limited storage capacity, leading to issues such as stock shortages or overstocking. The current inventory management practices have proven ineffective in meeting consumer demand efficiently. This research utilizes a quantitative methodology, focusing on numerical data analysis to address the research objectives. Through this approach, measurable data are collected and examined to provide clear insights into patterns, relationships, and trends. The quantitative method ensures objectivity and precision, making it ideal for evaluating factors such as raw material supply schedules, storage capacity, and demand fluctuations, thereby supporting data driven decision-makingThrough the analysis of sales data and raw material requirements, this research aims to develop a more effective scheduling strategy that aligns supply with demand while optimizing storage space. The findings of this study offer potential solutions for improving operational efficiency, reducing waste, and enhancing the overall supply chain performance. By implementing optimized supply scheduling, Company X can ensure smoother operations and better meet consumer needs, thus maximizing value across the entire supply chain.

Keywords: *Supply Scheduling; Raw Materials; Optimization; Storage Utilization; Inventory Management.*

INTRODUCTION

Company X operates in the food and beverage industry and is headquartered in Surabaya. Established in 2017, the company has gained significant recognition, as evidenced by its numerous branches widely distributed across Surabaya. The company specializes in producing healthy food products, primarily vegetable salads and cold-pressed juices. The raw materials used consist of fresh vegetables and fruits. Monitoring the inventory of raw materials is crucial to ensuring the smooth operation of the company. Effective monitoring guarantees sufficient stock availability, optimizes supply efficiency, ensures timely deliveries, and maintains the quality of raw materials, all of which significantly impact the production and distribution processes [1]. This, in turn, enables the company to maximize value creation across the entire supply chain, from suppliers and the company itself to the end consumers [2].

For Company X, inventory monitoring is conducted based on demand, which also dictates the production process. Higher demand results in increased raw material usage for production, and vice versa. This demand is often assessed based on the sales activity and foot traffic at the sales stands. The company faces storage limitations for both unprocessed and processed raw materials. The following outlines the chiller capacity and its utilization for storage purposes.

Based on the observations, several key improvements are required to enhance the efficiency of raw material management. First, evaluating raw material supply needs is essential to ensure that procurement aligns with production requirements and consumer demand [3]. By analyzing demand patterns and sales data, the company can estimate the necessary quantities of raw materials to avoid shortages or disruptions in production [4]. Additionally, scheduling procurement periods with suppliers is critical to maintaining a steady supply flow while minimizing storage constraints. Properly timed deliveries will help the company reduce the risk of overstocking and maintain the freshness of raw materials, ensuring high-quality products for consumers.

Another important aspect is optimizing the limited storage capacity of the company’s chiller. By assessing the shelf life of raw materials, the company can implement a more efficient storage strategy, prioritizing perishable items and ensuring timely utilization [5]. This approach reduces waste due to spoilage and maximizes the effective use of the available space. Through this research, the company seeks to create a balance between supply chain efficiency and storage limitations, allowing it to meet consumer demand consistently while minimizing operational costs. These improvements will ultimately contribute to the company’s ability to sustain growth and maintain its reputation for delivering fresh and healthy food products [6].

The primary objective of this research is to establish an optimal scheduling system for raw material procurement from suppliers. This scheduling aims to align with the company's production needs while addressing storage constraints [7]. By analyzing demand patterns and the available chiller capacity, the study seeks to determine the ideal frequency and volume of raw material deliveries to prevent stock shortages or overstock situations. Efficient scheduling is essential to maintain the freshness and quality of raw materials, which are critical for the company's products vegetable salads and cold-pressed juices [8]. Additionally, an accurate supply plan will enable the company to adapt quickly to fluctuating consumer demand, ensuring seamless production and sales operations [9,10].

Moreover, the research emphasizes maximizing the utilization of the company's limited chiller capacity. By integrating data on the shelf life of raw materials and their usage rates, the study will propose strategies for efficient storage management. This includes prioritizing fast-moving or perishable items and minimizing waste caused by spoilage [11,12]. Ultimately, the research aims to enhance operational efficiency, reduce unnecessary costs, and support the company's commitment to delivering high-quality, healthy products to consumers. Through this approach, the company can achieve a balance between supply chain efficiency and its storage limitations, thereby sustaining its competitive advantage in the market.

METHOD

This research adopts a quantitative methodology as its core approach, emphasizing numerical data analysis to address the research objectives systematically and effectively. This method is particularly suited for studies that require precision and objectivity in evaluating measurable variables. By focusing on numerical data, this methodology provides the foundation for identifying clear insights into the patterns, relationships, and trends that influence the research problem. In this study, the quantitative approach is applied to assess critical factors such as raw material supply schedules, storage capacity, and fluctuations in consumer demand, all of which are integral to optimizing supply chain performance. The strength of a quantitative approach lies in its ability to support data-driven decision-making, enabling the development of solutions that are based on empirical evidence rather than assumptions. By collecting and analyzing measurable data, the research ensures objectivity, reliability, and replicability, making it particularly effective for evaluating operational and logistical challenges faced by businesses such as Company X.

To achieve the research objectives, the study follows a structured series of steps:

1. Identification Phase: This initial stage involves formulating the research problem based on observed challenges. In the context of Company X, the primary issues identified include inefficiencies in raw material supply scheduling, limited storage capacity, and misalignment between supply and demand.
2. Data Collection Phase: During this phase, relevant data are gathered to provide a comprehensive understanding of the operational context. Key data collected include:
3. Raw Material Supply Data: Information on the quantity and frequency of raw material deliveries from suppliers.
4. Bill of Materials (BOM) for Each Menu: Detailed breakdown of the raw materials required for producing specific menu items, ensuring accurate demand planning.
5. Chiller Capacity Data: Data on available storage space for both raw and processed materials, crucial for optimizing inventory management.
6. Data Processing Phase: This stage involves the application of advanced forecasting and error measurement techniques to analyze the collected data. The methods used include:
7. Moving Average: A technique to smooth data fluctuations and identify trends over time.
8. Exponential Smoothing: A forecasting method that assigns exponentially decreasing weights to past observations for predicting future demand.
9. Error Metrics: Methods such as Mean Absolute Deviation (MAD), Mean Square Error (MSE), and Mean Absolute Percentage Error (MAPE) are employed to evaluate the accuracy of the forecasting models and determine the best-fit parameters [13].
10. Conclusion Phase: The final step synthesizes the findings from the data analysis to develop actionable insights and recommendations. These conclusions are designed to address the

identified problems, offering practical solutions to optimize raw material supply scheduling, improve storage utilization, and enhance overall operational efficiency.

RESULT AND DISCUSSION

Raw Material Supply

The recapitulation of raw material supplies distributed to the Gwalk stand from each supplier over 14 days in July 2024 provides valuable insights into the contribution of each supplier to the availability of raw materials required by Company X. The raw material supplies provided by the suppliers are recorded as gross weight, which indicates that a portion of these materials is still in their raw state and must undergo kitchen processes, including waste removal and preparation, before being transformed into finished goods ready for sale.

Waste refers to the portion of raw materials that cannot be processed or must be discarded, such as inedible parts of vegetables. Additionally, waste arises from the reduction in material weight during processing. The table highlights that when raw materials enter the production process, all materials undergo kitchen preparation, resulting in a decrease in weight due to shrinkage or the removal of non-usable parts, such as vegetable cores. This emphasizes the importance of considering waste and processing loss in managing raw material supply effectively.

Bill of Materials for Each Menu

The bill of materials (BOM) is utilized to identify the specific raw materials and their required quantities for each menu item. This data provides detailed information on the components necessary for preparing each dish, ensuring accurate planning and efficient use of resources. Below is the data outlining the raw materials required for each menu item.

Table 1. Bill of Materials for Each Menu

Caesar Teaser (Rp. 56.000,-)		Game of Truffle (Rp. 65.000,-)		The Hulk (Rp. 60.000,-)	
BAHAN BAKU	QTY	BAHAN BAKU	QTY	BAHAN BAKU	QTY
Sayur	100 gram	Sayur	100 gram	Sayur	90 gram
Egg	0,5 butir	Aragula	5 gram	Kale	5 gram
Chicken Plain	40 gram (1 pac)	Egg	0,5 butir	Onion	8 gram
Smoked Beef	20 gram (1 pac)	Smoked Beef	20 gram (1 pac)	Kubis	15 gram
Parmesan	2,5 gram	Jamur	20 gram	Chicken Plain	40 gram (1 pac)
Cracker	15 gram	Mozarella	25 gram	Edamame	25 gram
		Crouton	15 gram	Wijen	2,5 gram
Waldorf Chicken (Rp. 60.000,-)		**Happy Garden (Rp. 60.000,-)**		**Konichiwa Salad (Rp. 60.000,-)**	
BAHAN BAKU	QTY	BAHAN BAKU	QTY	BAHAN BAKU	QTY
Sayur	90 gram	Sayur	90 gram	Sayur	90 gram
Aragula	5 gram	Aragula	5 gram	Onion	8 gram
Onion	8 gram	Onion	8 gram	Egg	0,5 butir
Celery	8 gram	Carrot	15 gram	Crabstick	30 gram (1 pac)
Chicken Plain	40 gram (1 pac)	Egg	0,5 butir	Cherry Tomato	10 gram (4-5 slice)
Cherry Tomato	10 gram (4-5 slice)	Chicken Plain	40 gram (1 pac)	Corn	30 gram
Grape	35 gram	Smoked Beef	20 gram (1 pac)	Edamame	25 gram
Feta	21 gram	Cherry Tomato	10 gram (4-5 slice)	Bonito	4 gram
Cracker	15 gram	Parmesan	2,5 gram		
		Fried Garlic	2,5 gram		
		Cracker	15 gram		
Wow Wow West (Rp. 60.000,-)		**Cajun Chicken (Rp. 60.000,-)**		**Tasty Thai (Rp. 60.000,-)**	
BAHAN BAKU	QTY	BAHAN BAKU	QTY	BAHAN BAKU	QTY
Sayur	90 gram	Sayur	90 gram	Sayur	90 gram
Kale	10 gram	Kale	5 gram	Carrot	15 gram
Carrot	15 gram	Onion	20 gram	Chicken Plain	40 gram (1 pac)
Onion	20 gram	Egg	0,5 butir	Grape	35 - 40 gram
Egg	0,5 butir	Chicken Plain	40 gram (1 pac)	Jicama	15 gram
Chicken Plain	40 gram (1 pac)	Smoked Beef	20 gram (1 pac)	Fried Shallot	15 gram
Cherry Tomato	20 gram (8-10 slice)	Cherry Tomato	20 gram (8-10 slice)		
Mozarella	25 gram	Corn	30 gram		
		Crouton	15 gram		

Mix Mix (Rp. 56.000,-)		The Yogi (Rp. 60.000,-)		Chop Suey (Rp. 60.000,-)	
BAHAN BAKU	QTY	BAHAN BAKU	QTY	BAHAN BAKU	QTY
Sayur	90 gram	Sayur	90 gram	Sayur	100 gram
Carrot	15 gram	Kale	5 gram	Carrot	15 gram
Cucumber	15 gram	Carrot	15 gram	Kubis	15 gram
Kubis	15 gram	Onion	8 gram	Chicken Plain	40 gram (1 pac)
Egg	0,5 butir	Cucumber	15 gram	Orange	35 gram (7 slice)
Tempe	2 pcs	Chicken Plain	40 gram (1 pac)	Wijen	2,5 gram
Potato	25 gram (4-5 slice)	Cherry Tomato	10 gram (4-5 slice)	Cracker	15 gram
Cherry Tomato	10 gram (4-5 slice)	Feta	21 gram		
Fried Shallot	15 gram	Corn	30 gram		
Ranch Chicken (Rp. 60.000,-)		**Autumn Crunch (Rp. 60.000,-)**		**Seoul Yummy (Rp. 60.000,-)**	
BAHAN BAKU	QTY	BAHAN BAKU	QTY	BAHAN BAKU	QTY
Sayur	90 gram	Sayur	90 gram	Sayur	90 gram
Celery	8 gram	Aragula	5 gram	Onion	8 gram
Chicken Plain	40 gram (1 pac)	Carrot	15 gram	Carrot	15 gram
Cherry Tomato	25 gram (10-12 slice)	Tofu	2 pcs	Egg	0,5 butir
Beetroot	15 gram	Orange	35 gram (7 slice)	Crabstick	30 gram (1 pac)
Potato	35 gram (8 slice)	Feta	21 gram	Mushroom	20 gram
Mozarella	25 gram			Jicama	15 gram
Crouton	15 gram				

Chiller Capacity Data

Company X has a total of 15 chillers. However, only a few shelves in each chiller are available for storing both raw and processed raw materials. This limitation is due to space constraints, which result in some chillers being used to store a mix of different types of materials. Below is the data detailing the available chiller capacity for storage purposes:

Table 2. Chiller Capacity Data

Letak	Nama	Kapasitas	Terpakai	Kegunaan
Ruang Mg	Chiller 1	568 kg	568 kg	Menyimpan sayur 80 kg, Kale
	Chiller 2	568 kg	568 kg	Menyimpan sayur 80 kg, Aragula
	Chiller 3	510 kg	510 kg	Menyimpan sayur 40 kg, Kubis, Celey
	Chiller 4	568 kg	568 kg	Menyimpan 50 box mg
	Chiller 5	180 kg	180 kg	Menyimpan 24 box mg
Lorong Mg	Chiller 6	180 kg	25 kg	Menyimpan Kale 10 pack
				Menyimpan Celery 15 pack
Kitchen	Chiller 7	180 kg	108 kg	Menyimpan Chicken Plain 60 pack
				Menyimpan Smoked Beef 100 pack
				Menyimpan Crabstick 20 pack
Condiment	Chiller 8	1081 kg	540,5 kg	Menyimpan Anggur 60 pack
				Menyimpan Onion 25 pack
				Menyimpan Edamame 30 pack
				Menyimpan Kubis 15 pack
				Menyimpan Jamur 20 pack
				Menyimpan Bengkuang 30 pack
				Menyimpan Wortel 30 pack
				Menyimpan Mozzarella 70 pack
				Menyimpan Tofu 10 pack
	Chiller 9	228 kg	228 kg	Menyimpan Ayam Mentah 80 kg
Gudang	Chiller 10	568 kg	189 kg	Menyimpan Parmesan 14 pack
	Chiller 11		284 kg	Menyimpan Feta 21 pail
	Chiller 12	370 kg	370 kg	Menyimpan Tortilla 244 pack
	Chiller 13	371 kg	371 kg	
	Chiller 14	372 kg	372 kg	
	Chiller 15	373 kg	373 kg	Menyimpan Beef Mentah 200 pack

After performing the forecasting calculations using the Exponential Smoothing method with alpha values ranging from 0.1 to 1, and calculating the error rate in the forecast, the next step is to select the optimal alpha (α) based on the error rate results. The purpose is to determine which alpha value provides the lowest error, as a smaller error indicates a more accurate forecast. Below is the recap of the error rate calculations from the forecasting trials using alpha (α) values ranging from 0.1 to 1.

Table 3. Exponential Smoothing

Menu	FE	0,1	0,2	0,3	0,4	0,5	0,6	0,7	0,8	0,9	1
	MAD	275,75	285,67	294,98	294,98	343,13	365,85	387,83	408,88	428,61	446,40
Caesar Teaser	MSE	120440,91	121800,06	128157,21	128157,21	150221,82	365,85	182206,72	201834,58	223789,16	247752,40
	MAPE	0,018	0,018	0,019	0,019	0,022	0,024	0,025	0,026	0,028	0,029
	MAD	56,57	52,20	48,52	48,52	48,70	48,35	50,21	53,88	57,31	60,40
Waldorf Chicken	MSE	4278,92	3778,94	3580,60	3580,60	3577,45	48,35	3822,10	4019,03	4267,36	4566,00
	MAPE	0,010	0,009	0,008	0,008	0,008	0,008	0,009	0,009	0,010	0,010
	MAD	97,09	93,14	90,57	90,57	98,29	104,74	110,85	116,58	121,83	126,40
Happy Garden	MSE	12239,06	12216,89	12676,20	12676,20	14335,39	104,74	16697,52	18149,16	19782,43	21574,80
	MAPE	0,031	0,030	0,029	0,029	0,031	0,033	0,035	0,037	0,038	0,040
	MAD	391,30	454,98	505,63	505,63	573,73	594,19	607,70	615,85	635,24	648,00
Cajun Chicken	MSE	449499,05	477289,12	511456,34	511456,34	589667,34	594,19	683114,29	739517,82	805354,19	883546,00
	MAPE	0,151	0,189	0,218	0,218	0,256	0,267	0,274	0,277	0,287	0,293
	MAD	88,40	98,21	106,63	106,63	119,58	124,29	128,03	130,98	133,67	138,60
Game of Truffle	MSE	15515,44	16937,81	18459,13	18459,13	21759,17	124,29	25653,42	27995,95	30725,42	33962,60
	MAPE	0,060	0,067	0,073	0,073	0,083	0,086	0,088	0,090	0,092	0,095
	MAD	26,34	27,30	28,25	28,25	31,45	33,61	35,90	38,31	40,82	43,40
Konichiwa	MSE	857,66	950,49	1055,44	1055,44	1308,56	33,61	1634,67	1833,36	2063,02	2332,60
	MAPE	0,076	0,071	0,067	0,067	0,065	0,066	0,072	0,077	0,083	0,089
	MAD	48,72	45,41	43,53	43,53	42,19	43,03	47,10	50,72	54,65	58,60
Wow Wow West	MSE	3536,22	3329,27	3321,52	3321,52	3560,73	43,03	3938,17	4153,66	4382,41	4623,00
	MAPE	0,046	0,047	0,049	0,049	0,054	0,058	0,062	0,067	0,071	0,076
	MAD	23,99	23,27	22,77	22,77	23,70	25,70	27,60	29,32	30,81	32,00
The Hulk	MSE	900,58	867,49	875,17	875,17	954,65	25,70	1075,73	1143,97	1214,00	1282,80
	MAPE	0,044	0,042	0,042	0,042	0,044	0,047	0,051	0,054	0,057	0,059

Menu	FE	0,1	0,2	0,3	0,4	0,5	0,6	0,7	0,8	0,9	1
	MAD	12,91	10,49	8,61	8,61	7,28	7,58	8,08	8,50	9,09	9,80
The Yogi	MSE	211,90	171,65	151,48	151,48	141,79	7,58	151,96	161,64	174,14	189,80
	MAPE	0,040	0,032	0,026	0,026	0,022	0,023	0,025	0,026	0,028	0,030
	MAD	16,17	16,36	16,08	16,08	14,54	13,45	12,74	12,07	12,40	12,60
Ranch Yogurt	MSE	288,53	289,43	292,67	292,67	291,00	13,45	279,81	274,07	269,99	268,60
	MAPE	0,036	0,037	0,037	0,037	0,033	0,031	0,029	0,028	0,028	0,029
	MAD	26,76	26,43	26,34	26,34	26,65	28,26	29,97	31,78	33,71	35,80
Seoul Yummy	MSE	858,28	920,48	999,65	999,65	1193,66	28,26	1433,93	1574,38	1731,74	1910,60
	MAPE	0,088	0,087	0,087	0,087	0,088	0,093	0,099	0,104	0,110	0,116
	MAD	9,55	8,83	8,64	8,64	8,51	8,53	8,57	8,61	8,63	8,60
Tasty Thai	MSE	160,70	139,77	128,78	128,78	122,04	8,53	123,57	125,60	128,13	131,00
	MAPE	0,018	0,017	0,016	0,016	0,016	0,016	0,016	0,016	0,016	0,016
	MAD	19,43	21,00	22,62	22,62	25,69	26,98	28,01	28,71	29,08	31,60
Chop Suey	MSE	888,45	943,87	1016,78	1016,78	1196,65	26,98	1421,61	1555,77	1708,53	1884,80
	MAPE	0,042	0,046	0,050	0,050	0,057	0,060	0,063	0,065	0,066	0,072
	MAD	26,74	27,08	29,76	29,76	32,71	33,23	33,27	32,94	33,30	34,00
Autumn Crunch	MSE	1290,41	1346,22	1406,54	1406,54	1500,38	33,23	1564,48	1595,93	1631,88	1674,80
	MAPE	0,059	0,060	0,067	0,067	0,074	0,075	0,075	0,074	0,075	0,077
	MAD	17,02	16,16	15,71	15,71	15,71	16,02	16,45	16,98	17,56	18,20
Mix Mix	MSE	342,27	303,69	286,40	286,40	290,35	16,02	326,30	353,97	388,67	431,80
	MAPE	0,146	0,138	0,133	0,133	0,131	0,133	0,135	0,139	0,142	0,147

Based on the error rate calculations using the Exponential Smoothing method with alpha (α) values ranging from 0.1 to 1, the smallest forecast error was achieved with an alpha value of 0.1. After determining the optimal period for the Moving Average method and the appropriate alpha (α) for the Exponential Smoothing method, the next step is to compare the error rates from both forecasting methods. According to the calculations, the error rate for the Moving Average method was based on a 3-month period, while the Exponential Smoothing method used an alpha (α) of 0.1. The following results show the error rates for both methods:

Table 4. Exponential Smoothing and Moving Average

Menu	Moving Average			Exponential Smoothing		
	MAD	MSE	MAPE	MAD	MSE	MAPE
Caesar Teaser	322,11	115783,52	2,1%	275,75	120440,91	1,8%
Waldorf Chicken	30,00	1332,89	0,5%	56,57	4278,92	1,0%
Happy Garden	91,56	11420,22	2,9%	97,09	12239,06	3,1%
Cajun Chicken	480,56	234916,78	28,6%	391,30	449499,05	15,1%
Game of Truffle	87,44	8323,30	6,6%	88,40	15515,44	6,0%
Konichiwa	22,33	783,74	4,0%	26,34	857,66	4,6%
Wow Wow West	27,22	1513,30	3,8%	48,72	3536,22	7,6%
The Hulk	15,33	455,78	3,0%	23,99	900,58	4,4%
The Yogi	1,89	7,59	0,6%	12,91	211,90	4,0%
Ranch Yogurt	16,78	393,52	3,9%	16,17	288,53	3,6%
Seoul Yummy	32,22	1605,41	11,2%	26,76	858,28	8,8%
Tasty Thai	9,11	98,59	1,7%	9,55	160,70	1,8%
Chop Suey	20,44	526,15	4,9%	19,43	888,45	4,2%
Autumn Crunch	31,78	1236,37	7,8%	26,74	1290,41	5,9%
Mix Mix	10,67	142,44	9,3%	17,02	342,27	14,6%

Based on the comparison of the error rates between the Moving Average method with a 3-month period and the Exponential Smoothing method with an alpha (α) of 0.1, it can be concluded that the Exponential Smoothing method with an alpha (α) of 0.1 yields the smallest error rate. This comparison allows the researcher to more accurately determine future requirements based on the forecasting results. Therefore, the future demand can be forecasted by considering the calculations made using the Exponential Smoothing method with an alpha (α) of 0.1. Below is the data for the future demand forecast:

Table 5. Future needs

Menu	May-25	Jun-25	Jul-25	Aug-25	Sep-25	Oct-25	Total (Porsi)
Caesar Teaser	15827	15827	15781	15772	15774	15717	94698
Waldorf Chicken	5950	5950	5939	5933	5930	5924	35626
Happy Garden	3233	3233	3218	3213	3210	3195	19301
Cajun Chicken	1692	1692	1683	1831	1823	1803	10525
Game of Truffle	1355	1355	1348	1374	1373	1367	8172
Konichiwa	578	578	576	580	576	575	3463
Wow Wow West	720	720	709	703	706	703	4260
The Hulk	515	515	515	521	523	522	3111
The Yogi	306	306	309	309	310	311	1851
Ranch Yogurt	431	431	433	435	437	435	2603
Seoul Yummy	304	304	307	308	310	305	1839
Tasty Thai	552	552	552	550	548	548	3302
Chop Suey	423	423	423	430	428	427	2554
Autumn Crunch	415	415	416	424	425	422	2517
Mix Mix	138	138	135	136	135	133	816

Gross Raw Material Requirements

After performing the forecasting calculations, the results indicate the raw material requirements for the future. Raw material needs are divided into two types: gross requirements and net requirements. The gross raw material requirement refers to the future demand or the product demand for each period, without considering the initial inventory. The gross requirement is calculated as follows:

Gross Requirement = Sales Portion x Raw Material Quantity per Serving

For example, to calculate the gross requirement for each menu item, the calculation is as follows:

Table 6. Caesar teaser

Menu	May-24	Jun-24	Jul-24	Aug-24	Sep-24	Oct-24	Total (Porsi)	Rata-Rata/hari (ALL STAND)	Rata-rata Kebutuhan/stand
Caesar Teaser	15827	15827	15781	15772	15774	15717	94698	515	47

The forecast calculation for the Caesar Teaser menu using the Exponential Smoothing method with an alpha (α) of 0.1, spanning from May 2025 to October 2025, indicates a total of 94,698 servings, with sales occurring across 11 stands. The total forecast for each month is as follows:

1. May 2025 = 15,827 servings
2. June 2025 = 15,827 servings
3. July 2025 = 15,781 servings
4. August 2025 = 15,772 servings
5. September 2025 = 15,774 servings

Therefore, the total forecast for the Caesar Teaser menu over 6 months, across 11 stands, is 94,698 servings. To calculate the daily forecast for the Caesar Teaser menu, the following calculation is used:

$$\text{Daily Forecast for All Stands} = \frac{94.698 \text{ servings}}{184 \text{ hari (6 month)}} = 515 \text{ servings per day for all stands.}$$

To determine the daily forecast for each stand, the calculation is as follows:

$$\text{Daily Forecast per Stand} = \frac{515 \text{ servings}}{11 \text{ stand}} = 47 \text{ servings per stand per day.}$$

CONCLUSION

This study successfully developed optimized raw material supply scheduling for Company X to address challenges related to limited storage capacity and fluctuating demand. By applying advanced forecasting methods, such as Exponential Smoothing with an optimal alpha value, the research identified strategies to align raw material supply with production requirements effectively. The findings demonstrated the importance of balancing procurement schedules with storage constraints to minimize waste and ensure the freshness of raw materials. The integration of gross and net requirement calculations enabled precise forecasting of future needs, which significantly enhanced inventory management. Ultimately, the optimized scheduling system proposed in this study offers a robust solution for improving operational efficiency, reducing costs associated with waste and overstocking, and enhancing the overall performance of the supply chain. These strategies not only enable smoother operations but also help Company X sustain its competitive advantage in the food and beverage industry by consistently delivering high-quality, fresh products to consumers.

REFERENCE

[1] Amorim, P., Meyr, H., Almeder, C., & Almada-Lobo, B. (2013). Managing perishability in production-distribution planning: a discussion and review. *Flexible Services and Manufacturing Journal*, *25*, 389-413.

[2] Lee, Y. H., & Kim, S. H. (2002). Production–distribution planning in supply chain considering capacity constraints. *Computers & industrial engineering*, *43*(1-2), 169-190.

[3] Ben-Daya, M., As'Ad, R., & Seliaman, M. (2013). An integrated production inventory model with raw material replenishment considerations in a three layer supply chain. *International Journal of Production Economics*, *143*(1), 53-61.

[4] Wrigley, E. A. (2017). The supply of raw materials in the industrial revolution. In *The causes of the industrial revolution in England* (pp. 97-120). Routledge.

[5] Wei, X., Xu, G., & Kusiak, A. (2014). Modeling and optimization of a chiller plant. *Energy*, *73*, 898-907.

[6] Khan, R. S., Grigor, J., Winger, R., & Win, A. (2013). Functional food product development–Opportunities and challenges for food manufacturers. *Trends in food science & technology*, *30*(1), 27-37.

[7] Spinelli, S., Masi, C., Dinnella, C., Zoboli, G. P., & Monteleone, E. (2014). How does it make you feel? A new approach to measuring emotions in food product experience. *Food Quality and Preference*, *37*, 109-122.

[8] Gao, K., Huang, Y., Sadollah, A., & Wang, L. (2020). A review of energy-efficient scheduling in intelligent production systems. *Complex & Intelligent Systems*, *6*, 237-249.

[9] Du, B., Tan, T., Guo, J., Li, Y., & Guo, S. (2021). Energy-cost-aware resource-constrained project scheduling for complex product system with activity splitting and recombining. *Expert Systems with Applications*, *173*, 114754.

[10] M. Athoillah And M. I. Irawan, "Perancangan Sistem Informasi Mobile Berbasis Android Untuk Kontrol Persediaan Barang Di Gudang," Jurnal Sains Dan Seni Pomits, Vol. 1, No. 1, Pp. 1–6, 2013.

[11] K. Alim, B. Matsaany, and A. Rahmawati, "Diversification of Jakarta Islamic Index (JII) Stock Optimal Portfolio for the Period 2018-2023", J Statistika, vol. 16, no. 2, pp. 585–593, Dec. 2023.

[12] A. Amiseno, "Analisa Perbandingan Statistik Kelemahan SPI dan Biaya Politik sebagai Pemoderasi Kerugian Keuangan Daerah pada Belanja Daerah ", J Statistika, vol. 12, no. 2, pp. 17–22, Dec. 2019.

[13] G. Anuraga, A. Indrasetianingsih, and M. Athoillah, "Pelatihan pengujian hipotesis statistika dasar dengan software r," BUDIMAS: Jurnal Pengabdian Masyarakat, vol. 3, no. 2, pp. 327–334, 2021.