Assignment 2: Individual Project

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# Contents

[Contents 2](#_Toc134385703)

[0.0 Introduction 3](#_Toc134385704)

[0.1 Aim of the report 3](#_Toc134385705)

[1.0 Problem 1: Sales Forecasting for ACME Retail 4](#_Toc134385706)

[1.1 The Problem 4](#_Toc134385707)

[1.2 The model 4](#_Toc134385708)

[1.3 Analysis of Outcomes 6](#_Toc134385709)

[2.0 Problem 2: Energy Use Prediction for Skytech Builders\_323 7](#_Toc134385710)

[2.1 The Problem 7](#_Toc134385711)

[2.2 The model 7](#_Toc134385712)

[2.3 Analysis of Outcomes 8](#_Toc134385713)

[3.0 Problem 3: Project Network Analysis for International Capital Inc. 10](#_Toc134385714)

[3.1 The Problem 10](#_Toc134385715)

[3.2 The model 11](#_Toc134385716)

[3.3 Analysis Outcomes 11](#_Toc134385717)

[Conclusion 12](#_Toc134385718)

[References 13](#_Toc134385719)

[Appendix – A 13](#_Toc134385720)

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| Managerial Report  ACME Retail, Skytech Builders & International Capital Inc. Introduction This managerial report addresses three distinct problem sets and provides analysis outcomes to support decision-making in each case. The first problem focuses on sales forecasting for ACME Retail, aiming to develop an accurate forecasting model for Q1-2021. The second problem involves energy use prediction for Skytech Builders, utilizing a multiple linear regression model. The third problem revolves around project network analysis for International Capital Inc., constructing the project network and assessing completion time and probabilities. 0.1 Aim of the report This report aims to provide an overview of the problems and describes the models and analysis outcomes for each case. It aims to equip the respective organizations with valuable insights and practical tools for effective planning, resource allocation, and project management. 1.0 Problem 1: Sales Forecasting for ACME Retail1.1 The Problem *Table\_1.1 –Historical Data*  This section addresses the sales forecasting problem for ACME Retail, utilizing historical sales data spanning three years on a quarterly basis (see table 1.1). The objective is to develop a forecasting model that accurately predicts sales for Q1-2021, with the Mean Absolute Percent Deviation (MAPD) metric serving as the performance evaluation criterion. This section provides an overview of the problem and presents analysis outcomes to support ACME Retail in their decision-making process.  *Table\_1.2 – Initial forecast, α, β and MA*. 1.2 The model This section offers an explanation of the forecasting model developed for ACME Retail, aiming to achieve accurate sales predictions for Q1-2021 and reporting the MAPD as an indicator of forecast accuracy. The excel solution comprises several stages of improvement, labeled 1 to 6, with the final model designated as "6. Adjusted with 2-Quarter MA" (table 1.2). The model components include the level (α) and trend (β), estimating the baseline value and rate of change of the time series, respectively (table 1.2). Additionally, the MA weight assigns weights to historical data points in the moving average forecasting model.  *Table\_1.3 – Seasonality*  Initially, the model is developed through exponential smoothing and adjusted forecast *(1&2 in table 1.2)*, resulting in high MAPDs of 12.11% and 11.46%. To address seasonality, seasonality indexes and de-seasonalized data are calculated *(see table 1.3).* Forecasts without and with seasonality are generated *(see 3&4 in table 1.4)*.  *Table\_1.4 – Final stages of forecasting model.*  In the final stage, an adjusted 2-Quarter MA approach is employed. The de-seasonalized forecast is computed using a 2-quarter moving average, followed by re-adjustment for seasonality and trend (see 5&6 in table 1.4). Initially, a what-if analysis data table (see tables A1 & A2) explores optimal levels, trends, and MA weights, while the solver (see figure A3) verifies the optimal combination, resulting in a final MAPD of 3.95%. The forecasting model enables ACME Retail to make informed decisions for effective planning and resource allocation. 1.3 Analysis of Outcomes Answering the two questions, the final sales prediction for Q1-2021, after undergoing the described improvement stages, is **112.95** (in 1000s). Figure 1.5 displays all stages of the model forecasts, depicting the progression and refinement of predictions. The final model prediction plot (6) is highlighted in yellow, while the actual sales are depicted in black. With the final model, a desirable MAPD of 3.95% was achieved. These outcomes indicate that incorporating seasonality and a specific MA approach significantly enhanced the accuracy of the forecast. However, achieving an ideal MAPD below 2% would require further improvements, such as optimizing the number of quarters included in the MA or refining the seasonality adjustments. ACME Retail can use the insights from this analysis to make informed decisions and further improve the model for more accurate forecasts.  *Figure\_2.5 – Actual sales vs all forecast sales predictions.* 2.0 Problem 2: Energy Use Prediction for Skytech Builders\_3232.1 The Problem This section addresses problem 2: the monthly energy use prediction for Skytech Builders. The management at Skytech Builders believes that energy use is influenced by the production volumes, daily outside temperature and the number of workdays. Historical data collected over the past year (see table 2.1) has been provided to develop a regression model. 2.2 The model The developed multiple linear regression model predicts energy use based on the given predictors. Table 2.1 illustrates positive correlations between all predictors and energy use, while scatter plots in figures A4-A6 depict these correlations. Figures 2.2 and A7-A9 display the four regression models utilizing different predictor combinations.  *Table\_2.1 – Historical data, predictions & correlation coefficient.* 2.3 Analysis of Outcomes *Figure\_2.2 – Multiple linear regression model 4.*  The analysis of outcomes addresses the given questions on the model. Based on the regression models, not all variables should be included in the final model. Model 4 (figure 2.2) is preferred, including only the production and temperature variables, despite model 3 (figure A9) having a higher R^2 value of 0.79. The P-value of the "Days" predictor exceeds the significance level of 0.05, indicating its lack of statistical significance. Omitting unnecessary variables aligns with the principle of model parsimony, favoring simpler models with comparable predictive power. Including unnecessary variables may lead to overfitting to the training data, leading to poorer performance on new data (Gupta, 2021).  *Figure\_2.3 – Fit of model 4 predictions to historical data.*  Model 4 predicts energy use using the formula:  Energy Use = 229.8930446 + (1.374877855 \* Production) + (1.339876197 \* Temperature)  For a month with 25 days, a temperature of 55 units, and production of 120 units, the predicted energy use is 468.5. Overall, the analysis demonstrates the effectiveness of the developed regression model in predicting energy use for Skytech Builders and provides a practical method for predicting energy use with new production and temperature values. 3.0 Problem 3: Project Network Analysis for International Capital Inc.3.1 The Problem International Capital Inc. (IC), a small investment bank, specializes in securing funds for small-to-medium-sized logistic companies. This managerial report addresses a specific project engagement, where IC follows a standardized project format with variable activity times and circumstances. The objective is to construct the project network based on the given data and analyze the project's expected completion time, as well as the probabilities of completing the project within specific time frames.  *Table 3.1 – Given data and calculations.* 3.2 The model The given data provided, including the activity descriptions, time estimates, and predecessor information is shown in table 3.1, along with the calculated values and earliest/latest start and finish times. Using this information, a project network diagram has been constructed (figure 3.2), along with determining the critical path and use of the PERT method to calculate the project’s expected completion time. Statistical analysis was performed (table A10) to calculate the variance and SD of the critical path, assessing the project’s overall risk.  *Figure 3.2 – Project network diagram.* 3.3 Analysis of Outcomes The model reveals that the expected completion time for the project is 73 days, considering the critical path A->B->C->G->H->J. Probability of completing the project in 85 days or less in 97.27%, indicating a high likelihood of meeting the target timeframe. Conversely, the probability of the project exceeding 90 days in 0.32%, suggesting a low risk of project delays.  By presenting the project network diagram, expected completion time, and probability calculations, this report gives International Capital Inc. valuable information for project scheduling and risk assessment. It will allow informed decision-making and effective project management to ensure successful outcomes for their clients. Conclusion In conclusion, this managerial report has provided valuable insights and practical solutions for ACME Retail, Skytech Builders, and International Capital Inc. The analysis outcomes have demonstrated the effectiveness of the developed models in sales forecasting, energy use prediction, and project network analysis. These findings enable informed decision-making, effective resource allocation, and enhanced project management. By implementing the recommended approaches, the respective organizations can optimize their operations, improve forecast accuracy, and mitigate risks, ultimately leading to improved outcomes and success in their respective domains. References Gupta, A. (2021). *Model Selection Techniques -Parsimony & Goodness of Fit*. [online] Geek Culture. Available at: <https://medium.com/geekculture/model-selection-techniques-parsimony-goodness-of-fit-fc2f1863ccfd>. Appendix – A |

Table A1 – Optimizing level and trend. 

Table A2 – Optimizing MA.



Figure A3 – Solver parameters, where Z16 = MAPD, J5 = level, J6 = trend and J8 = MA.   
Graphical user interface, application

Description automatically generated

Figure A4 – Temperature vs Energy Use scatter plot. Figure A5 – Days vs Energy Use scatter plot.

Figure A6 – Production vs Energy Use

Figure A7 – Multiple linear regression model 1. 

Figure A8 – Multiple linear regression model 2. 

Figure A9 – Multiple linear regression model 3. 

Table A10 – Critical path and statistical analysis. 