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Assessment and Feedback: Student Template

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Contents

INTRODUCTION

The report is complete analysis of the supply chain and sales trends within the operational environment of a company Winter Rock. Following these key aspects, the report will discuss sales analysis, forecasting, distribution planning, strategic implications of new product demands. The report starts with the sales trend from last year. It will use the centered moving average to smooth away irregularities in time series data that may not be very easy to observe, thus helping bring out underlying patterns. This will lead to further analysis of seasonal sales variations, which are basically required for marketing strategies and tendency. Next, we look at the forecasting model of products sold all year round, one of which is the Single Exponential Smoothing method, of which we use to forecast future sales. This section does not outline the forecast results only but also discusses the implications for management. This is in the line with distribution planning, where the optimization model using a linear programming model in supply chain logistics, will be undertaken. This has significance towards cost reduction, bearing in mind the efficiency of product distribution across regions. The strategic planning for the approaches and their implementation into action would put them in a good position, it means that this company is in position to definitely strengthen in the market for sustainable growth.

SECTION 2: INVESTIGATING THE SALES TRENDS

The data was treated carefully to offer a 12-month centered moving average, which removed the irregularities within the data and was able to get a view of the trend. Utilising this moving average, the original sales data with the de detrended values indicated deviation from the underlying trend The detrended values were collected in a seasonal matrix, the intention of which was to evaluate changes in sales every month for different years.

Month	Seasonal Index 2019	Seasonal Index 2020	Seasonal Index 2021	Seasonal Index 2022	Annual Seasonal Factor	Median Seasonal Factor
January		2,05,351.83	2,44,503.00	3,22,512.54	2,57,455.79	2,44,503.00
February		-1,19,278.75	-1,47,861.88	-1,49,954.67	-1,39,031.76	-1,47,861.88
March		-2,18,492.75	-2,37,283.54	-2,60,738.33	-2,38,838.21	-2,37,283.54
April		-2,06,012.79	-2,20,781.29	-2,46,271.25	-2,24,355.11	-2,20,781.29
May		-1,84,963.25	-1,89,798.88	-2,16,308.04	-1,97,023.39	-1,89,798.88
June		-9,696.38	18,344.25	25,907.00	11,518.29	18,344.25
July	79,068.46	52,402.33	1,15,638.25		82,369.68	79,068.46
August	-39,657.54	-70,850.88	-81,880.04		-64,129.49	-70,850.88
September	-1,917.88	-36,267.21	-47,934.00		-28,706.36	-36,267.21
October	1,67,026.08	1,80,538.33	1,66,328.13		1,71,297.51	1,67,026.08
November	1,96,220.13	2,04,498.75	1,89,797.17		1,96,838.68	1,96,220.13
December	1,30,596.29	1,50,261.29	1,16,979.88		1,32,612.49	1,30,596.29

Figure 1: Time series analysis

This plot of time series is done between actual sales and centered moving average. These two plots show the smoothing effect of CMA-12 and give the feeling of trends in sales without monthly fluctuations. The analysis goes a step further by the analysing of seasonal matrix, categorizing detrended values between months and years to demonstrate variations of sales around the average trend at different times. It also determines the median seasonal profile for the detrended sales, which displays the average of monthly sales deviations over all the years. The following critical seasonal trends were pinpointed by the graph.

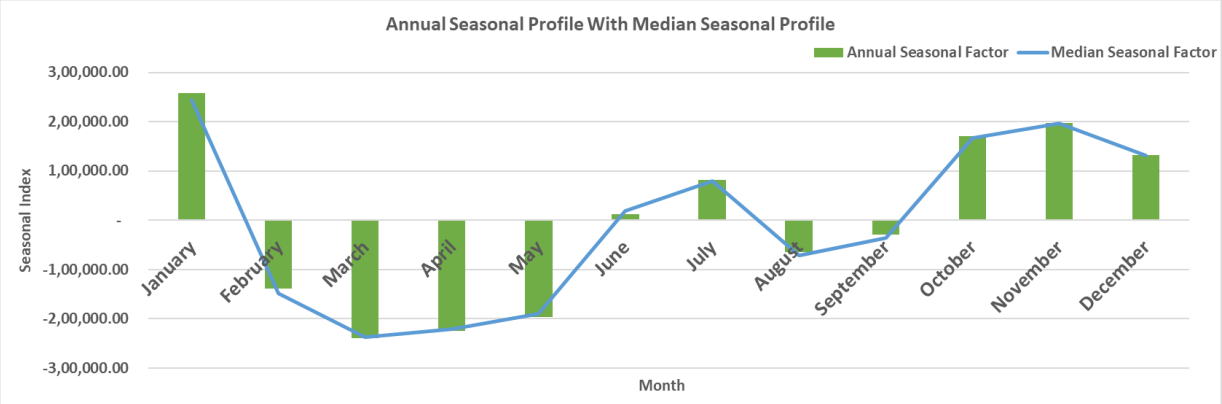


Figure 2: Annual Seasonal Profile

In Winter and Early Spring, the peak in sales for January is very sharp, most likely because of the demand for skiing and snowboarding products in the winter period. This would suggest that consumers purchase to be ready for winter sports activities. Sales dip sharply from March to May, quite likely indicating a period of relative quieting in business after the winter season. This again is an opportunity for promotional efforts to keep the momentum in sales on track. Sales start picking up from July and keep increasing from around October and November, peaking early in preparedness for the winter season.

This observation will have direct consequence to the operational and strategic judgments of Winter Rock:

Marketing efforts should be reinforced during the low sales period, i.e., late spring through the beginning of summer, to compensate for the seasonal decline. Promotions, discounts, and marketing efforts in these months may provide a flow of revenue. The inventory level should be according to the seasonal demand. So, pre-stocking should be higher in the months from late autumn to early winter than during the spring and summer season. Scaling of operations, staffing, and logistics should be done to meet surges of increased demand during peak seasons. It should utilize the resources to their full potential during off-peak times, maintaining the same level of operational efficiency but keeping the costs lower.

SECTION 3: FORECASTING SALES OF YEAR-ROUND PRODUCTS

In here we have applied Single Exponential Smoothing (SES) in forecasting sales for the year-round products, all-purpose hiking shoes and t-shirts. It pertains to the inventory optimization model for a period of six months before December 2022. Very simple and effective forecasting, the data has little to no trend/seasonality effect.

Alpha Parameter	0.5

Metrics	In Sample	Out Sample
Error	7	6,924
Mean Absolute Error	17185.06	22470.33
Mean Squared Error	619306086.5	649371246.8

The SES model for this analysis is parameterized with an alpha value of 0.5. This is just enough so the model can be sensitive to new sales information but without overreacting to changes, while not ignoring such change. This middle-of-the-road approach should help keep reasonable levels of forecast accuracy, but without the complexities in more intricate models. The performance of the SES model is assessed in terms of in-sample and out-of-sample accuracy measures. In-sample, the model reflects a mean error of 7, representing negligible bias in the forecast. The mean absolute error (MAE) is 17,185, showing the average magnitude of forecast errors, whereas the mean squared error (MSE) sits at about 619 million, which shows the variance of the forecast errors. The out-of-sample metrics indicate a mean error of 6,924, a mean absolute error of 22,470, and a mean squared error of about 649 million. These measures indicate an increase only in the forecast error from in-sample data ranges to out-of-sample data ranges, since the model is now concluding into unexplored region.

Although the SES model provides a simple and low-computational-requirement way of forecasting, the surge of error metrics out of the sample must signal that its use should be in caution, particularly in strategic decisions involving large capacity expansion or investment in inventory. Winter Rock would be interested in more developed forecasting models or even maybe collective methods to optimize their forecast accuracy, especially for the long term. This would ensure support for its decision-making process to be far more robust, with operational capabilities much better matched to the dynamics of the market's demand.

SECTION 4: DISTRIBUTION PLAN

Now the company has a strategic challenge of optimization of its distribution network to be aligned with demands of local market entry. Its two major distribution centers in operation are in Manchester and London, through which the company ensures smooth flow with good distribution of its products to areas such as East and West, and North. Such a situation would necessitate very detailed analysis in order to develop the most cost-effective distribution strategy that does not defy the regional demand constraints and the capacity constraints.

Decision Variables and Objective Function

In this optimization problem, the decision variables represent the quantity of goods to be shipped from each distribution center to each region:

- Xem: Items shipped from Manchester to East.
- Xwm: Items shipped from Manchester to West.
- Xnm: Items shipped from Manchester to North.
- Xel: Items shipped from London to East.
- Xwl: Items shipped from London to West.
- Xnl: Items shipped from London to North.

Objective Function = Total Cost = (15 * X_em) + (21 * X_wm) + (17 * X_nm) + (23.5 * X_el) + (25.5 * X_wl) + (22 * X_nl)

Region	Demand	Distribution Centre	Unit Cost
East	2000	Manchester	15
East	2000	London	23.5
West	930	Manchester	21
West	930	London	25.5
North	2200	Manchester	17
North	2200	London	22

Distributor Capacity				Used	Limit
Manchester Capacity	1	1	1	2500	2500
London Capacity	1	1	1	2630	3000

East Region Demand	1	1		2000	2000
West Region Demand	1	1		930	930
North Region Demand	1	1		2200	2200

CONSTRAINTS

Capacity Constraints: The capacities of the Manchester and London distribution centers are limited to 2,500 and 3,000 units, respectively, leading to the following constraints:

- **Manchester:** $Xem+Xwm+Xnm \leq 2500$
- **London:** $Xel+Xwl+Xnl \leq 3000$

Demand Constraints: Each region has a specific demand that must be met precisely, translating to:

- **East:** $Xem+Xel=2000$
- **West:** $Xwm+Xwl=930$
- **North:** $Xnm+Xnl=2200$

Optimization Approach

In this LP problem, the linear model used an appropriate solver that gave the optimal quantities for each of the decision variables. From the solver output, a distribution plan that effectively utilizes the capacity and does not have any excess but meets the demand of the regions.

Decision Variables	X_em	X_wm	X_nm	X_el	X_wl	X_nl
	2000	0	500	0	930	1700

From Manchester, it can supply 2000 units to the East, 500 units to the North, and 0 units to the West. From London, 0 units East, 930 units West, and 1700 units North.

This is part of distribution, ensuring that Manchester is running at full, and London is running below full with some overhead room for change or scaling.

Total Distribution Cost

Total Distribution Cost	99615

The cost of this optimal distribution plan totals £99,615. This is determined by summing up the products of each route's respective units shipped and the unit cost, all optimized to keep expenses minimized as per the given constraints.

SECTION 5: MEETING NEW PRODUCT DEMAND

Now the company is considering the idea whether to offer a completely new, profitable product with bindings to mount skis to its customers. The strategic move comes at the time the firm evaluates its supplier options between Europe and the United States, each with varying cost structures and attendant risks brought by a market demand that is uncertain.

The two future scenarios, regarded as having an equal probability of 0.5 each, would amount to 500 units in a low-demand scenario and 1,000 in a high-demand scenario. This will be highly dependent on the return on investment: cost efficiency and the risk that comes with the individual supplier.

	EU	US
Selling Price Per Unit Skis	150	150
Fixed Cost	0	5000
Variable Cost	120	100

Both suppliers offer the skis at a retail price of £150 per unit

Profit Calculation for Each Scenario:

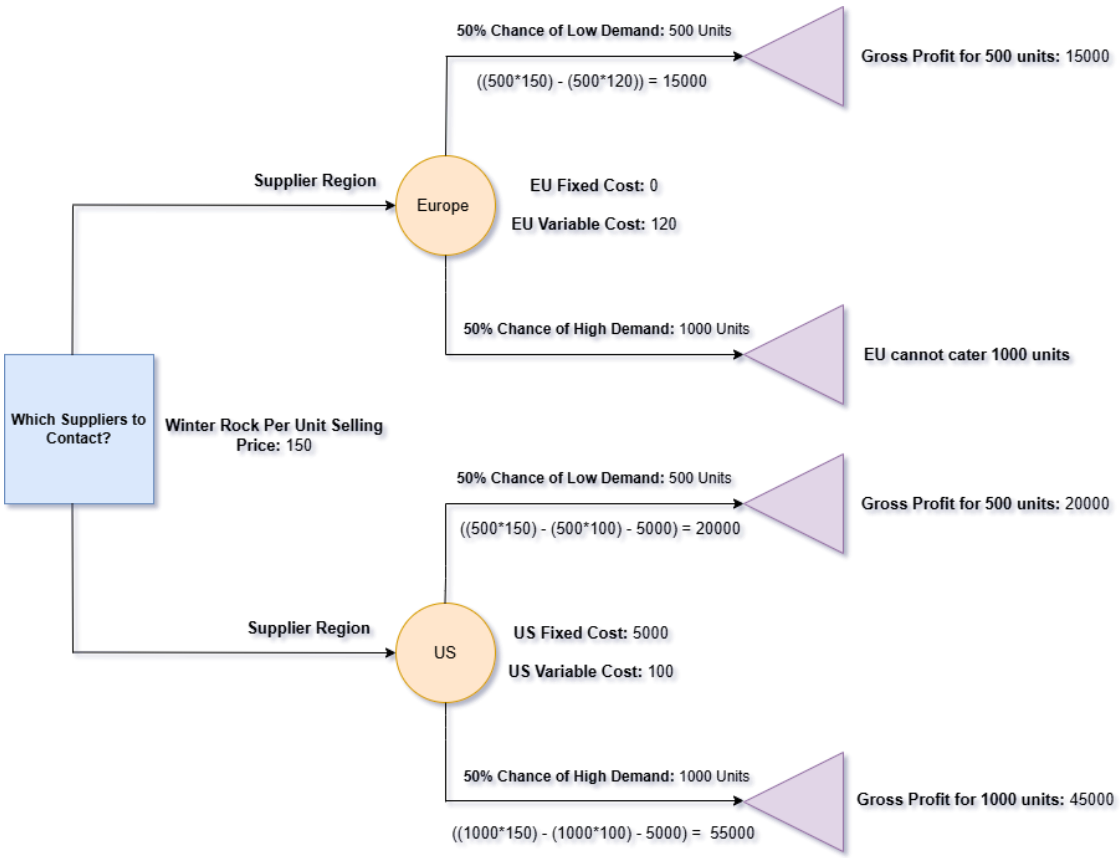
The profit for each supplier under different demand scenarios is calculated as:

Profit=(Price per unit×Quantity)−(Fixed Costs+Variable Costs×Quantity)Profit=(Price per unit ×Quantity)−(Fixed Costs+Variable Costs×Quantity)

United States							
	Probability	**Demand**	**Fixed Cost**	**Variable Cost**	**Cost Price**	**Revenue**	**Profit**
Low Demand (500 Skis)	0.5	500	5000	100	55000	75000	20000
High Demand (1000 Skis)	0.5	1000	5000	100	105000	150000	45000

Europe							
	Probability	**Demand**	**Fixed Cost**	**Variable Cost**	**Cost Price**	**Revenue**	**Profit**
Low Demand (500 Skis)	0.5	500	0	120	60000	75000	15000
High Demand (1000 Skis)	0.5						

Decision Tree:



Strategic Considerations

Maximin Strategy (Risk-Averse):

Europe offers a single profit scenario of £15,000, limited by its inability to meet high demand.

The USA offers a minimum profit of £20,000, with potential up to £45,000, surpassing Europe even at the lowest expected profit. Even though USA offers greater profit ability than Europe, In conditions of uncertainty when the demand is low (below 500 units), Winter Rock will face high financial crisis due to the fixed cost of USA thus based on the risk-averse decision. It should consider Europe as a supplier as it would minimise the potential loses based on maximin rule.

Pros: Very less risk because there is no fixed cost.

Cons: Higher profits can't be made if demand exceeds the capacity of the supplier.

Maximax Strategy (Risk-Seeking):

The maximum possible profit with the European supplier is not feasible due to their capacity limitation.

The USA maximizes potential profits with £45,000 in high demand, making it the preferred choice for a risk-seeking strategy that aims to capitalize on the best-case scenario.

Pros: If the demand reaches 1000 skis, then there is potential to earn higher profits

Cons: Given the fixed cost of £5000, there can be a high financial risk if the demand comes low.

Expected Profit Maximization

Calculations for expected profits, considering both low and high demand scenarios significantly favour the USA with a combined expected profit of £32,500 as compared to Europe's £7,500. This decision metric suggests that on average USA gives better financial outcomes.

Pros: If the expected demand scenario is considered then it maximizes the potential returns.

Cons: If the demand turns out low there is a risk in assumption of initial upfront cost.

Recommendations:

Risk-Averse (Europe): Best for minimising the potential losses and bad for capitalizing on high demand.

Risk-Seeking (U.S): Best for maximizing profit if high demand occurs and very risky if the demand comes low.

Expected Profit Maximization (U.S.): Provides a very balanced approach, manages the potential risk and rewards by considering the expected scenarios.

Winter Rock should contract with the U.S. supplier based on Higher expected profit, which integrates both potential scenarios and provides a comprehensive fiscal outlook. Greater

flexibility in meeting demand fluctuations, especially the capacity to supply a larger quantity if the demand spikes. Risk mitigation, as the U.S. supplier offers a better minimum profit scenario, protecting Winter Rock against potential losses in less favorable market conditions.

SECTION 6: THE IMPACT OF MEETING NEW PRODUCT DEMAND

Now here Winter Rock will have to face perfectly unpredictable forecast demand, which can fall in the range from 200 up to 800 units of low-cost mountain skis newly introduced to the market. To reduce this uncertainty and improve their supply strategy, Winter Rock had an analysis through simulation with all the financial impact from different demand scenarios using two suppliers, one located in Europe and the other in the USA. This simulation gives a quantitative ground for choice among suppliers of whom to outsource based on the new demand expectation.

The simulation involved generating 1,000 random samples of demand between 200 and 800 units, using a uniform distribution to reflect potential market behavior. The simulation parameters include:

Highest Demand		800
Lowest Demand		201
First Four Digits of Student ID		2659
Capacity	**Supplier USA (1000 units)**	1000
Capacity	**Supplier Europe (500 units)**	500
Unit Selling Price		150

Parameters / Place	EU (£)	USA (£)
Variable Production Cost	120	100
Fixed Production Cost	0	5000
Average Revenue	63343.43	74178.75
Average Variable Cost	50674.74	49452.02
Average Profit	12668.68	19726.01
Std Dev	2861.49	8641.24

Europe as supplier:

Avg. Revenue: At 63,343.43 it is lower than USA but without any fixed cost.

Avg. Variable cost: At 50,674.74 it is very close to USA.

Avg. Profit: At 12668.68 the profit averaged but with a low standard deviation of 2861.49. This shows that in smaller magnitude the profits are more consistent.

USA as supplier:

Avg. Revenue: At 74,178.75 it is higher than Europe despite the fixed cost.

Avg. Variable cost: At 49,452.02 it is very close to Europe and lends an average production cost of 54452.02

Avg. Profit: At 19726.01 the profit averaged but with a high standard deviation of 8641.24. This shows that in high magnitude there could be an impact on the financial stability.

Results from the simulation data

The option of hosting in Europe is less risky, more so at demand levels that are not very high. Under such conditions, profits are stable but lower, in general as compared to the USA mainly from higher variable costs. In USA higher initial costs are incurred because of the fixed fee but lower variable costs may allow for higher profits at increased demands. However, the financial risk is at higher stakes and according to the demand so is the profit margin. The results of the simulation show that Average profit in the United States (£19,726.01) is higher compared to Europe (£12,668.68) due to its lower variable costs per unit. High standard deviation, as a measure of profit volatility significantly indicates a higher risk and reward scenario for the USA (8641.24) compared to Europe (2861.49).

In such uncertain demand with clear financial impacts, several other strategic components come in for the winter rock to consider its choice of supplier. The European supplier gives a better safety space if ever demand is potentially going to be low. There are no fixed costs to consider, this would give a kind of protection from huge financial losses if skis were not to sell as expected. The opportunity from the USA supplier is for higher profitability in scenarios of high demand, although with more risk due to fixed costs. This option could however be more lucrative if consumer response based on market research and promotional strategies used is positive. Employing both suppliers could balance risk and reward. While Europe could hold

the fort of base level demand the USA could tap into additional demand, which should optimize overall profitability.

CONCLUSION

The report details comprehensive analysis on sales trends, forecasting accuracy, and distribution strategies accompanied by analysis on the probability of new product introduction. From the analysis that has been conducted in the various sections it is a source deep in insights and recommendations that the company should undertake. Section 2 analyses sales trends, using 12 months centered moving average, due to significant fluctuations on an annual basis. The products depict peak sales in winter due to skiing and snowboarding demand, while the late spring depicts a drop in sales. It is for this reason that recommendations are made for marketing-targeted adjusting inventory levels to these trends. Section 3 applies Single Exponential Smoothing (SES) to the series of year-round product sales, such as hiking shoes and t-shirts with an unassuming trend effect. The model under moderate sensitivity provided acceptable forecast quality but a few errors, including percentage bias, were also introduced, proposing a better and more robust method of forecasting for purposes of strategic planning. Section 4 describes the optimization approach for the network distribution to Winter Rock through the use of major centers at Manchester and London in order to reach the regional demands. It therefore uses the linear programming model which will distribute the shipments strategically in reducing costs and at the same time utilizing the capacity fully in the fulfilment of a total distribution cost of £99,615. Thus, based on the analysis Winter Rock should supply 2000 units to East region from Manchester, 930 units to west region from London and North region should receive 500 units from Manchester and 1700 units from London. Section 5 reflects the introduction of ski bindings from two suppliers, one from Europe and one from the USA, with variable demand scenarios. From the analysis, in this scenario, it is assumed that the U.S. supplier will bring more profit and better risk management. Recommendations are in favour of contracting with the U.S. because of its ability to flex with potential high demand and balancing risk with reward. Section 6 deals with the problem of random demand for the new low-cost mountain skis and analyses by simulating the case where suppliers of the essential component are based in Europe rather than the US. According to demand, Europe has a better choice. In the U.S, there is potential

profit but also more risk due to fixed costs, while Europe also provides a safer and beneficial choice at a lower demand level.

Thus based on the analysis result of section 5 and 6, Winter Rock should consider entering the market with Europe as the supplier due to the less financial risk and variable demand, consequently when Winter Rock is confident of the higher demand it can transition to US as the supplier for greater profitability.