Part A:

Visualisations and Mathematical Understanding

This is a report on the hotel's financial performance [Excel File Link], displaying a range of patterns, metrics and actionable recommendations to improve profitability and customer satisfaction.

1. Total Revenue by Season:

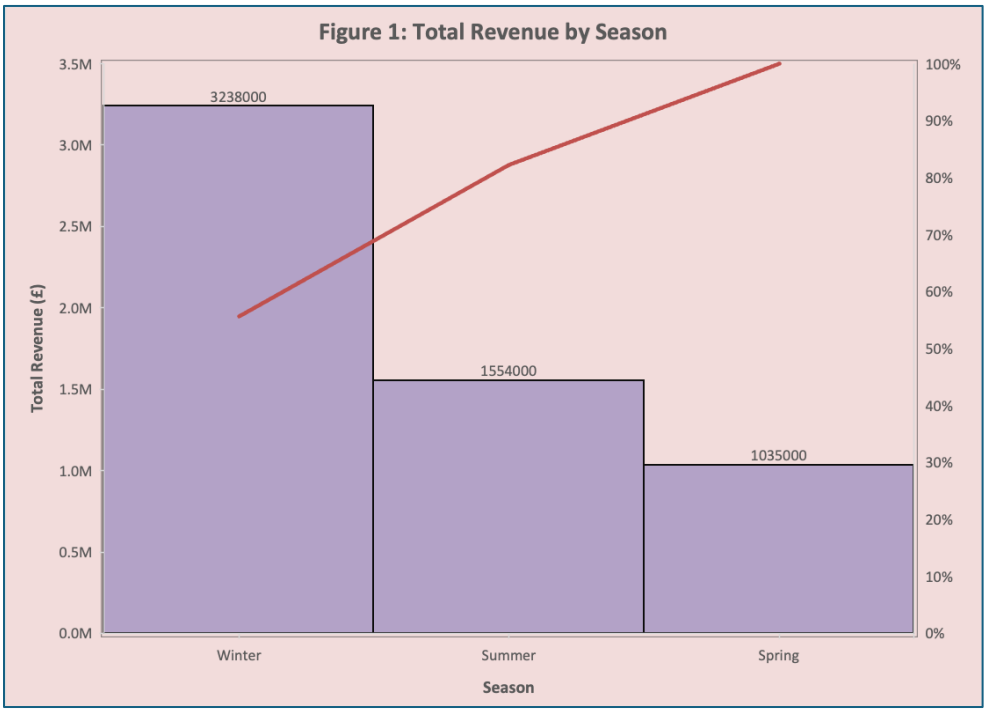

Figure 1: Revenue Breakdown by Season (Pareto Chart)

Table 1: Average and Distribution of Total Revenue by Season			
	Winter	**Spring**	**Summer**
Mean	**53967**	**54474**	51800
Median	**55000**	**55000**	52000
Skewness	**-0.17**	-0.42	0.18

Table 1: Average and Distribution of Revenue by Season

The cumulative percentage line in **Figure 1** shows Winter and Summer combined contribute over 80% of revenue, reflecting the Pareto Principle, following the 80/20 target rule (Abyad, 2021). **Table 1** shows Winter and Spring's central tendency measures (mean:

£53.9k, £54.4k; median: £55k each) demonstrate their higher daily revenue. Skewness analysis shows Winter's revenue is nearly symmetric (skewness = -0.17), indicating consistent performance.

2. Total Revenue across ADR and Marketing Spend:

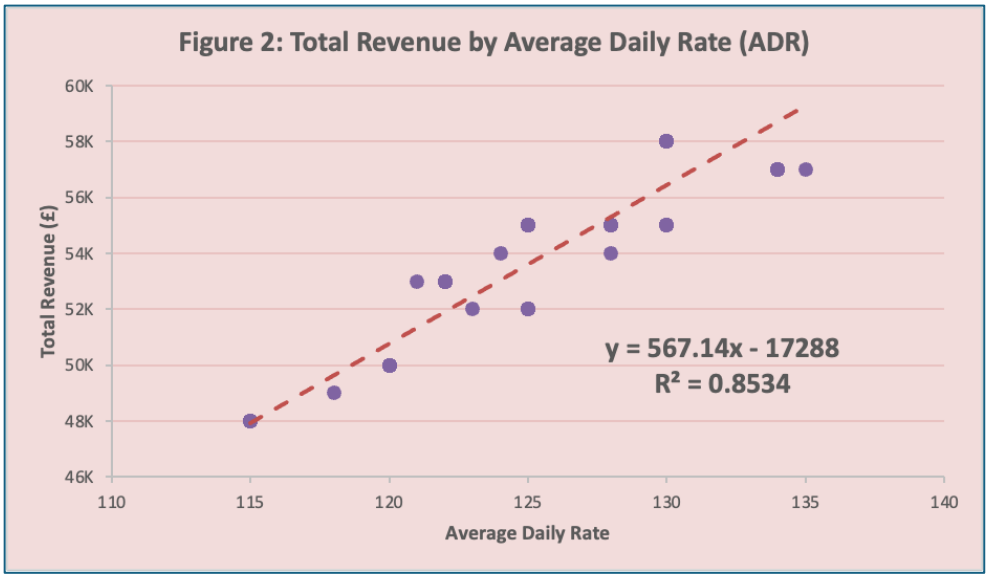

Figure 2: Revenue vs. Average Daily Rate (Scatter Plot)

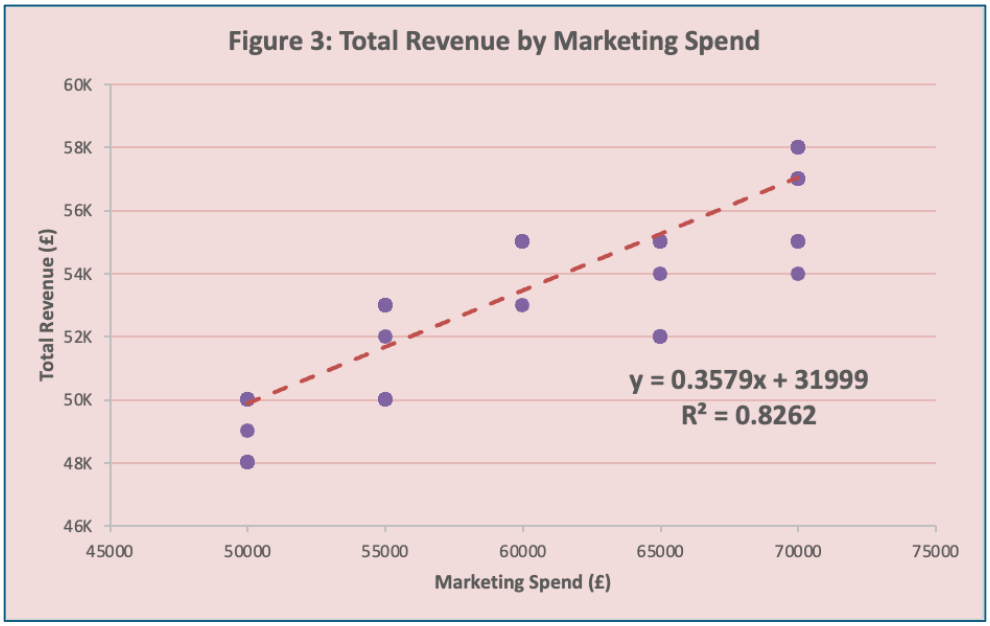

Figure 3: Revenue vs. Marketing Spend (Scatter Plot)

Figures 2 and **3** highlight the strong impact of ADR and Marketing Spend on Total Revenue. ADR explains 85.34% of revenue variation (R^2 = 0.85) and Marketing Spend accounting for 82.62% (R^2 = 0.83). The significant regression slopes (567.14 for ADR and 0.36 for Marketing Spend) verify the relevance of both factors, emphasising the value of data-driven strategies in optimising pricing and marketing decisions.

3. Occupancy Rate across Seasons:

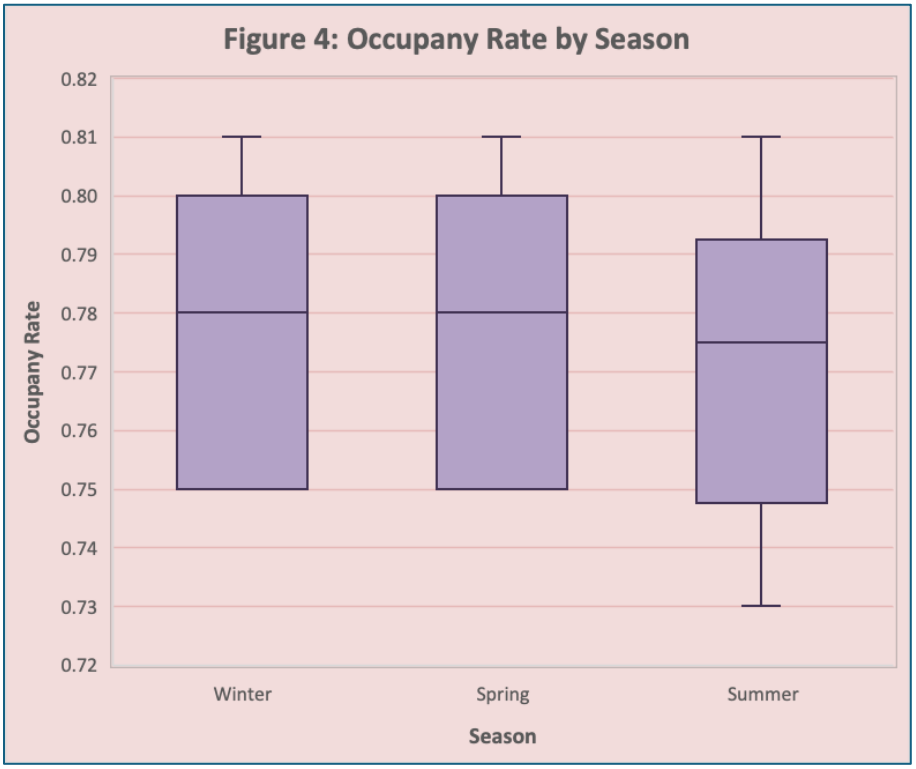

Figure 4: Seasonal Occupancy Rate Comparison (Box and Whisker Plot)

In **Figure 4**, the mean spread is 0.78 for Winter and Spring and 0.775 for Summer. There is slightly lower variability in Summer. Outlier analysis reveals no significant deviations in occupancy rates, indicating stable performance with minimal impact from seasonal changes.

4. Guest Types and Profit by Countries:

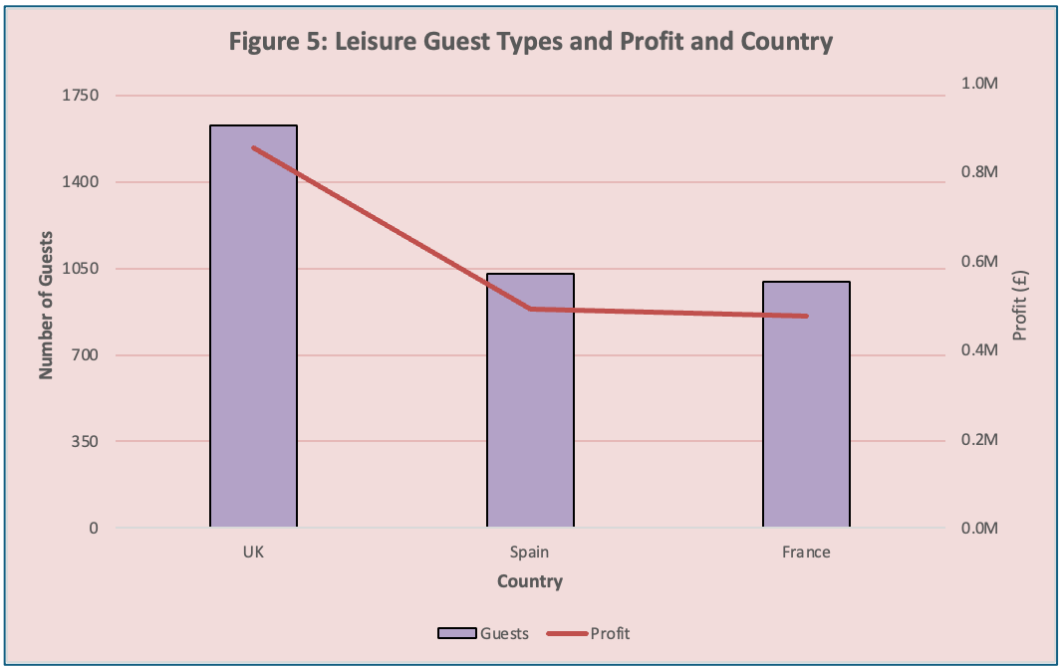

Figure 5: Leisure Guests and Profit by Country (Bar and Line Chart)

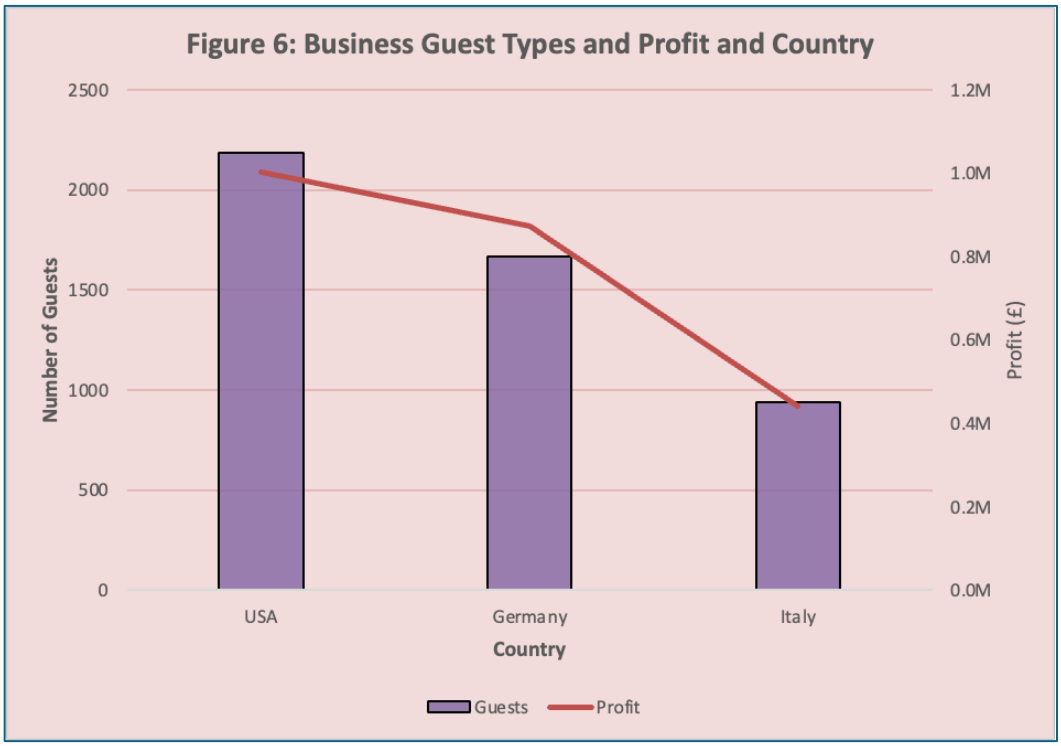

Figure 6: Business Guests and Profit by Country (Bar and Line Chart))

Table 2: Profit by Guest Types Statistics		
	Leisure Guests	**Business Guests**
25th Percentile	36500	35000
50th Percentile	41500	35000
75th Percentile	43000	43375
Interquartile Range	**6500**	**8375**
Average Profit (£)	**38766**	**37411**
Total Profit (£)	**1822000**	**2319500**

Table 2: Profit Distribution for Guest Types

Figure 5 and **6** display Guest Types and Profit by Country, and **Table 2** compares central tendencies, showing average Leisure profits at £38,766 and Business profits at £37,411. The interquartile range is higher for Business guests (£8,375) than Leisure guests (£6,500), which indicates higher profit per Business guest. Although total profit from Business guests (£2.3 million) exceeds Leisure guests (£1.8 million), the mean values suggest outliers are present in the Business guest data.

5. Number of Complaints, Compliments and Cancellations per Country:

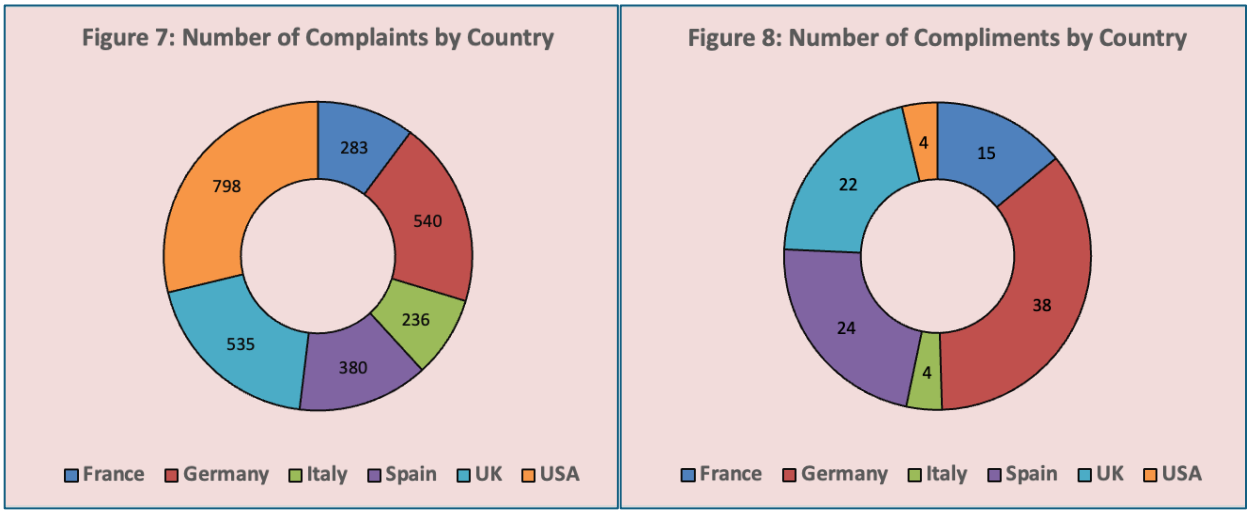

Figure 7: Complaints and Compliments Distribution by Country (Donut Charts)

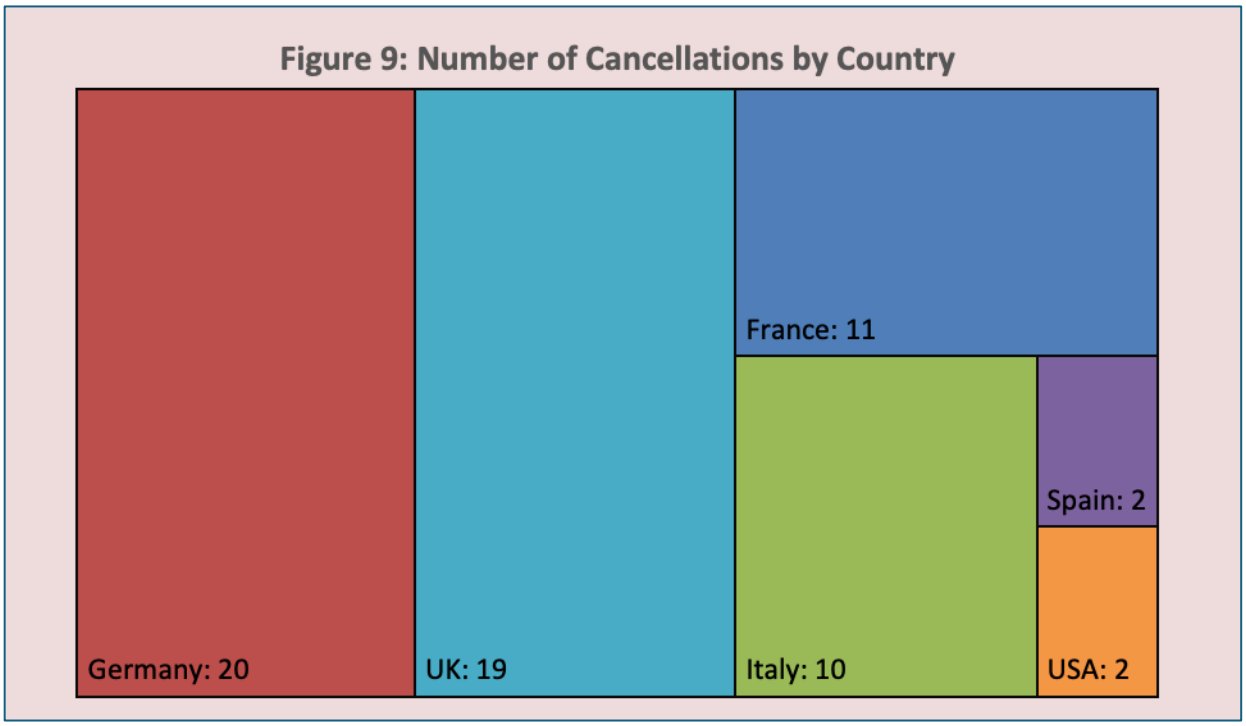

Figure 8: Cancellations by Country (Treemap)

Figures 7 and **8** show Germany leads in complaints (30.8%, 540) and compliments (31.4%, 38). **Figure 9** shows Germany (20) and the UK (19) with the most cancellations. Despite 798 complaints, the USA reports only 2 cancellations, suggesting dissatisfied customers prefer raising concerns over cancelling bookings.

6. Correlation Heatmap:

Figure 10: Correlation Heatmap

	Marketing_Spend	Occupancy_Rate	ADR	Complaints	Compliment	Total_Revenue	Profit
Marketing_Spend	1						
Occupancy_Rate	0.96	1					
ADR	0.94	0.98	1				
Complaints	0.02	0.05	0.08	1			
Compliment	0.80	0.74	0.70	0.07	1		
Total_Revenue	0.91	0.96	0.92	0.06	0.71	1	
Profit	0.60	0.75	0.70	0.07	0.44	0.87	1

Figure 9: Correlation Heatmap of Key Variables

Figure 10 shows a strong positive correlation between Marketing Spend and Total Revenue ($r = 0.91$), confirming that higher marketing investment boosts revenue. Marketing Spend also moderately correlates with Profit ($r = 0.60$), while Complaints have a negligible correlation with Profit ($r = 0.07$), suggesting minimal impact of dissatisfaction on profitability. These findings emphasise the importance of marketing strategies to maximise profits.

7. Descriptive Statistics of Profit by Season:

Table 3: Descriptive Statistics of Profit across Seasons				
	Winter	**Spring**	**Summer**	**Spark line**
Mean	**39842**	**40711**	**32583**	
Standard Error	449	925	773	
Median	**40000**	**43000**	**32000**	
Mode	35000	43000	35000	
Standard Deviation	**3479**	**4032**	**4233**	
Sample Variance	12105862	16258772	17915230	
Kurtosis	**-1.38**	**-1.45**	**-0.56**	
Skewness	**-0.41**	**-0.79**	**0.56**	
Range	**9000**	**9000**	**14000**	
Minimum	35000	35000	28000	
Maximum	44000	44000	42000	
Sum	2390500	773500	977500	
Count	60	19	30	

Table 3: Descriptive Statistics of Profit across Seasons

Table 3 reveal prominent differences in profit across seasons. Spring records the highest average profit (£40,711) and median (£40,000), closely followed by Winter (£39,842 mean, £40,000 median), while Summer trails with a mean of £32,583. Spring shows the greatest variability with a standard deviation of £4,032, compared to £3,479 in Winter. Both Winter and Spring have a profit range of £9,000, whereas Summer shows a broader range of £14,000.

Winter's skewness (-0.41) suggests a nearly symmetrical and stable profit distribution, while Spring shows a slightly left-skewed pattern (-0.79). In contrast, Summer's positive skewness (0.56) indicates more frequent lower profit values. The kurtosis values for Winter (-1.38) and Spring (-1.45) suggest flatter distributions, whereas Summer's kurtosis (-0.56) reflects a more typical spread. Sparklines show Winter's profit trend is steady, while Spring and Summer exhibit more significant fluctuations, pointing to the need for better profit stabilisation during these seasons.

Statistical Problem

Report: Maximising Profit Through Strategic Marketing Investments

Introduction

Marketing expenditures are a vital part of the organisation as it directly influences revenue and profitability. It ensures optimal allocation of resources while maintaining revenue growth and a competitive edge (Morgan and Hunt, 1999). This report critically examines the relationship between marketing investments and profit, providing actionable recommendations to guide future budget allocations.

Analysis

Data Overview:

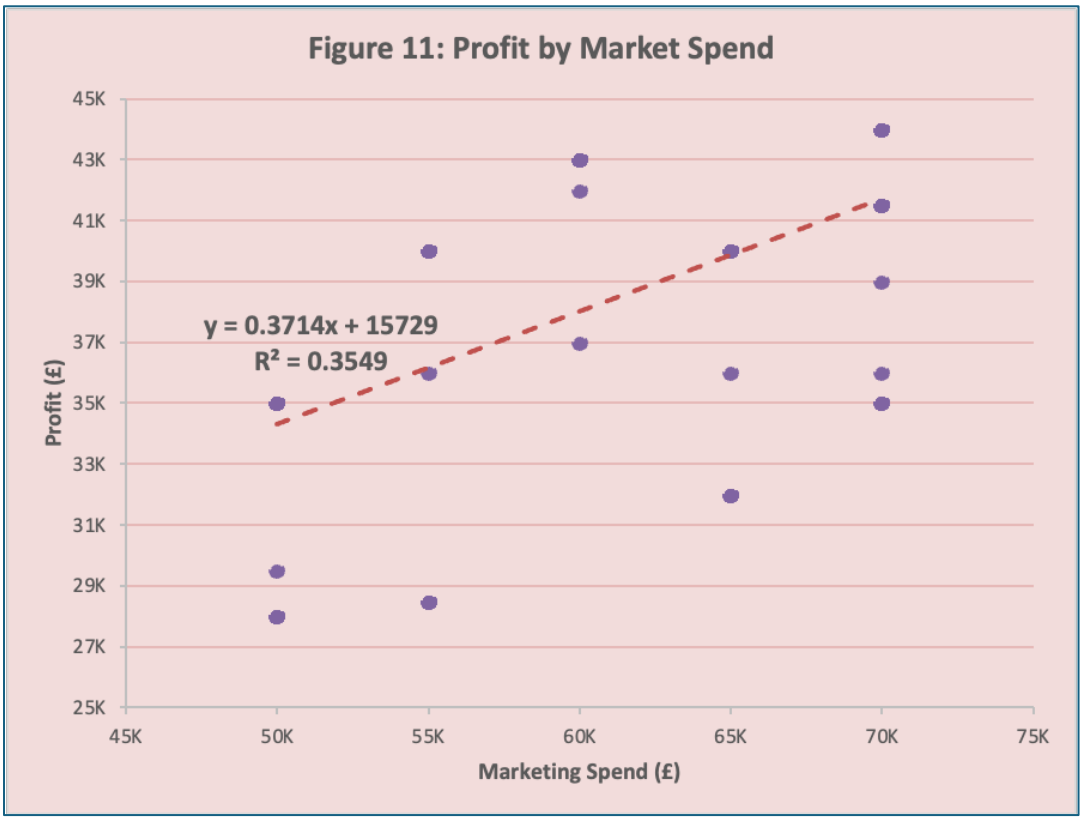

Figure 10: Profit Correlation with Marketing Spend (Scatter Plot)

Figure 11 utilises analysis on marketing spend and profit across various campaigns. The dataset covers a wide range of spend levels, allowing for an in-depth exploration of trends and patterns.

Statistical Findings:

1. **Correlation Analysis:**
   - Referring to Figure 10, Marketing Spend moderately correlates with Profit (r = 0.60), suggesting that higher marketing expenditures are generally associated with increased profit, though the relationship is not perfectly linear.

2. **Regression Analysis**:
   - A linear regression model, using the least squares method, was applied to analyse the relationship between marketing spend (independent variable) and profit (dependent variable):

     Profit = 0.37 * Marketing Spend + 15,729.24

     The coefficient of 0.37 indicates that each additional £1 spent on marketing increases profit by £0.37. The £15,729.24 intercept represents profit without marketing spend, calculated using Excel's regression tool for statistical reliability.

Table 4: Regression Statistics	
Multiple R	0.60
R Square	**0.35**
Adjusted R Square	0.35
Standard Error	4072
Observations	109

Table 5: Coefficient Summary			
	Coefficients	***Standard Error***	***P-value***
Intercept	**15729.24**	2928.37	4.5933E-07
Marketing_Spend	**0.37**	0.05	**8.3226E-12**

Table 6: ANOVA					
	df	***SS***	***MS***	***F***	***Significance F***
Regression	1	975810535	975810534.7	58.86	8.32255E-12
Residual	107	1773937172	16578852.07		
Total	108	2749747706			

Figure 11: Regression Analysis of Model Statistics, Coefficients, and ANOVA Results for Profit Prediction

- The coefficient of determination (R^2 = 0.35) shows that 35% of profit variation is explained by marketing spend, with the remaining 65% influenced by other factors, such as booking efficiency (Figure 12 below), highlighting the need for diversified strategies.

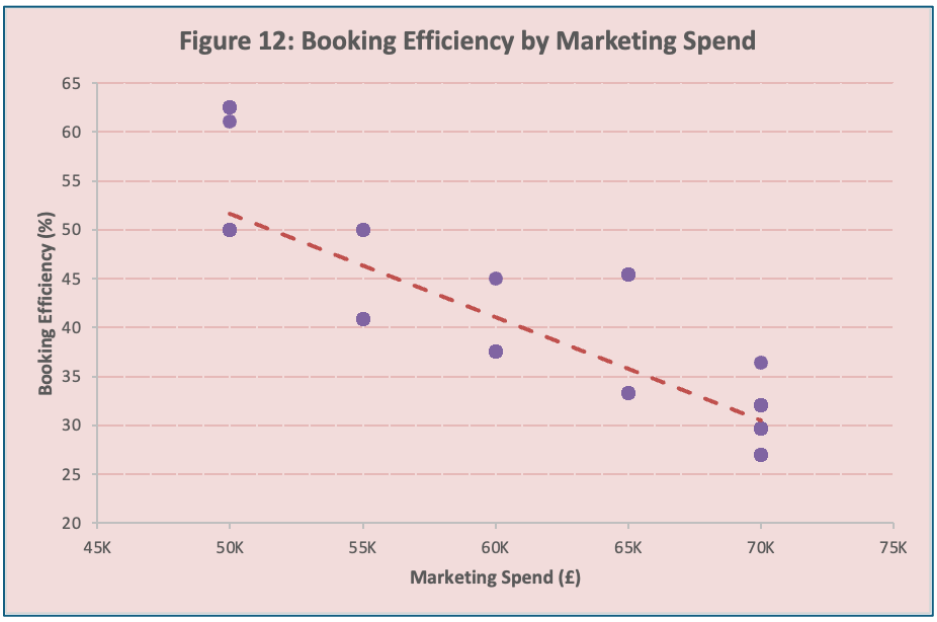

Figure 12: Booking Efficiency vs. Marketing Spend (Scatter Plot)

3. ROI Analysis:

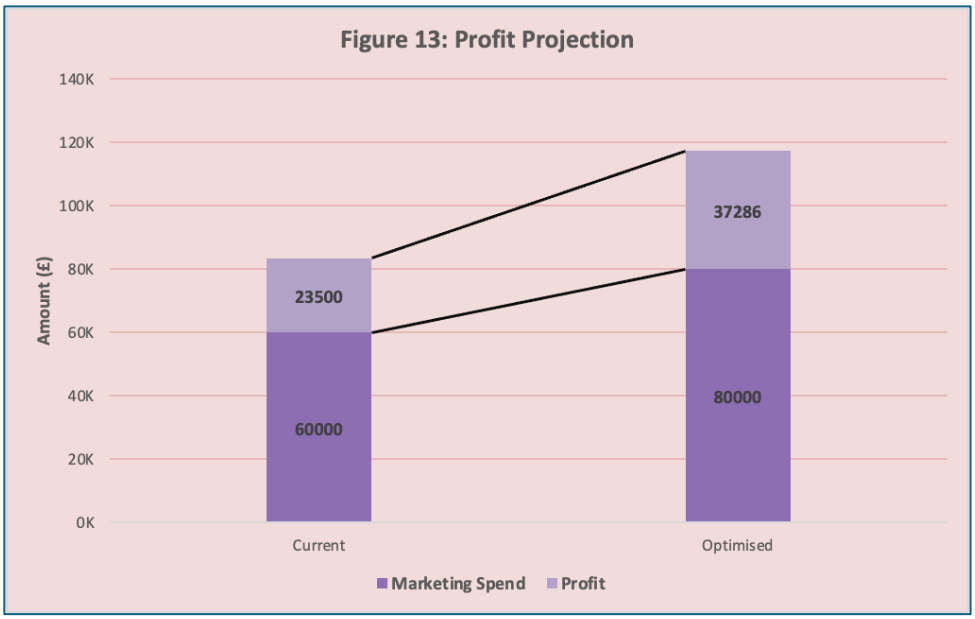

Figure 13: Profit Projection with Optimized Marketing Spend (Bar Chart)

- Figure 13 shows an average marketing spend of £60,000, and profit of £23,500. Increasing the spend to £80,000, an optimal amount based on the regression, could raise profits to £37,286. It will lead to a 19% growth in profit, balancing growth potential and minimising diminishing returns.

4. **Standard Deviation**:

    - The standard deviation of profit at different marketing spend levels is calculated at £2,500, indicating moderate variability and suggesting that factors like campaign effectiveness or market saturation can influence results (Palmatier *et al.*, 2006).

Hypothesis Testing:

- **Null Hypothesis**: There is no significant relationship between marketing spend and profit.
- **Alternative Hypothesis**: There is a significant positive relationship between marketing spend and profit.
- The p-value from the regression analysis is less than 0.001, leading to the rejection of the null hypothesis. This confirms that the relationship is statistically significant.

Recommendations:

- **Adjust Budget Allocation**:
    - Increase the marketing budget to approximately £80,000 to capitalise on the projected profit growth of 19%.
- **Seasonal Targeting**:
    - Focus additional spend during Winter, the season with the highest revenue (Figure 1), to maximise ROI.
- **Monitor ROI Continuously**:
    - Implement a system to track profit against spend in real time, allowing for dynamic adjustments to campaigns (Agrawal, Najafi-Asadolahi and Smith, 2022).
- **Diversify Marketing Strategies**:
    - Comparing Figures 5 and 6, the hotel should expand services to Leisure guests to increase the customer base for higher revenues.

Conclusion

This analysis highlights the value of data-driven decisions in optimising marketing budgets. Strategic increases in marketing spend and focus on high-performing periods can boost profitability and drive growth. Considering external factors, continuous monitoring and adaptable strategies are essential for long-term resource efficiency and maintaining a competitive edge.