Section 1: Introduction

This report is crafted for Winter Rock, a prominent retailer in the UK specialising in winter sports gear. With a variety of ski, snow and climbing products from renowned global brands, the store attracts local customers and international tourists. The increase in winter tourism and the use of artificial dry ski slopes across the UK have increased the demand for Winter Rock's offerings.

The goal of this analysis is to understand current market demand and prepare for the next six months leading up to December 2022. This involves studying past sales trends, forecasting sales for both year-round and seasonal products, evaluating distribution strategies and planning for new product launches. As a data analytics consultant I have used sales data and advanced data analytics techniques like time series analysis and simulation to gain insights that shape the recommendations made in this report.

I will present the results of the analysis and propose strategies to improve Winter Rock's market position, ensure product availability and effectively meet the growing demand. These recommendations will help in making informed decisions regarding inventory management, marketing initiatives and resource allocation. Ultimately, implementing these suggestions will optimise operations and facilitate the company's growth.

Figure 1: Winter Ski gear

Section 2: Investigating Sales Trends

a) Produce a chart showing the original time series data and a centred moving average of length 12. Show the calculation of the centred moving average.

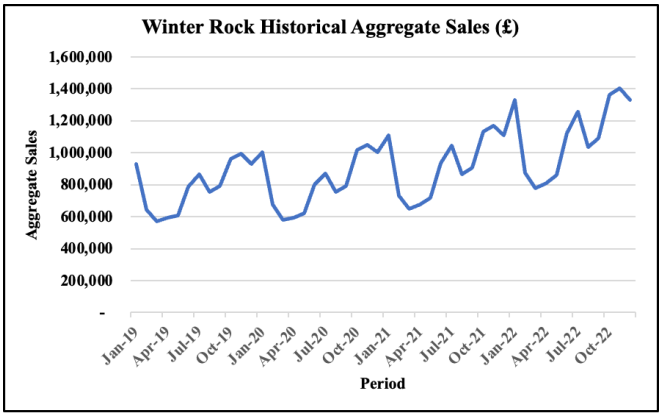

Figure 2:Original time series Winter Rock Sales Data

The Figure 2 shows that between January 2019 and October 2022 the sales of Winter Rock show fluctuating patterns with occasional peaks. For example, in January 2019, sales were £927,616 and the highest peak was in December 2022, reaching £1,332,201.

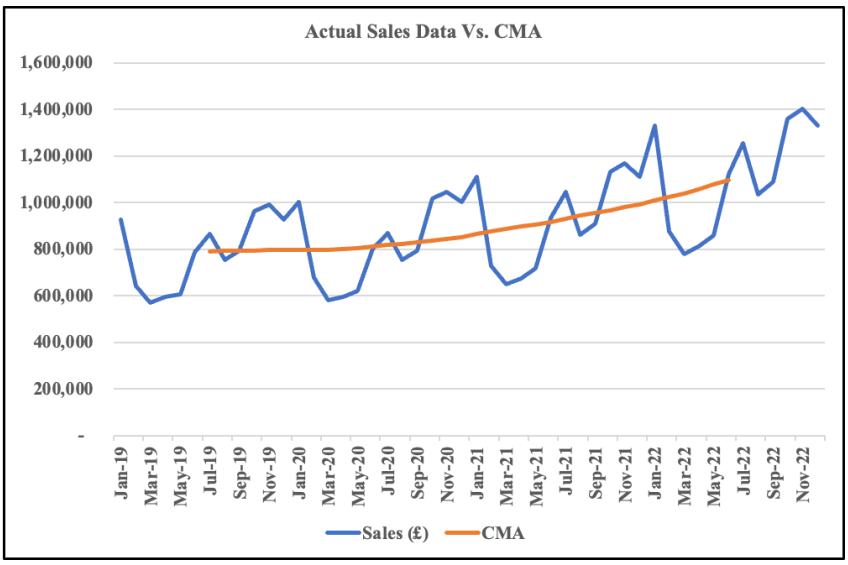

Figure 3: Actual Sales Data vs. Centred Moving Average

Figure 3 compares Winter Rock's actual sales data to the Centred Moving Average (CMA). The CMA shown as the orange line was calculated by averaging 12 months of data starting from January 2019. The initial value was determined in December 2019 using the formula "=AVERAGE(B3:B14)". CMA values were obtained by averaging pairs of moving average values, such as "=AVERAGE(D14:D15)" for the transition from December 2019 to January 2020. The CMA reveals a gradual increase in sales from around £800,000 in early 2019 to consistently exceeding £1,000,000 by mid-2021.

b) Provide a table showing the detrended monthly values for each year. Remember to use the most appropriate decomposition approach. This should be arranged in the form of a seasonal matrix.

Table 1: Seasonal Matrix

Seasonal Matrix				
Month	**2019**	**2020**	**2021**	**2022**
Jan		205352	244503	322513
Feb		-119279	-147862	-149955
Mar		-218493	-237284	-260738
Apr		-206013	-220781	-246271
May		-184963	-189799	-216308
Jun		-9696	18344	25907
Jul	79068	52402	115638	
Aug	-39658	-70851	-81880	
Sep	-1918	-36267	-47934	
Oct	167026	180538	166328	
Nov	196220	204499	189797	
Dec	130596	150261	116980	

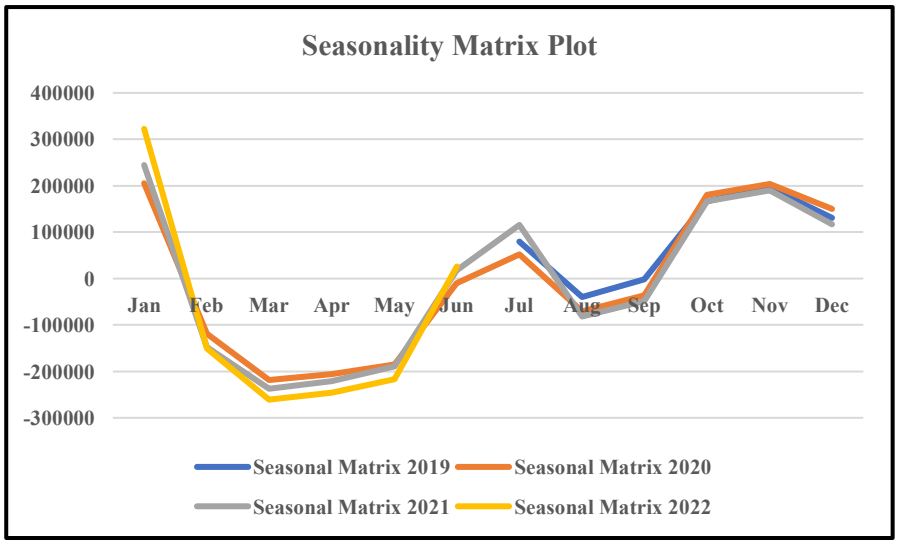

Figure 4: Seasonality Matrix Plot

Detrending was achieved by subtracting the Centred Moving Average from the Actual Sales Data, effectively eliminating the overall trend and uncovering the seasonal fluctuations. The seasonal table displayed in Table 1, illustrates the monthly deviations from the average for each year showcasing the unique shifts in demand across the months. A sharp decline in sales from January to May each year suggesting a consistent seasonal downturn post-winter season.

c) Present a chart showing the annual seasonal profile (all years) as well as highlighting the overall median seasonal profile of the data.

Table 2: Annual Average and Median Seasonal Profile

Month	Season Average Mean Profile	Median Seasonal Profile
Jan	257456	244503
Feb	-139032	-147861.875
Mar	-238838	-237283.5417
Apr	-224355	-220781.2917
May	-197023	-189798.875
Jun	11518	18344.25
Jul	82370	79068.45833
Aug	-64129	-70850.875
Sep	-28706	-36267.20833
Oct	171298	167026.0833
Nov	196839	196220.125
Dec	132612	130596.2917

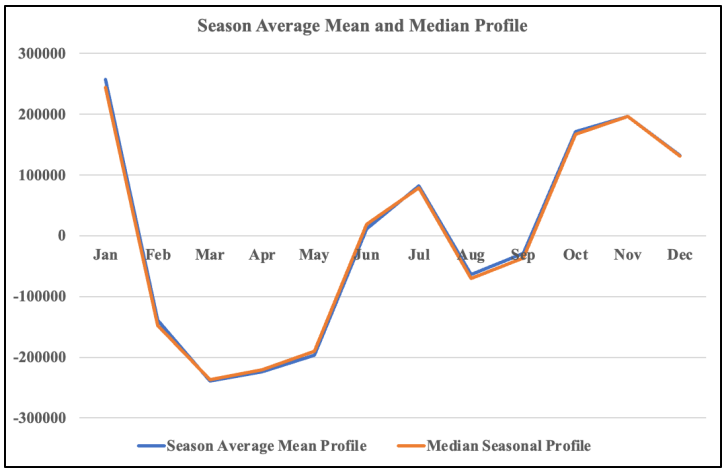

Figure 5: Season Average Mean and Median Profile

Figure 5 and table 2 show an average and median sales trend throughout the years (from 2019 to 2022). Sales decrease after winter and hit a low point in March and April at around (£300,000). However, the sales start to recover in May and reach their peak in July. This suggests a strong comeback possibly because of early shoppers preparing for winter. By October, sales stabilise at around £200,000 indicating consistent purchasing patterns.

d) Comment on any trends and/or seasonality that can be observed from your analysis of the time series data.

Winter Rock's sales data from January 2019 to November 2022 shows a seasonal pattern with increasing sales. Sales have risen from £400,000 to £1,600,000, indicating market expansion and higher consumer demand. Analysis of the Seasonality Matrix and Season Average Mean/Median Profiles reveals peak sales in winter especially in December and a decrease in summer particularly in May and June. The Median Seasonal Profile shows a peak of £200,000 in November and a dip of £(237,283.54) in March.

Comparing Actual Sales Data to the CMA (Cumulative Moving Average) shows a consistent upward trend in sales over time, despite seasonality increasing from £785,000 to over £1,018,402, reflecting growth in the customer base and market reach. This growth is attributed to the rising demand for winter sports and effective marketing strategies.

e) Comment on the implications of your observations of the sales pattern for capacity planning and marketing at Winter Rock.

Capacity Planning:
The sales trends and seasonality evident in Winter Rock's data highlight several critical times for inventory and operational adjustments:

- Operational Readiness: Increased sales volumes during peak seasons require expanding warehouse and distribution capacities, as well as ensuring efficient customer service.
- Off-peak Strategy: To manage excess capacity during the post-holiday period, Winter Rock can consider cost-saving measures like flexible staffing or downsizing operations. This time can also be used for equipment maintenance and strategic planning.
- Inventory Management: To avoid stock shortages in peak months, Winter Rock must plan ahead and secure sufficient inventory before winter. This requires considering lead times and potential supply chain disruptions to effectively increase stock levels of popular items.

Marketing Strategy:
The clear seasonality in Winter Rock's sales provides valuable insights for optimizing marketing strategies to align with consumer purchasing cycles:

- Targeted Promotions: Intensive promotions during busy times, especially in winter, can maximize profits. Incentives like package deals, discounts, and perks for returning customers can boost sales during high-demand periods.
- Diversification: Offering a wide range of outdoor gear throughout the year can help stabilize sales for Winter Rock. By catering to activities like hiking and camping we can attract customers beyond the usual winter sports market reducing the impact of seasonal fluctuations.

Section 3: Forecasting Sales of Year-Round Products

a) Using data prior to July 2022 as your in-sample, calculate the one-step-ahead in-sample forecasts.

Using Single Exponential Smoothing(SES-Fit) with a smoothing factor of 0.1, I have calculated one-step ahead in-sample forecasts for year-round product sales at Winter Rock from January 2019 to June 2022. The forecasts beginning with February 2019 provided a smoothed sequence of expected sales values such as 394,143, 394,248, and 391,285 enabling reliable future sales planning.

b) Produce a fixed origin 6-month ahead forecast for the period July 2022 to December 2022.

Firstly, I split the data in two columns, one was Sales (£) in -sample and Sales (£) out-of-sample using the heuristic approach of dividing the data of 70%/30% split hence the last 6 observations that is from July 2022 to December 2022. Using Single Exponential Smoothing, the projected sales for each month from July to December 2022 remain steady at approximately £379,705. This consistent forecast reflects the latest smoothed data point and indicates a stable sales projection for Winter Rock's products during the festive season.

c) Select and justify your choice of a suitable alpha value (a**).**

I chose an α value of 0.1 to forecast sales of Winter Rock's year-round products, aiming for stability and reducing the risk of overfitting to short-term fluctuations. A lower alpha value gives more weight to historical data, smoothing out random variations for consistent forecast results. This approach is especially useful for products with steady demand like hiking shoes and t-shirts allowing for reliable long-term planning and inventory management.

By using Mean Error (ME) to assess bias, an α value of 0.1 helps maintain minimal bias in forecasts preventing significant changes based on recent anomalies. This balance between forecast precision and stability is crucial for informed decision-making in supply chain and inventory operations.

d) Estimate the in-sample accuracy of your forecast using mean error (ME), mean absolute error (MAE) and mean squared error (MSE) metrics.

Table 3: In-sample summary errors

Summary Error Measures (In-sample)	
ME	-3521.39
MAE	17768.84
MAPE	4.55%
MSE	539,997,183.86
RMSE	23237.84

Winter Rock's sales forecasts in Table 3 are consistently inaccurate, with a Mean Error (ME) of -3521.39. Adjustments are needed to improve the accuracy of predictions, as shown by Mean Absolute Error (MAE) of 17,768.84 To calculate performance on accuracy and root mean squared error of 23,237.84. Despite a mean absolute percentage error of 4.55%, the model's high mean squared error suggests significant discrepancies between forecasted and actual sales, impacting business decisions.

ME is calculated by calculating the average of e that is =AVERAGE(G4:G44), and MAE by taking the average of **|e|** =AVERAGE(H4:H44).

e) Estimate the out-of-sample accuracy of your forecast using mean error (ME), mean absolute error (MAE) and mean squared error (MSE) metrics.

Table 4: Out of sample summary error

Summary Error Measures (out-of-sample)	
ME	12495.71
MAE	22470.33
MAPE	5.52%
MSE	757,567,356.17
RMSE	27523.94

The out-of-sample forecast (Table 4) for Winter Rock indicates the model overestimates sales with a mean error of 12,495.71. Significant discrepancies are evident with a mean absolute error of 22,470.33 and a root mean squared error of 27,523.94. Despite these issues, the mean absolute percentage error of 5.52% shows the model maintains a reasonable level of reliability.

f) Comment on the in- and out-of-sample performance based on each metric. Discuss any pros and cons of each method.

Winter Rock's forecasting model shows significant differences in performance between the in-sample and out-of-sample evaluations. In the in-sample analysis, the model underestimates with an ME of -3521.39, and has moderate forecast discrepancies with an MAE of 17,768.84 and RMSE of 23,237.84. Despite a reasonable MAPE of 4.55% and a high MSE of 539,997,183.86, the model is susceptible to significant errors. On the other hand, the out-of-sample assessment reveals an overestimation bias with an ME of 12495.71, and deteriorated accuracy with an MAE of 22,470.33 and RMSE of 27,523.94. The slightly increased MAPE of 5.52% and a substantial rise in MSE to 757,567,356.17 further highlight the model's struggle to adapt to new data. These results indicate the need for improvements to enhance adaptability and reduce prediction volatility.

Pros and Cons of Each Method:

In-Sample Evaluation:

Pros: This approach provides a controlled environment to adjust and optimize the predictive model, ensuring it aligns with historical data. It is beneficial for making initial tweaks and understanding the model's basic performance.

Cons: There is a risk that this method may not accurately predict future conditions, leading to potential overfitting. In-sample metrics can give a false sense of confidence if the model is too tailored to past data.

Out-of-Sample Evaluation:

Pros: The model is evaluated for its capacity to generalize and maintain robustness in real-world scenarios, offering a more accurate prediction of its future performance.

Cons: Exposing the model to unpredictability can reduce performance if it is not well-adjusted or lacks complexity to handle various conditions effectively.

Section 4: Distribution Plan

a) Discuss what is the overall decision to be made and define each decision variable.

Overall Decision to be made: Winter Rock's strategic distribution challenge requires a decision on the most efficient quantity of goods to be distributed from two centres, Manchester and London to satisfy the expected demands of three new target regions: East Midlands, West Midlands and Northwest in a cost effective way.

Decision Variables Defined:

The decision variables in this scenario represent the quantities of goods dispatched from each distribution centre to each target region. These are defined as follows:

X_{ME}: Units shipped from Manchester to the East Midlands.
X_{MW}: Units shipped from Manchester to the West Midlands.
X_{MN}: Units shipped from Manchester to the Northwest.
X_{LE}: Units shipped from London to the East Midlands.
X_{LW}: Units shipped from London to the West Midlands. X_{LN}: Units shipped from London to the Northwest.

Each variable X_{IJ} (where I refer to the distribution centre and J to the destination region) will be used to ascertain the most cost-efficient shipping plan that adheres to capacity and demand constraints while minimising the total distribution costs.

b) Discuss what is the objective and the objective function.

Objective: The primary objective of Winter Rock in this specific situation is to minimize the overall costs of distributing merchandise from two distribution centres, Manchester and London to three different regions, East Midlands, West Midlands, and Northwest. This goal is crucial in ensuring cost-effectiveness in the supply chain as the company expands into new markets.

Objective Function: The objective function is defined within the cell that contains the formula calculating the total cost of shipping goods from each distribution centre to each destination. The function would be expressed as in mathematical expression as:

Z = 15XME + 21XMW + 17XMN + 23.5XLE + 25.5XLW + 22XLN

c) Discuss all relevant capacity/supply constraints. These should be defined algebraically.

Manchester Distribution Centre Capacity Constraint:
Capacity: The Manchester distribution centre has a maximum capacity of 2,500 items that it can distribute over the specified period.

Algebraic Representation: This constraint ensures that the total shipments from Manchester to all regions do not exceed this capacity. It is represented as:

$$X_{ME} + X_{MW} + X_{MN} <= 2500$$

London Distribution Centre Capacity Constraint:
Capacity: The London distribution centre has a maximum capacity of 3,000 items for distribution.

Algebraic Representation: Similar to Manchester, the shipments from London must not surpass its capacity. This is algebraically formulated as:

XLE + XLW + XLN <= 3000

d) Discuss all relevant demand constraints. These should be defined algebraically.

Demand Constraint for the East Midlands:
Demand: The demand for the East Midlands is specified as 2,000 items.

Algebraic Representation: This constraint ensures that the total shipments from both Manchester and London to the East Midlands exactly meet this demand. It is represented as:

XME + XLE = 2000

Demand Constraint for the West Midlands:
Demand: The demand for the West Midlands is set at 930 items.

Algebraic Representation: This ensures that the combined shipments from Manchester and London to the West Midlands meet this figure. It is formulated as:

XMW + XLW = 930

Demand Constraint for the Northwest:
Demand: The demand in the Northwest is 2,200 items.

Algebraic Representation: This constraint ensures that the total shipments to the Northwest from both centres meet this demand. It is expressed as:

XMN + XLN = 2200

e) If relevant, state and define algebraically all other constraints.

Non-negativity Constraints: All variables (units shipped from any centre to any region) must be greater than or equal to zero to ensure solutions are feasible in real-world scenarios.

XME, XMW, XMN , XLE , XLW , XLN >= 0

f) Using an appropriate solver or methodology find the optimal distribution plan to be pursued by the management of Winter Rock. What is the total cost associated with this distribution plan.

I have utilised Microsoft Excel's Solver, an optimisation tool to find the most efficient distribution plan for Winter Rock. Solver considers specified constraints and objective function to identify the optimal solution to algebraic models. By setting up a linear programming model, Microsoft Excel's Solver helps in determining the best distribution plan for Winter Rock.

Solver Configuration:

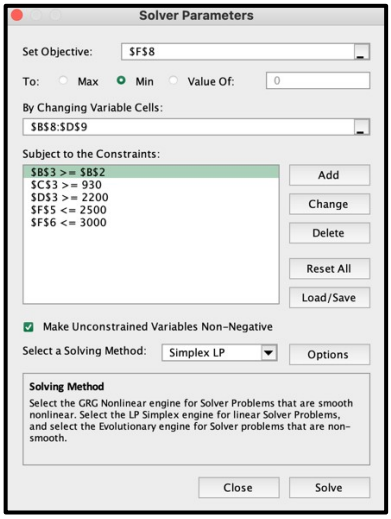

Figure 6 : Solver parameters

Objective Cell: Minimise total cost in cell $F$8(total cost cell), calculated as the sum of shipping quantities multiplied by their respective costs.

Variable Cells: $B$8:$D$9, representing shipping quantities from Manchester and London to the East Midlands, West Midlands, and Northwest.

Constraints:
Capacity: Manchester ($F$5 <= 2500), London ($F$6 <= 3000).
Demand: East Midlands ($B$3 = 2000), West Midlands ($C$3 >= 930), Northwest ($D$3 >= 2200).
Non-negativity: All shipping quantities (>= 0).
Solver Method: Simplex LP, ideal for linear objectives and constraints.

Optimal Distribution Plan:

Table 5: Optimal Distribution Plan

	East	West	North		Total Cost
Manchester	**2000**	**0**	**500**		99615
London	**0**	**930**	**1700**		

Manchester Distribution:
East Midlands: 2000 units
West Midlands: 0 units
Northwest: 500 units

London Distribution:
East Midlands: 0 units
West Midlands: 930 units
Northwest: 1700 units

Conclusion:

Total Cost
99615

The Solver analysis has confirmed that Winter Rock's strategy can achieve a distribution cost of 99,615, ensuring the company can efficiently meet regional demands and minimise expenses. As a result, Winter Rock can effectively expand into new markets.

Section 5: Meeting New Product Demand

a) Create a decision tree representation for the choices faced by Winter Rock management showing the profit obtained from each choice. Provide a detailed Interpretation of what is shown in the decision tree.

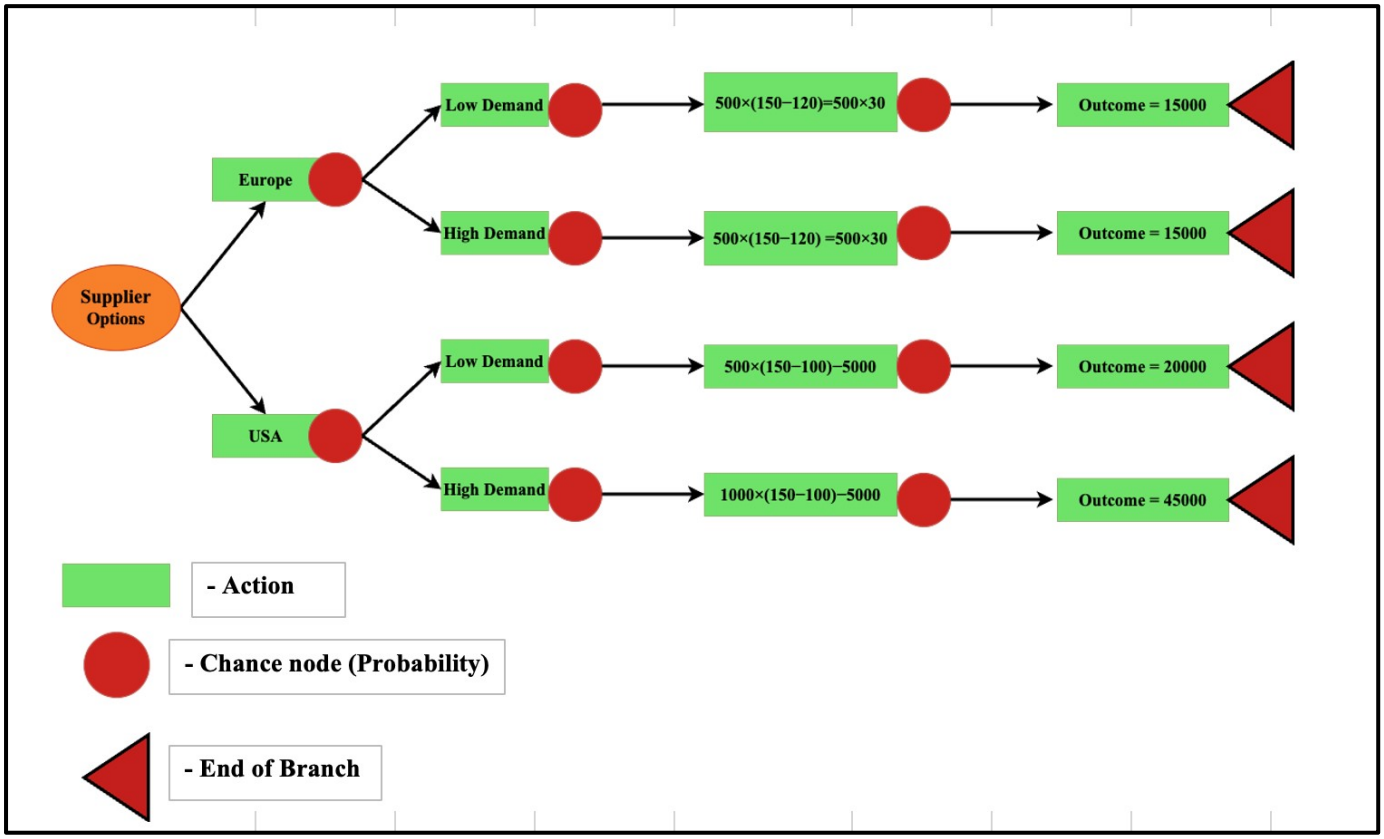

Figure 7: Decision Tree

Cost Calculation:

Europe Total Cost: £60 (labour) + £40 (material) + £20 (shipping) = £120/ski **USA Total Cost:** £30 (labour) + £40 (material) + £30 (shipping) = £100/ski

Europe Supplier:
High Demand (1000 skis, only 500 can be supplied due to capacity limits)**:**
As Europe can supply only up to 500 skis, the calculation will be the same as for the low demand scenario:
Profit= 500×(150−120) =500×30 =£15,000

Low Demand (500 skis):
Profit= 500×(150−120)=500×30=£15,000

USA Supplier:
High Demand (1000 skis):
Profit=1000×(150−100)−5000= 1000×50−5000= £45,000

Low Demand (500 skis):
Profit=500×(150−100)−5000= 500×50−5000= £20,000

We have ordered 1000 units from the USA supplier even if the demand is for only 500 units, especially considering the minimum shipping charge of £5000. This approach may have financial implications worth analysing to see if it results in a better financial outcome despite the potentially unsold surplus.

USA Supplier:

Cost per ski: £100 (Labour: £30, Material: £40, Shipping: £30)
Selling price per ski: £150

Low Demand (500 units) but Ordering 1000 Units:
1. Total Cost:
Cost for 1000 skis = 1000 × £100 = £100,000 Plus, the minimum charge of £5000.
Total = £105,000

2. Total Revenue from Selling 500 Skis:
Revenue = 500 × £150 = £75,000

3. Potential Unsold Surplus: The remaining 500 skis would be unsold under the low demand scenario, which means the additional cost incurred might not be recouped unless additional sales channels or future demand can absorb the surplus.

4. Profit Calculation:
Profit = Total Revenue - Total Cost = £75,000 - £105,000 = -£30,000

Financial Comparison:

When Ordering 1000 Units for 500 Demand:
Total Cost: £105,000
Total Revenue: £75,000
Profit/Loss = -£30,000 (Loss due to unsold stock)

When Ordering Exactly 500 Units:
Total Cost: £55,000
Total Revenue: £75,000
Profit = £20,000

Conclusion:

Pros of Ordering 500 Units:

- **Reduced financial risk**: By ordering only what is expected to sell, Winter Rock avoids the risk associated with unsold inventory.
- **Positive profit:** The company makes a profit of £20,000, in contrast to the loss incurred when overordering.
- **Less storage requirement:** No need to manage surplus stock, which could incur additional costs or become obsolete.

Cons of Ordering 500 Units:

- **Higher unit cost impact**: The minimum charge spread over fewer units increases the effective cost per unit, though in this case, it still results in a profit.

Pros of Ordering 1000 Units:

- **Potential for greater revenue:** If additional demand materializes unexpectedly or in future seasons, the surplus can turn into profit.

Cons of Ordering 1000 Units:

- **Immediate financial loss:** The company incurs a significant loss initially due to the minimum charge and unsold stock.
- **Storage and management costs:** Additional costs for storing and managing the unsold skis could increase if they are not sold quickly.

Final Recommendation:
Ordering exactly as per the expected demand (500 units) is financially safer and profitable under the given demand forecast. This strategy avoids the complications of managing surplus inventory and reduces the financial risks associated with speculative higher orders, especially important for products with uncertain demand like new market entries.

b) Assuming Winter Rock are risk averse, provide a supplier recommendation employing the maximin rule. Discuss pros and cons of that recommendation.

	Demand	Europe	USA
Low Demand	500	15000	-30000
High Demand	1000	15000	45000
Expected Profit	0.5	15000	7500
Expected Profit	0.6	15000	0
Expected Profit	0.7	15000	-7500
Expected Profit	0.4	15000	15000
Expected Profit	0.3	15000	22500

MaxiMin Rule - Max Profit for Low Demand	
Europe	15000
USA	-30000

Expected Profit	0.55	15000	3750

Figure 8: MaxiMin Rule - Max Profit for Low Demand

Employing the Maximin rule (Figure 8), which prioritises risk-averse decisions by selecting the option with the best worst-case outcome, we propose that Winter Rock sources its skis from Europe. The decision tree illustrates that the minimum profit for sourcing from Europe is £15,000, in contrast to a £30,000 loss when sourcing from the USA in low demand scenarios.

Pros of Selecting Europe:

- **Reduced Financial Risk:** Europe guarantees a positive minimum profit, eliminating any losses in the worst-case demand scenario, which is essential for risk-averse strategies.
- **No Minimum Charge:** Europe's absence of a minimum charge allows for better cost management, making it a more secure financial choice for uncertain demand.

Cons of Opting for Europe:

- **Limited Capacity:** Europe can only provide a maximum of 500 skis, potentially falling short if demand surpasses this number, leading to missed sales opportunities.
- **Higher Production Costs:** Europe's higher unit production costs may reduce profitability per unit compared to the lower costs in the USA.

This suggestion aligns with Winter Rock's risk-averse inclination by ensuring no losses in the worst-case scenario and offering a steady, predictable cost framework. Nonetheless, it may restrict market potential in high-demand scenarios due to Europe's constrained supply capacity.

c) Assuming Winter Rock to be risk seeking, provide a supplier recommendation employing the Maximax rule. Discuss pros and cons of that recommendation.

MaxiMax Rule - Max Profit for High Demand	
Europe	15000
USA	45000

Figure 9: MaxiMax Rule - Max Profit for Low Demand

Assuming Winter Rock is risk-seeking, employing the Maximax rule, the recommendation would be to choose the supplier offering the highest potential profit in the best-case scenario. The provided data shows that under high demand, the USA supplier could generate a maximum profit of £45,000, compared to Europe's £15,000. Thus, the Maximax rule suggests choosing the USA supplier for maximising potential returns.

Pros of Choosing the USA Supplier:

- **Higher Profit Ceiling:** The USA's maximum profit potential of £45,000 is significantly higher than Europe's, making it the best choice for maximizing earnings in a high-demand scenario.
- **Capacity to Meet Demand:** The USA supplier has a capacity of 1000 units, perfectly aligning with the high-demand estimate, ensuring that supply will not constrain sales.

Cons of Choosing the USA Supplier:

- **Higher Initial Cost:** The USA requires a minimum charge of £5000, which could impact overall profitability if demand unexpectedly falters.

- **Increased Financial Risk:** The higher potential gains come with greater risk, especially if the actual sales do not meet the high-demand expectations.

This recommendation aligns with a risk-seeking strategy by focusing on the potential for maximum gains, suitable for a scenario where Winter Rock is willing to accept higher risks for greater rewards. This approach is optimal for capitalising on market opportunities, assuming confidence in market demand forecasts.

d) Provide a supplier recommendation to Winter Rock which maximizes the expect profit from this new product. Discuss pros and cons of that recommendation.

To maximize expected profit for Winter Rock's new ski product, we need to calculate the expected profit for each supplier based on the potential high and low demand scenarios. Given that the demand can either be 1000 skis (high) or 500 skis (low), and assuming each scenario is equally likely, the expected profit calculation can guide the supplier selection.

Expected Profit Calculations:
Europe Supplier:
- **High Demand (1000 skis, only 500 can be supplied due to capacity limits):** Profit = £15,000
- **Low Demand (500 skis)**: Profit = £15,000
- **Expected Profit**: ½*(15,000 + 15,000) = £15,000

USA Supplier:
- **High Demand (1000 skis):** Profit = £45,000 (After £5000 minimum charge)
- **Low Demand (500 skis):** Profit = £20,000 (After £5000 minimum charge)
- **Expected Profit:** ½* (45,000 + 20,000) = £32,500

Recommendation:
Based on the expected profit calculations, Winter Rock should choose the USA supplier as it offers a higher expected profit of £32,500 compared to £15,000 from the European supplier.

Pros of Choosing the USA Supplier:
- **Higher Expected Returns:** The USA supplier provides a significantly higher expected profit, making it a financially sound choice.
- **Capacity to Fulfil Higher Demand:** The USA supplier can meet the high demand scenario without constraints, maximizing potential sales and profits.

Cons of Choosing the USA Supplier:
- **Minimum Charge Risk:** The £5000 minimum charge imposes a financial burden, particularly noticeable in lower demand scenarios which reduces profitability.
- **Financial Risk in Low Demand:** If demand turns out to be lower than expected the profits from the USA are reduced significantly, though still positive, making it riskier than Europe in terms of cost recovery.

Conclusion:
Choosing the USA supplier aligns with maximizing expected profit, offering higher potential returns despite the associated risks of a minimum charge and the uncertainty of demand levels. This approach is beneficial if Winter Rock's market analysis supports a reasonably high likelihood of achieving near or full high-demand levels. However, they should remain cautious of market fluctuations that could impact these projections, potentially leveraging contractual agreements to mitigate risks associated with the minimum charge and unsold inventory.

e) Compare and contrast the recommendations based on the three strategies in b), c) and d). What does Winter Rock need to consider in making its final decision.

Winter Rock can make their decision on selecting a supplier for their new skis by considering three distinct decision-making strategies, each of which corresponds to varying levels of risk tolerance and market expectations.

Maximin (Risk-Averse): Europe guarantees a minimum profit of £15,000 with no potential loss, prioritizing risk minimization despite limited supplier capacity.

Maximax (Risk-Seeking): The USA aims for the highest profit of £45,000 in high-demand scenarios but comes with a £5000 minimum charge and poses a risk if demand falls short.

Expected Profit Maximization: The USA offers the highest expected profit of £32,500 considering both high and low demand scenarios for a balanced financial outcome.

Comparison and Final Considerations:
Risk vs. Reward: Maximin avoids losses, Maximax seeks high gains despite risk while expected profit maximization balances gains and losses.

Decision Factors: Winter Rock should consider their level of confidence in demand forecasts, their financial ability to absorb potential losses, and their strategic objectives, which may be centred around either stabilizing their market presence or maximizing their profits.

Section 6: The Impact of Meeting New Product Demand

a) Simulating Demand: I employed the first four digits of my student ID (2662356) to create demand simulation using Excel's Random Number Generation tool found in the Data Analysis features. By doing this, I created a series of 1,000 unique values evenly spread between 200 and 800 units to accurately represent the possible demand for the recently launched skis.

b) Calculating Revenue:

Multiply each demand value by the selling price per ski, which is £150.
Formula: Revenue = Random Demand * 150
This approach provides valuable information on possible changes in revenue due to fluctuations in market reactions, which have a direct effect on Winter Rock's financial income.

c) Calculate the Associated Fixed Cost:

For each simulation, USA supplier with a fixed cost is £5000:

- **Fixed Cost:** £5000 for each sample.
- **Interpretation:** The fixed cost is a significant financial commitment that Winter Rock must consider, especially when there is a possibility of reduced demand and revenue. This expense is incurred regardless of the number of skis sold, impacting profitability significantly in situations of lower demand.

d) Calculation of Variable Costs Associated:

Assuming the variable cost per ski for the USA supplier is £100:

Variable Cost Calculation: For each simulated demand scenario, multiply the demand by £100.

Formula: Variable Cost = Demand * 100
Interpretation: The total cost of manufacturing the skis is determined in this stage, and it rises proportionally with the level of demand. The variable cost has a direct influence on the profitability, as it escalates with the increase in demand.

e) Assuming the variable cost per ski for the USA supplier is £120:

Variable Cost Calculation: For each simulated demand scenario, multiply the demand by £120.
Formula: Variable Cost = Demand * 120

f) Calculate the associated profit:

Formula: Profit = Revenue - Fixed Cost - Variable Cost

European Supplier (Supplier A)
Profit is determined by deducting revenue from variable costs. Revenue is obtained from selling skis at a set price of £150 per pair, which varies in accordance with sales volume. Variable costs, on the other hand, rise as sales increase, estimated at £120 per unit, thus resulting in higher costs as sales volumes grow. The trend in profits for the European supplier is closely tied to demand since there are no fixed costs involved. This leads to profits increasing in tandem with demand, capitalizing on a steady additional revenue per unit sold.

USA Supplier (Supplier B)
Profit is calculated by deducting the total of fixed and variable costs from revenue. Revenue is generated from sales at £150 per pair, mirroring the European market. Fixed costs stay steady at £20,000, impacting the break-even point. Variable costs are determined by the European supplier price of £100 per unit. The trend of profits is largely shaped by fixed costs, necessitating increased sales to surpass the initial financial obstacle. Initially, profits may be minimal or negative with low demand, but they rise as demand increases.

g) The average profit and the standard deviation:

Average Profit: The mean profit suggests a generally favourable forecast for Winter Rock's latest ski product, with average profits hovering at approximately £19,872.74 per situation. This implies that the decision to enter the ski market irrespective of selecting a supplier from the USA or Europe is expected to result in favourable returns in the long run.

Standard Deviation: The high standard deviation of £8,576.25 indicates significant variability in profit results, highlighting a substantial financial risk. This fluctuation suggests that potential profits can vary greatly from the average leading to a wide range of financial outcomes.

h) Provide a detailed summary of the simulated. What do these findings mean for your previous analysis in Section 5.

Overall Analysis: The European supplier has a lower level of risk because they do not have fixed costs, which means they are less likely to experience losses even when demand is low. However, they are limited in their ability to make significant profits during times of high demand because they do not benefit from economies of scale.

On the other hand, the USA supplier faces the risk of losses during periods of low demand due to their fixed costs. However, they have the potential to earn higher profits during times of high demand because their fixed costs are spread out. This makes their financial outcome more susceptible to changes in demand.

Supplier Selection Impact

Preference for USA: In most cases 907 out of 1000 the United States is chosen over Europe because of its higher profit potential, despite the higher initial costs. This indicates that the pricing and cost structure in the United States are more advantageous in the majority of simulated demand situations.

Strategic Recommendations:

1. Risk Management: Develop robust risk management strategies, including flexible manufacturing processes, dynamic pricing approaches, and potentially hedging tactics.

2. Demand Forecasting: Improve demand prediction techniques using advanced analytics to align production with market requirements and minimize inventory fluctuations.
3. Evaluation of Supplier Contracts: Re-evaluate agreements with European suppliers or explore avenues to reduce variable costs to benefit from the simulation's preference for the USA.

4. Integration into Overall Business Strategy: Seamlessly integrate findings into Winter Rock's overarching business strategy by aligning production levels with forecasted demand, adapting marketing strategies, and accounting for profit volatility in financial planning.

Section 7: Conclusion and Recommendations

Key Findings:

- **Sales Trends (Section 2):** The historical sales data illustrated seasonal variations, with the highest sales occurring during the winter months. This emphasizes the necessity of maintaining sufficient stock levels to meet the increased demand during peak periods.

- **Distribution Plan (Section 4):** The most efficient distribution strategy identified through linear programming analysis emphasized the cost-saving benefits of utilizing the USA supplier while ensuring that the anticipated demand is adequately met.

- **New Product Launch (Sections 5-6):** The simulation outcomes for the launch of the new ski product demonstrated a greater average profit margin when sourcing from the USA. However, the high standard deviation in profits indicates a considerable level of variability suggesting potential for significant returns but also highlighting the risks associated with demand uncertainty.

Recommendations:

- **Distribution Strategy Recommendation**: Implement a distribution plan that maximizes the USA's capacity to meet demand while managing fixed costs effectively, ensuring product availability and long-term cost-effectiveness.

- **New Ski Launch:** Exercise prudence by selecting the USA as the supplier for higher profits. Mitigate financial risks with strong demand forecasting and risk management strategies to minimize negative impacts and maximize overall success.

To conclude, despite the potential for growth and profitability there are significant risks involved that necessitate careful inventory management. It is imperative to engage in strategic planning and consistently monitor both market trends and internal performance indicators in order to effectively execute these proposed strategies.