INDEX

- Task 1 – Customer Spending Analysis (Continued)
    - Modelling
    - Recommendations
    - Task 2 – Recommendation Analysis
- Task 2 – Recommendation Analysis (Continued)
    - Evaluation
    - Practical Aspects Evaluation
    - Make a Recommendation
    - Justify the Recommendation

PART-1

Introduction

With its innovative use of autonomous robot drones, Autonomous Shipment, a Leeds-based startup, is set to transform last-mile logistics. With the use of advanced assessment methods like TOPSIS and linear programming, this report offers a thorough study of a trial roll-out that helps with future planning.

Key Findings

1. **Optimal Robot Prototype Choice:** The TOPSIS model evaluation identifies "Deviant" as the best robot prototype for the trial. Its superior performance on all important criteria, in line with the management's prioritised priority, makes it the wise decision for the trial.
2. **Effective Robot Allocation:** The report uses a linear programming technique to identify the best distribution of robot prototypes among different stores. This allocation not only complies to financial limits, but it also maximises daily order completion, assuring a planned distribution to meet trial goals.
3. **Clear Trial Direction:** The outcomes of the TOPSIS model and linear programming when coupled provide Autonomous Shipment with a precise path for its experiment. The trial has the potential to be successful in accomplishing its objectives within the given budgetary limits if a prudent prototype selection and efficient robot distribution are made.

Robot Prototype Selection and Robot Allocation

Task Understanding and Data Processing Overview

A thorough understanding of the assigned objectives and dataset is essential for this work. Understanding the complexities of the robot prototype selection process necessitates a careful examination of the significance of each factor. Carrying capacity, battery size, average speed, cost per unit, and reliability are all evaluated qualitatively and quantitatively. To properly use the TOPSIS approach, it is essential to ensure that the data is processed correctly, including normalising criteria and adding weights set by management. This comprehension serves as the cornerstone for a methodical and knowledgeable decision-making procedure during the assignment.

Task 1 – Robot Selection

Overview of the Robot Prototypes:

Four unique robot prototypes are presented by Autonomous Shipment: Deviant, Bowler, Archer, and Corner. Each prototype has its own characteristics in terms of carrying capacity, battery size, average speed, cost per unit, and dependability.

Weight Distribution

In accordance with their relative importance, management has given the selection criteria weights. Weights of 6%, 13%, 20%, 26%, and 35% are held by carrying capacity, average speed, battery size, cost per unit, and reliability, in that order.

TOPSIS Analysis and Results

The robot prototypes were carefully evaluated using the TOPSIS approach, considering the required criteria and weights. The TOPSIS findings shown graphically show that "Deviant" is the best option for the trial, and "Bowler" is the least good option. This thorough assessment gives decision-makers a solid foundation for action and is in line with management priorities.

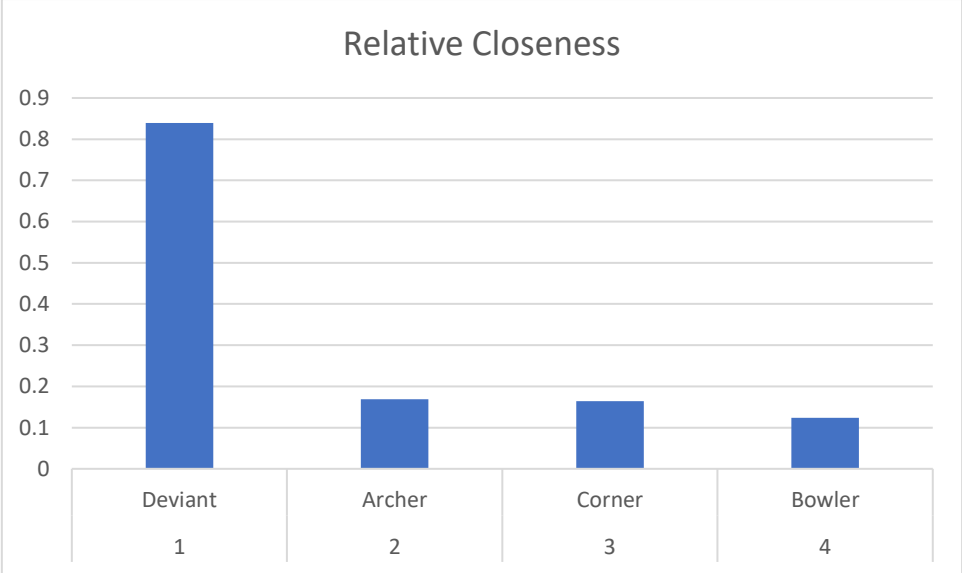

Figure 1: Bar Graph representing the TOPSIS scores of different robot's prototypes.

Why TOPSIS was the Ideal Option

The recommended Multi-Criteria Decision Analysis (MCDA) method was selected as TOPSIS, which is well-known for its adaptability in managing various criteria. Because different criteria have varying degrees of importance, its ability to rank options according to how closely they resemble the ideal answer is vital in the context of robot selection.

TOPSIS' robustness is enhanced by weighted criterion allocation, data normalisation, identification of ideal and non-ideal solutions, and Euclidean distance estimates. Decision-makers can easily use the method because of its transparency and easily comprehensible outcomes, which guarantee a distinct hierarchy of options.

Because Excel's user-friendly design makes data entry and manipulation easier, it was selected as the analytical tool of choice. Additionally, Excel's simplicity of use in creating

tables and charts as well as its compatibility with popular data formats helped produce findings that were comprehensible and visually appealing, which improved stakeholder communication.

Task 2 – Robot Allocation

Robot Allocation Strategy and Linear Programming Implementation

Task 2 necessitates a systematic approach to robot distribution across many stores while aligning with trial goals and limits. To formulate an ideal allocation method, a thorough comprehension of the trial's goals and constraints was necessary. The best mathematical model for maximising order fulfilment while abiding by restrictions like financial limitations, the number of robots needed per store, and the maximum number of hours that technicians can work is called linear programming, or LP.

Using Python Pulp as well as Excel Solver to implement LP made it possible to create effective allocation models. By carefully allocating robots to different retailers, these models seek to maximise productivity while achieving the maximum order completion rate. By using LP, store-wise robot allocation is certain to be methodical and measurable, providing a solid solution that aligns with the trial's main objectives.

Overview of Robot Allocation

To accomplish the most effective trial launch, this step carefully allocates the chosen robot prototype while considering several constraints. Goals include fulfilling daily orders as efficiently as possible, keeping an eye on the overall budget, and limiting the number of hours that technicians can spend at each store.

Linear Programming Approach

Linear Programming (LP) serves as the mathematical model to find the most efficient distribution of robots across stores. Both Excel Solver and Python's Pulp library were employed for LP implementation.

Why Linear Programming was the Ideal Option

To maximise order completion and overall efficiency, the trial's objectives are in line with LP's linear structure. Because LP is so good at resource allocation optimisation, it is a great fit for the task of figuring out how many robots are best for many stores while still adhering to different limitations. LP efficiently solves constraints such a limited budget, a minimum number of robots per store, and a maximum number of hours worked by technicians.

LP model creation can be done directly in Excel, thanks to Excel Solver's user-friendly interface. For users who are accustomed to coding environments and more sophisticated circumstances, Python Pulp is a stable and adaptable framework for LP modelling.

Total Tech Hours	250
Total Cost Optimally	£2,44,300.00
Objective	221 total orders

Figure 2: Results of Robot Allocation using LP model in Excel Solver.

```
Optimal Solution:
Robots for Grocery Store: 19.0
Robots for Clothing Store: 5.0
Robots for Sport Equipment Store: 5.0
Total Orders per Day: 221.0
```

Figure 3: Results of Robot Allocation using LP model in Python's Pulp library.

The findings presented in Figures 2 and 3 show the highest number of orders that can be completed while still meeting all restrictions.

Recommendations and Conclusion

Robot Prototype Recommendation

The deployment of the "Deviant" prototype is recommended after a thorough review utilising the TOPSIS technique. It is the best option because to its exceptional performance in terms of carrying capacity, battery size, average speed, cost per unit, and dependability. The management team's weight assignments were very important because the Deviant prototype matched their priorities, especially in terms of dependability.

Robot Allocation Recommendation

Using Python Pulp and Excel Solver for LP, the optimal distribution of robots among different stores was determined. It is advised that robots be assigned to maximise order fulfilment, making sure that every store satisfies the lowest robot demand while staying within financial constraints and technician personnel hour caps. To maximise completed orders and contribute to the overall success of the experiment, the allocation technique is used.

The best technique is to deploy the Deviant robot prototype and allocate robots based on the LP model results.

PART-2

Business Understanding

Introduction:

This report explores the consumer behaviour analysis of the online retailer "drinks@home.uk," with the goal of improving understanding of consumer purchasing patterns and suggesting successful marketing tactics. Significant factors impacting expenditure are revealed by the examination of 400 customer records, which includes information on revenue, ad channels, age, income, time spent on the website, and interactions with vouchers. Regression analysis is used in the study to provide light on how different variables affect revenue, enabling well-informed marketing choices.

Data Understanding

Key Findings

The analysis provides important insights, highlighting how revenue is greatly impacted by factors like voucher utilisation, expected income, and promotional channels. The statistical significance of these factors is supported by the linear regression model, which also demonstrates their applicability in forecasting consumer spending. Revenue growth is correlated with higher income and voucher visibility, offering insightful data for focused marketing.

Customer Spending Analysis and Marketing Strategy

Data Preparation

Overview:

Data cleansing and variable selection lay the groundwork for identifying the connections between revenue and client variables. Through statistical and graphical methodologies, the analysis reveals patterns in variables such as Advertisement_Channel, Estimated_Age, Estimated_Income, Time_On_Site, Seen_Voucher, and Revenue. Scatter graphs, histograms, and regression models provide a full picture of customer behaviour, with income and voucher visibility standing out as significant factors.

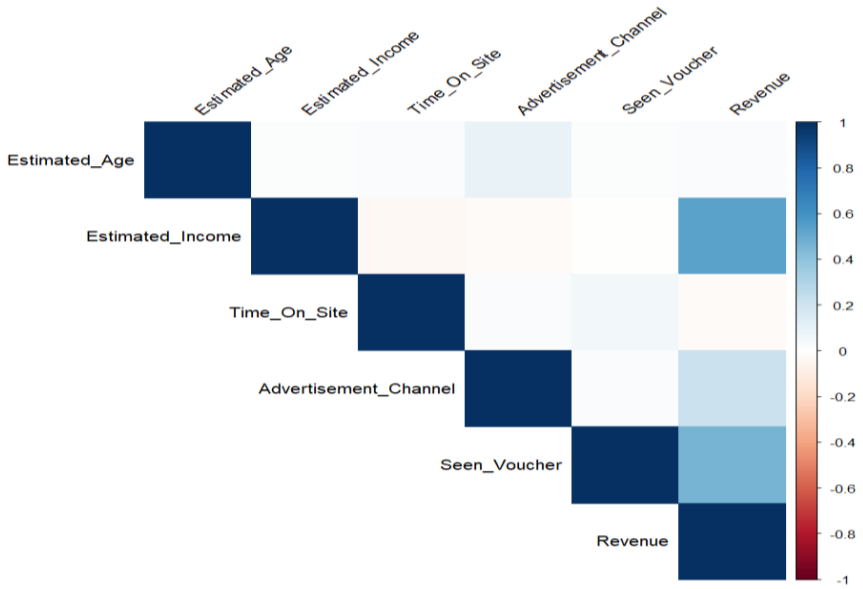

Figure 1: Correlation visualisation of all the relevant variables from the dataset.

```
Coefficients:
                     Estimate Std. Error t value Pr(>|t|)
(Intercept)       -3.2641828  6.4554034  -0.506    0.613
Advertisement_Channel  4.0248561  0.6338028   6.350 5.93e-10 ***
Estimated_Age     -0.0185628  0.0894369  -0.208    0.836
Estimated_Income   0.0028994  0.0001815  15.971   < 2e-16 ***
Time_On_Site      -0.0232912  0.0219098  -1.063    0.288
Seen_Voucher      19.6068852  1.4127344  13.879   < 2e-16 ***
```

Figure 2: Summary of the Regression Model (output from R)

Task 1 – Customer Spending Analysis

The primary objectives were identifying any potential changes, assessing the correlations, and comprehending the distribution of significant variables. To uncover hidden patterns in the data, a number of statistical and graphical techniques were applied in this process. Using visualization techniques including scatter plots, histograms, and bar charts, the distribution and central tendency of variables like age, income, time spent on the website, and revenue from customer orders were displayed.

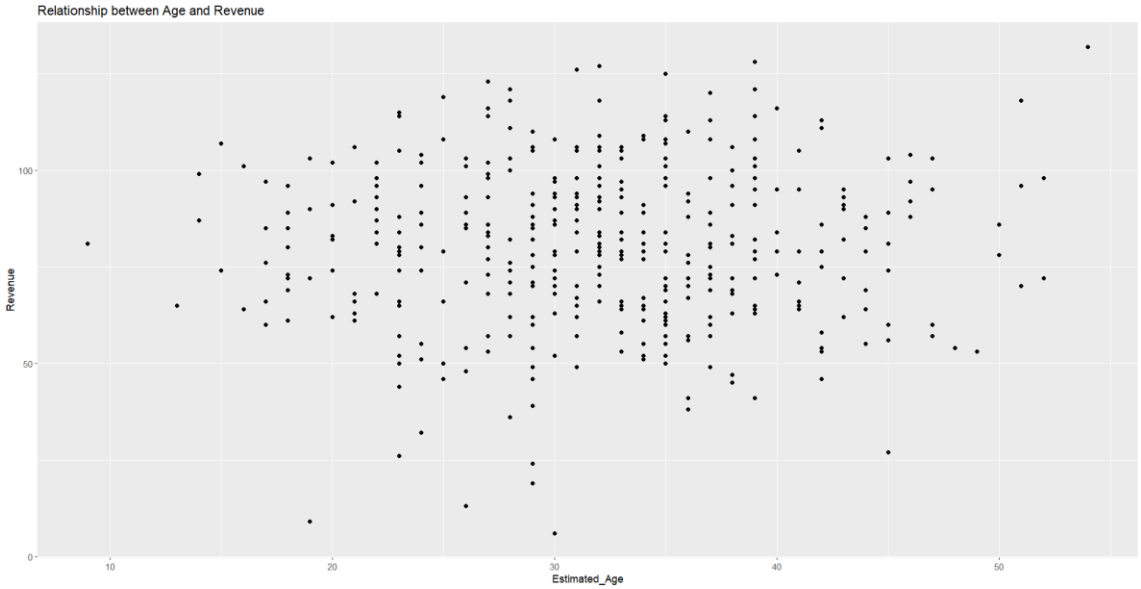

Figure 3 Relationship Between Age and Revenue

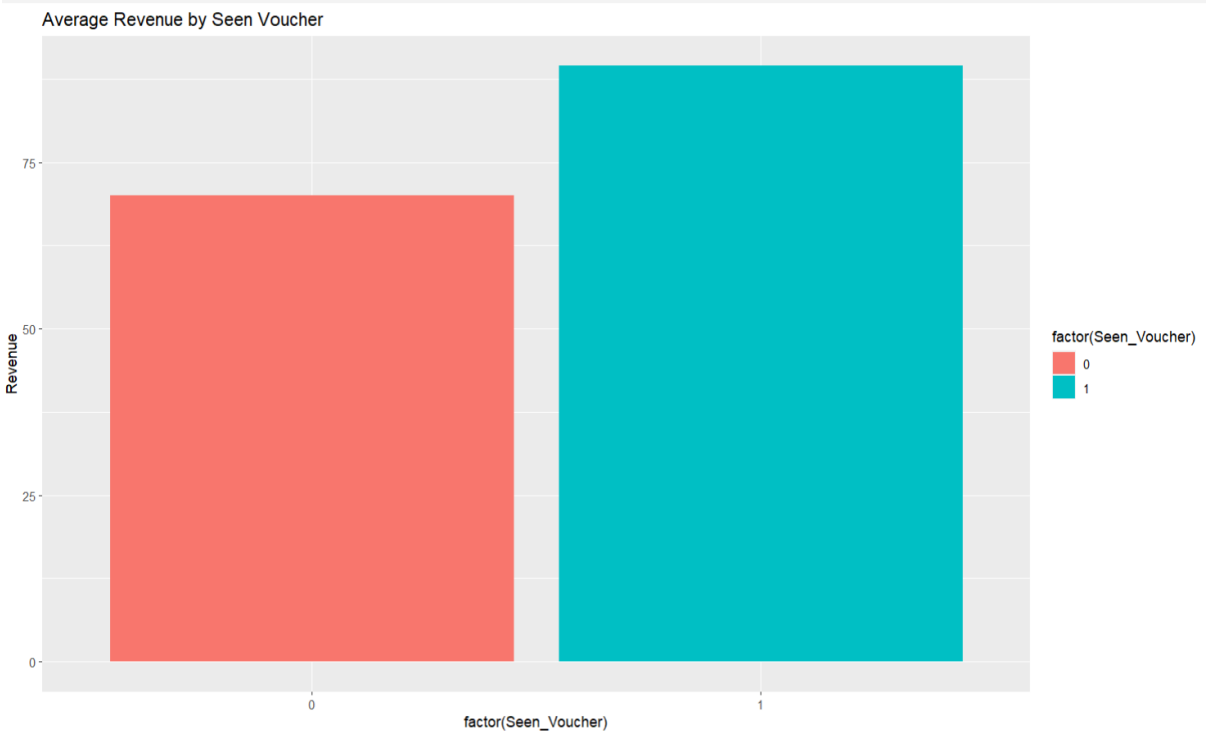

Figure 4 Average Revenue by Seen Voucher

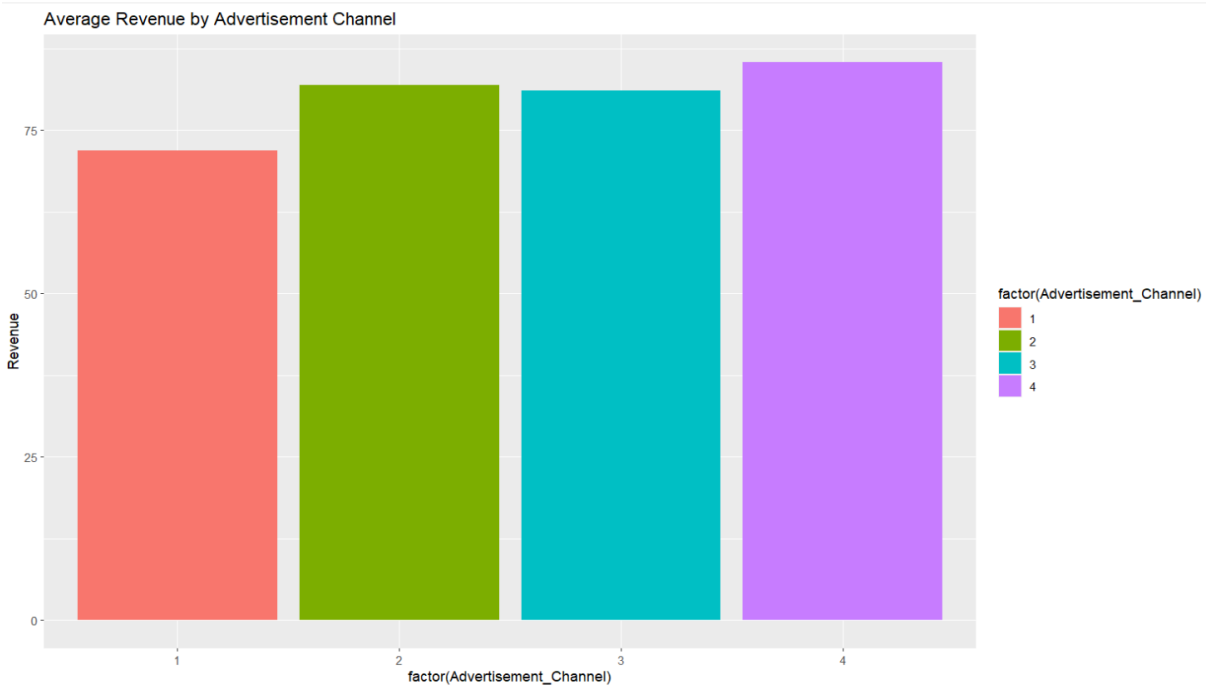

Figure 5 Average Revenue by Advertisement Channel

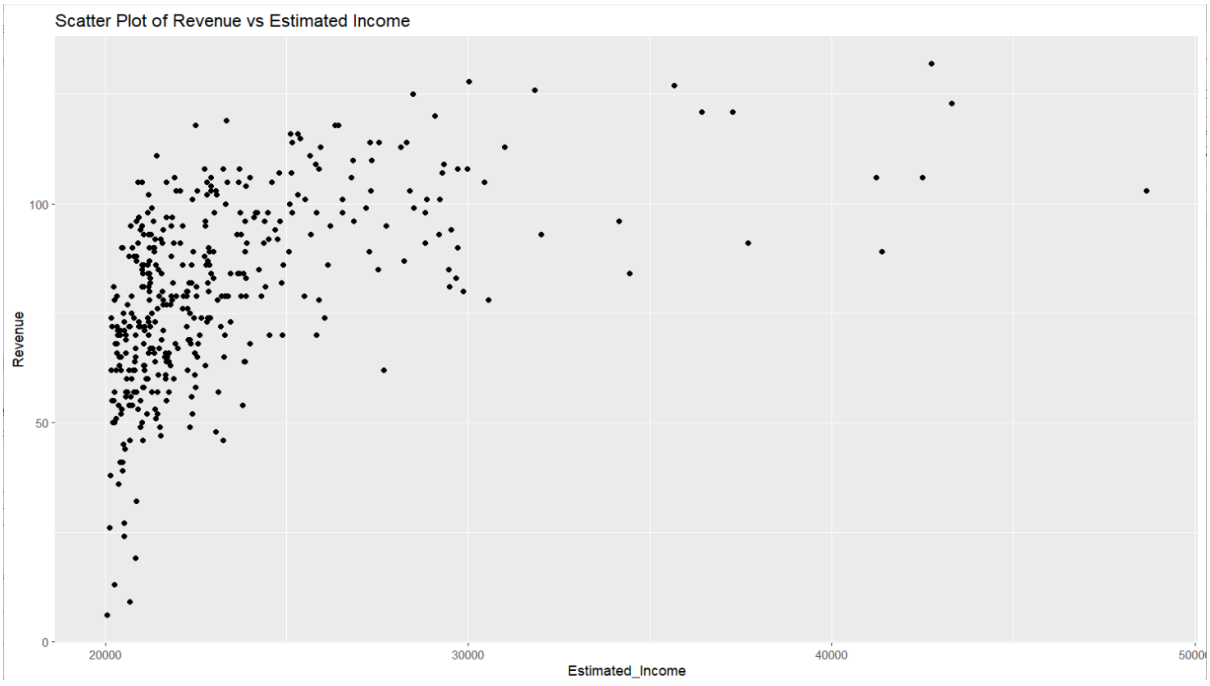

Figure 6 Scatter Plot of Revenue vs Estimated Income

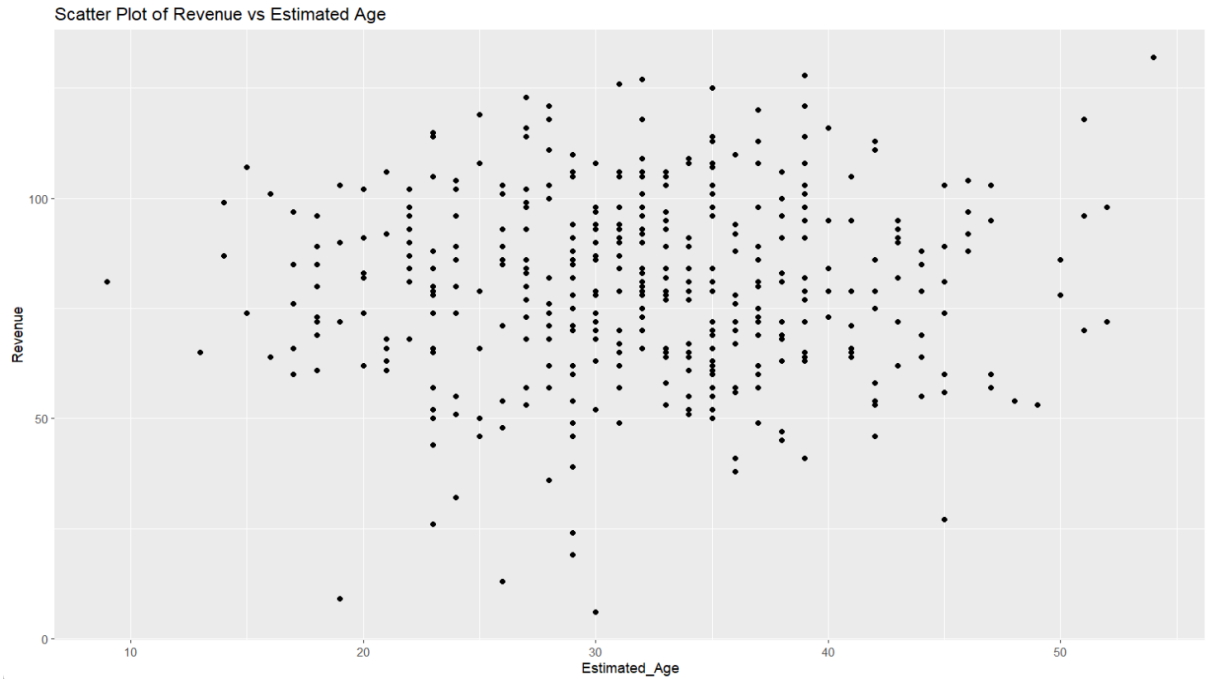

Figure 7 Scatter Plot of Revenue VS Estimated Age

✦p-value: < 2.2e-16

This task's dependent variable is revenue, as the goal is to determine the factors influencing it. The independent variables are Time On Site, Estimated Age, Seen Voucher, Advertisement Channel, and Estimated Income. We can see the large positive influence that Seen_Voucher and Estimated_Income has on Revenue from the correlation diagram above, which was created using the R Corrgram library. It is also evident that Revenue earned is positively impacted by Advertisement_Channel.

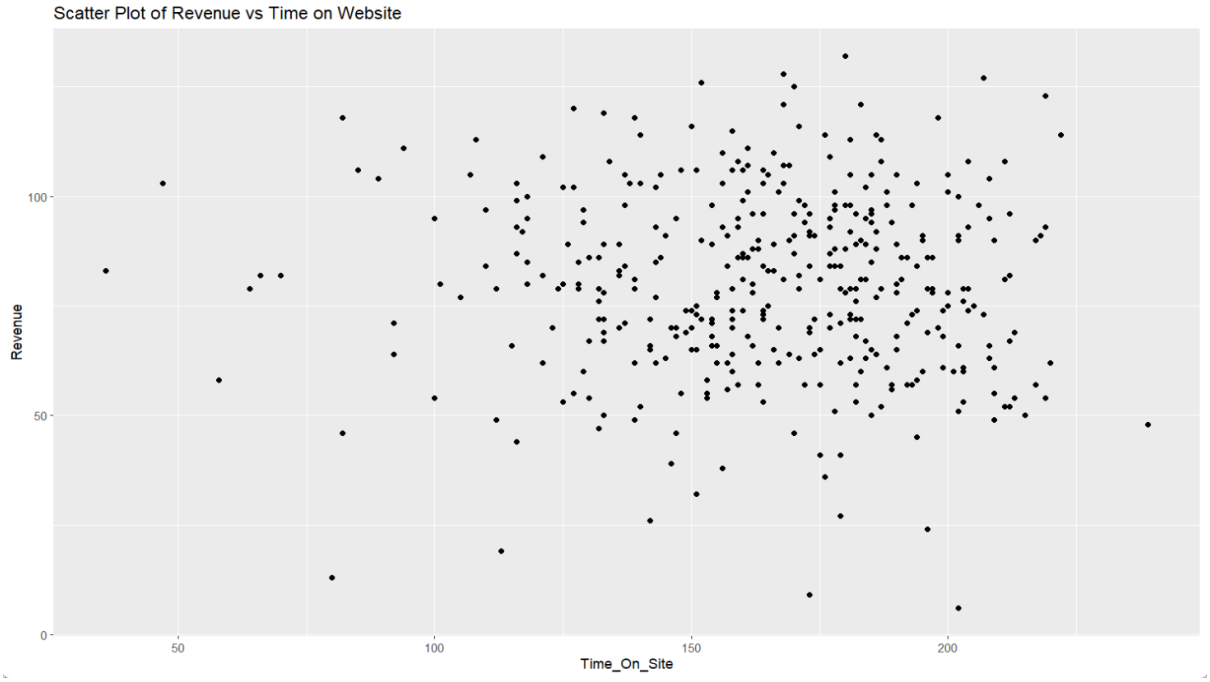

Figure 8 Scatter Plot of Revenue VS Time on Website

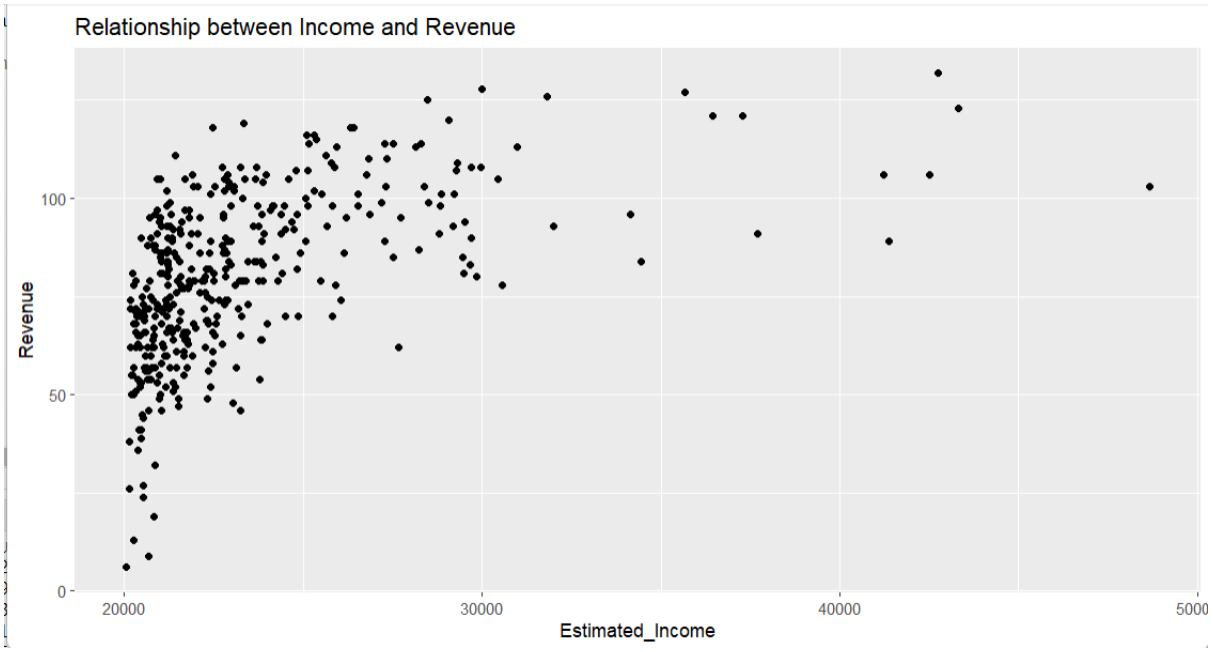

Figure 9 Relationship between Income and Revenue

If all other factors remain constant, revenue increases by £0.0029 for every unit increase in expected income. For this variable, a p-value of less than 0.001 indicates statistical significance. Additionally, if all other variables stay the same, users who have viewed a voucher are expected to spend £19.61 more on the website than users who have not. With a p-value of less than 0.001, this variable is highly significant. Although it does not have the same impact on income as the other two variables, advertising channel is associated with a £4.02 increase in revenue per unit. Revenue does not significantly correlate with the other two variables.

Modelling

Recommendations:

- Targeted Marketing: Invest more money in search engine optimisation and social media, paying particular attention to those outlets that show a strong increase in consumer spending.
- Customer segmentation: Tailor ads to draw in and keep clients with higher incomes by customising campaigns depending on demographics.
- Promotional Tactics: Introduce targeted discounts or incentives to capitalise on the good impact of vouchers on spending, especially for clients who haven't seen a voucher yet.

Task 2 – Recommendation Analysis

Evaluation

Practical Aspects Evaluation

Targeting Older Customers: Limited viability because to age's negligible influence on expenditure, perhaps expensive costs, and restricted reach.

Voucher Offering: Extremely useful and in line with the major advantages of having voucher visibility over expenditure. It's a targeted, measurable, and economical strategy.

Influencer Advertising: This channel has possible expenses and unpredictable results; therefore, its viability depends on how well it works.

Analyse the Impact of Age on Revenue:
The coefficient for the variable "Estimated_Age" is -0.01524, and the p-value is 0.8647. Given that the coefficient is negative, a rise in age may result in a minor decline in revenue. Nevertheless, the p-value is not statistically significant ($p > 0.05$), suggesting that there is no solid correlation between revenue and age. Consequently, age could not have a big influence on consumer buying.
Analyse the Impact of Voucher Visibility on Revenue:
The coefficient for the variable "Seen_Voucher" is 19.6955, and the p-value is 2e-16, indicating that it is highly significant. The positive coefficient suggests that users of the website typically make much larger purchases after seeing a coupon. This shows that distributing vouchers can be a successful tactic to encourage spending and that voucher visibility has a significant beneficial influence on revenue.
Analyse the Impact of Advertisement Channels on Revenue:

- **Advertisement_Channel2 (social media):** The coefficient is 6.8284, and the p-value is 0.000783, indicating a statistically significant positive impact on revenue. Customers reached through social media tend to spend more.
- **Advertisement_Channel3 (Search Engine):** The coefficient is 8.0909, and the p-value is 6.28e-05, showing a statistically significant positive impact on revenue. Customers from search engines contribute remarkably to revenue.
- **Advertisement_Channel4 (Influencer):** The coefficient is 12.9736, and the p-value is 2.66e-10, which is highly significant. The strong positive coefficient suggests that customers influenced by an influencer have a substantial impact on revenue. This channel stands out as a significant driver of spending.

In conclusion, the visibility of vouchers and the choice of advertising channels, especially social media, Search Engine, and Influencers, play crucial roles in influencing customer spending. Consideration of these factors is vital for effective marketing strategies.

Consider Practical Aspects:

Running an Advertisement Targeting Customers Older than 45 Years:
Practical considerations must be considered, even though this alternative may take advantage of an older demographic's potential for increased spending behaviour. Targeted advertising might have limited reach and increased expenditures when running inside a certain age range. Furthermore, it can be difficult to ensure engagement and reach the appropriate audience. The target group's propensity to respond to the ads and the accuracy of the age estimation are key factors in this strategy's efficacy.
Providing a Voucher for £20 Off Next Orders:
According to statistics, supplying a voucher has a significant positive impact on revenue. In practice, providing vouchers can be a cost-effective strategy that encourages impulse purchases. Offering discounts, on the other hand, has financial repercussions that should be carefully evaluated, taking into consideration how it may affect total profit margins. Voucher distribution and visibility should also be maximised for maximum efficacy.

Spending More on Advertising with an Influencer:
The statistical study highlights how the "Influencer" channel influences income. Finding the right influencers, negotiating price, and ensuring brand image coherence are all practical concerns even if influencer marketing may be quite successful. The reach and engagement of the influencer's audience should be carefully assessed to validate the investment. Influencer partnerships might cost different amounts, therefore it's important to compare the potential returns on investment with any potential advantages.

Make a Recommendation:

Considering both statistical evidence and practical aspects, the recommendation is to **Provide a Voucher for £20 Off Next Orders.** This alternative not only increased revenue significantly, but it is also cost-effective. Vouchers can be strategically distributed to reach a large audience, and the instant incentive stimulates increased spending. Additionally, voucher programmes have a controllable cost outlay, which makes them a sensible and efficient option.

Justify the Recommendation:

1. **Statistical Evidence:** The statistical analysis revealed a strong positive association between voucher visibility and increased spending. The coefficient for the "Seen_Voucher" variable was highly significant ($p < 0.05$), indicating a substantial impact on revenue.
2. **Cost-Effectiveness:** Giving out coupons is a more economical tactic than engaging in influencer marketing or executing targeted ads. Without requiring significant promotional expenditures, the immediate cash incentive promotes customer action right away.
3. **Feasibility:** Vouchers are simple to integrate into the website's architecture, making it possible to distribute them to a large audience without difficulty. Voucher distribution has scalable and realistic logistics.
4. **Customer Engagement:** Vouchers directly engage customers by providing an attractive discount, fostering a positive perception of the brand, and encouraging repeat purchases.

In conclusion, the analysis equips 'drinks@home.uk' with actionable insights to optimize marketing strategies, emphasizing targeted approaches, promotional tactics, and leveraging the influence of vouchers on consumer spending.