Masters Programmes: Group Assignment Cover Sheet

Student Numbers: Please list numbers of all group members	5521960, 5579997, 5583919, 5584180, 5561682
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Have you used Artificial Intelligence (AI) in any part of this assignment?	No

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1 Introduction

This report explores the implementation and potential impact of Revenue Management (RM) strategies at WCG, drawing essential comparisons with similar practices in the airline industry. It focuses on how WCG can leverage data-driven decision-making to significantly enhance its operational efficiency and profitability, particularly in its unique business setting characterised by fixed container capacity and fluctuating demand. This analysis explores container allocation optimisation and dynamic pricing strategies, highlighting the critical role of understanding customer behaviour and market trends in revenue maximisation.

2 Suitability Analysis

2.1 WCG's Suitability for Revenue Management

WCG's business environment is well-suited for Revenue Management (RM) due to several favourable factors, including comprehensive data on product offerings, demand fluctuations, and customer behaviour (Beaver, 2022). According to Cramer, C. and Thams, A. (2021) and Cleophas, C. et al. (2011) there are 4 additional factors supporting the introduction of RM:

- **Fixed Capacity**

WCG's fixed container capacity necessitates efficient allocation and dynamic pricing strategies to maximise profitability, contrary to surplus inventories that can deal with demand fluctuations.

- **Stochastic Demand**

Stochastic demand, characterised by seasonal variations and unrecognisable patterns, requires advanced forecasting to effectively allocate containers, aiming to meet customer needs in fluctuating demand.

- **Willingness to Pay**

WCG's service model offers customers logistical flexibility without significant capital investments, ideal to those with fluctuating shipping needs. This leads to varying willingness-to-pay that can be leveraged by WCG when allocating containers to different costing and customer segments.

- **High Fixed Cost, Low Variable Cost**

WCG has a total capacity of 300 containers, with high fixed costs for acquisition, maintenance, and storage, outweighing the variable costs of leasing containers.

When comparing WCG's and airline industry's methodologies, below similarities are founded:

- **Capacity Allocation**

In airline ticket sales, early bookings are typically priced lower. Therefore, accepting too many low-price seats may lead to losing customers that are willing to pay a higher price in the future, highlighting the significance of demand forecasting and effective capacity management (Littlewood, 2005). Likewise, WCG oversees capacity management, recognising that selling larger capacities at reduced rates could lead to missed opportunities to meet the peak season demands of customers willing to pay premium rates.

- **Pricing Strategy**

Airlines often implement advance purchase discounts to appeal to "price-sensitive" customers, while "time-sensitive customers" buy tickets closer to the departure date (Chiou and Liu, 2016). This pricing strategy is like WCG's container leasing strategy, offering reduced rates for longer commitments. Furthermore, both sectors perform dynamic pricing, adjusting rates based on seasonal demand, special events, and market conditions. allowing adaptation to changing customer needs and maintaining competitiveness by balancing supply and demand effectively.

- **Performance Metrics**

When evaluating performance, both the airlines industry and WCG utilise similar indicators to measure efficiency and profitability. According to Davila and Venkatachalam (2004), "Passenger load factor, measured as the number of passenger-miles divided by the total number of seat miles available, is among the most relevant measures" in the airline industry, parallel with "the degree to which WCG maximises the use of its container fleet". ROI, on the other hand, assesses profitability by comparing the revenue generated from assets against their costs, mainly used by WCG to evaluate the financial performance, like its use in the airline industry to "identify how effectively operating assets are used to generate operating income" (Huang et al., 2021).

3 Linear Programming Formulation

3.1 Resources

- Each week i represents one resource with inventory I_i, $\forall i \in \{2, 3, \cdots, 51\}$, with initial inventory $I_{i=1} = 77$.
- There are a total of 50 resources from week 2 to week 51.

3.2 Products

- Each week has 4 lease options (1-week, 4-weeks, 8-weeks and 16-weeks).
- There are a total of 200 products from week 2 to week 51.

3.3 Parameters

- Price of leasing one container per day in week i for j-week(s) lease

$$p_{ij}, \forall i \in \{2, 3, \cdots, 51\}, \forall j \in \{1, 4, 8, 16\}$$

- Expected demand

$$d_{ij}, \forall i \in \{2, 3, \cdots, 51\}, \forall j \in \{1, 4, 8, 16\}$$

- Revenue of leasing one container

$$r_{ij} = 7 \times j \times p_{ij}, \forall i \in \{2, 3, \cdots, 51\}, \forall j \in \{1, 4, 8, 16\}$$

- Inventory in week k (See Appendix 6.1 for the detailed proof)

$$\begin{aligned} I_k = 77 - \sum_{i=2}^{k} \Big[& \sum\nolimits_{j \in \{1,4,8,16\}} x_{i-1,j} \, I(i > 2) \\ & -x_{i-1,1} \qquad\qquad I(i > 2) \\ & -x_{i-4,4} \qquad\qquad I(i > 5) \\ & -x_{i-8,8} \qquad\qquad I(i > 9) \\ & -x_{i-16,16} \qquad\quad\; I(i > 17) \\ & -(1 + 10 + 10 + 4) \; I(i = 2) \\ & -(8 + 6 + 5) \qquad\;\; I(i = 3) \\ & -(9 + 8 + 2) \qquad\;\; I(i = 4) \\ & - \cdots \\ & -9 \qquad\qquad\qquad\; I(i = 17) \Big] \end{aligned}$$

$$\forall k \in \{2, 3, \cdots, 51\}$$

where $I(i > 2) = \begin{cases} 1 & if\ i > 2 \\ 0 & otherwise \end{cases}$ is an indicator function.

3.4 Decision Variables

Set x_{ij} as the accepted number of leased containers:

$$x_{ij}, \forall i \in \{2, 3, \cdots, 51\}, \forall j \in \{1, 4, 8, 16\}$$

3.5 Objective Function

Maximise the total revenue of leasing containers in year 2018:

$$Maximise \sum_{i=2}^{51} \sum_{j \in \{1,4,8,16\}} r_{ij} x_{ij} = \sum_{i=2}^{51} \sum_{j \in \{1,4,8,16\}} 7 \times j \times p_{ij} \times x_{ij}$$

3.6 Constraints

- **Inventory Constraint**

$$\text{Total accepted number of leased containers in week } k$$
$$\leq \text{Inventory in week } k, \forall k \in \{2, 3, \cdots, 51\}$$
$$\sum_{j \in \{1,4,8,16\}} x_{kj} \leq I_k, \forall k \in \{2, 3, \cdots, 51\}$$

where I_k can be expressed as the formulation in Section 3.3.

- **Demand Constraint**

$$\text{Accepted number of leased containers in week } i \text{ for } j\text{-week(s) lease}$$
$$\leq \text{Demand in week } i \text{ for } j\text{-week(s) lease}, \forall i \in \{2, 3, \cdots, 51\}$$
$$x_{ij} \leq d_{ij}, \forall i \in \{2, 3, \cdots, 51\}, \forall j \in \{1, 4, 8, 16\}$$

- **Non-negativity Constraint**

$$x_{ij} \geq 0, \forall i \in \{2, 3, \cdots, 51\}, \forall j \in \{1, 4, 8, 16\}$$

- **Total Constraint**

Inventory for each week must not exceed total number of containers.

$$I_i \leq 300, \forall i \in \{2, 3, \cdots, 51\}$$

3.7 Model Results

Table 1: Model Results [See Appendix 6.2, 6.3, and 6.4 for more details]

	Without RM Model	**With RM Model**	**% Increase**
Total Revenue	£ 675,832	£ 749,588	10.91%
Return on Investment (ROI)	0.150	0.167	11.33%
Load Factor	5.68	6.16	8.45%
Avg. Revenue per container annually	£ 2,252.77	£ 2,498.63	10.91%

The approach primarily focuses on inventory allocation, considering the lease duration, associated costs, and predictable demand to maximise branch profitability.

The shadow price method was employed to evaluate the impact of increasing the container limit on WCG's revenue. The results indicate a notable gain in profits, rising from $749,588 to $750,492.4. This significant increase suggests that expanding container capacity could be a valuable strategic move, offering a concrete reference point for its future operational decisions.

By leveraging data-driven optimisation, WCG can not only achieve a substantial increase in revenue but also reduce time-consuming manual operations. Currently, the process involves assessing the competitive environment and engaging in negotiations with customers, demanding considerable time and manpower. Human errors in decision-making could also lead to revenue losses. By shifting to an analytically focused approach the branch can improve overall operational efficiency, eliminating the need for negotiating with customers individually (Silkoset, 2023). This additionally enhances fairness and transparency in pricing policies ensuring that inventory allocation is determined solely by profitability rather than individual decisions made during negotiations.

3.8 Implementation

Implementing a data-driven decision-making approach at WCG should involve a transition strategy from current practices to more sophisticated revenue management techniques. This implementation process should include data collection, data analysis and modelling, system implementation, monitoring and evaluation, training, and deployment.

In the data collection step, historical pricing, demand, and utilisation data should be aggregated. This step can also include research about competitor pricing strategies and customer behaviour. Collected data should be utilised to develop predictive models for demand forecasting and price optimisation, the result of which can be fed into the RM model. During the deployment phase, a pilot program may be launched in select branches to implement the system within a controlled environment. Post deployment, performance should be continuously monitored and evaluated against key metrics like load factor and ROI. Additionally, employees should be trained to ensure that they understand the principles of data-driven decision-making, the recommendations of the system and the insights it provides.

3.9 Limitations and Recommendations

Transitioning WCG to a data-driven approach for revenue management presents several challenges, including the need for price differentiation through the development of distinct pricing models for one-way leases, varying container sizes, and total lease units. Decisions on lease types and managing the shipping network are critical to reducing container relocation costs. Consequently, it is important to incorporate constraints that consider both the anticipated costs and specific demand itineraries. (Wang et al., 2015). Furthermore, flexible pricing through customer negotiations is vital for sustaining B2B relationships in container shipping industry, which can be achieved through the incorporation of competitive pricing and the CRM-purposed pricing strategies.

The transition to digital data collection from paper-based systems is crucial for leveraging real-time analytics, requiring significant adjustments in operational processes and decision-making. Additionally, the move towards data-driven insights from managerial intuition necessitates investing in comprehensive employee training and advanced analytics tools like demand forecasting and price optimisation model. Furthermore, incorporating real-time dynamic pricing and efficient inventory management will be essential.

4 Conclusion

This report demonstrates that implementing revenue management strategies at WCG, inspired by the airline industry, holds a significant potential for enhancing operational efficiency and profitability. Through data-driven decision-making, WCG can optimise ROI and container allocation, leading to an estimated 11% increase in total revenue and ROI, and 8% increase in load factor.

However, this transition requires the overcoming of some challenges by introducing demand forecasting, price flexibility, and technological adaptation. Ultimately, an RM system will have a major impact on realising the company’s transformation towards data-driven operational excellence.

5 References

Beaver, S. (2022). 'Revenue Management Defined: Ultimate Guide for 2022.' [online] *Oracle NetSuite*. Available at: https://www.netsuite.com/portal/resource/articles/financial-management/revenue-management.shtml (Accessed: 1 March 2024)

Chiou, Y.-C. and Liu, C.-H. (2016). 'Advance purchase behaviors of air tickets', *Journal of Air Transport Management*, 57, pp. 62-69.

Cleophas, C., Yeoman, I., McMahon-Beattie, U. and Veral, E. (2011). 'The Applications of Revenue Management and Pricing', in Yeoman, I. and McMahon-Beattie, U. (eds.) *Revenue Management: A Practical Pricing Perspective*. Palgrave Macmillan UK, London, pp. 9-16.

Cramer, C. and Thams, A. (2021). 'Fundamentals of Airline Revenue Management', in *Airline Revenue Management: Current Practices and Future Directions*. Springer Books, 1, pp. 1-13.

Davila, A. and Venkatachalam, M. (2004). 'The Relevance of Non-financial Performance Measures for CEO Compensation: Evidence from the Airline Industry', *Review of Accounting Studies*, 9, pp. 443-464.

Huang, C.C., Hsu, C.C. and Collar, E. (2021). 'An Evaluation of the Operational Performance and Profitability of the U.S. Airlines', *Journal of Global Business and Commerce*, 16, pp. 73-85.

Littlewood, K. (2005). 'Forecasting and control of passenger bookings', *Journal of Revenue and Pricing Management*, 4(2), pp. 111-123.

Silkoset, R. (2023). *Pricing: A Guide to Pricing Decisions*. De Gruyter.

Wang, S., Wang, H., & Meng, Q. (2015). 'Itinerary provision and pricing in container liner shipping revenue management', *Transportation Research Part E: Logistics and Transportation Review*, 77, pp. 135-146.

6 Appendices

6.1 Proof of Inventory Formulation

We start with formulating the inventory of the first few weeks. At first, the inventory in week 1 is given as 77.

Week 1: $I_1 = 77$

Then, we can substitute I_1 into I_2.

Week 2: $I_2 = I_1 + (1 + 10 + 10 + 4) = 77 + (1 + 10 + 10 + 4)$

After calculating I_2, we can also substitute I_2 into I_3.

Week 3:

$$
\begin{aligned}
I_3 &= I_2 - \sum_{j\in\{1,4,8,16\}} x_{2,j} + \left(x_{2,1} + 8 + 6 + 5\right) \\
&= 77 + (1 + 10 + 10 + 4) \\
&\quad - \sum_{j\in\{1,4,8,16\}} x_{2,j} + \left(x_{2,1} + 8 + 6 + 5\right)
\end{aligned}
$$

Now the term I_3 is expressed as the decision variable $x_{2,j}$. If we substitute I_3 into I_4, then I_4 will be expressed as decision variables $x_{2,j}$ and $x_{3,j}$.

Week 4:

$$
\begin{aligned}
I_4 &= I_3 - \sum_{j\in\{1,4,8,16\}} x_{3,j} + \left(x_{3,1} + 9 + 8 + 2\right) \\
&= 77 + (1 + 10 + 10 + 4) \\
&\quad - \sum_{j\in\{1,4,8,16\}} x_{2,j} + \left(x_{2,1} + 8 + 6 + 5\right) \\
&\quad - \sum_{j\in\{1,4,8,16\}} x_{3,j} + \left(x_{3,1} + 9 + 8 + 2\right)
\end{aligned}
$$

By following the steps above, the inventory starting from week 18 can be derived as below.

Week i for $18 \le i \le 51$:

$$
\begin{aligned}
I_i &= I_{i-1} - \sum_{j\in\{1,4,8,16\}} x_{i-1,j} + \left(x_{i-1,1} + x_{i-4,4} + x_{i-8,8} + x_{i-16,16}\right) \\
&= 77 + (1 + 10 + 10 + 4) \\
&\quad - \sum_{j\in\{1,4,8,16\}} x_{2,j} + \left(x_{2,1} + 8 + 6 + 5\right) \\
&\quad - \sum_{j\in\{1,4,8,16\}} x_{3,j} + \left(x_{3,1} + 9 + 8 + 2\right) \\
&\quad - \cdots
\end{aligned}
$$

group 11

$$-\sum_{j\in\{1,4,8,16\}} x_{i-1,j} + \left(x_{i-1,1} + x_{i-4,4} + x_{i-8,8} + x_{i-16,16}\right)$$

By grouping all summation terms using index k, we can generalise the formulation of inventory, which is given by:

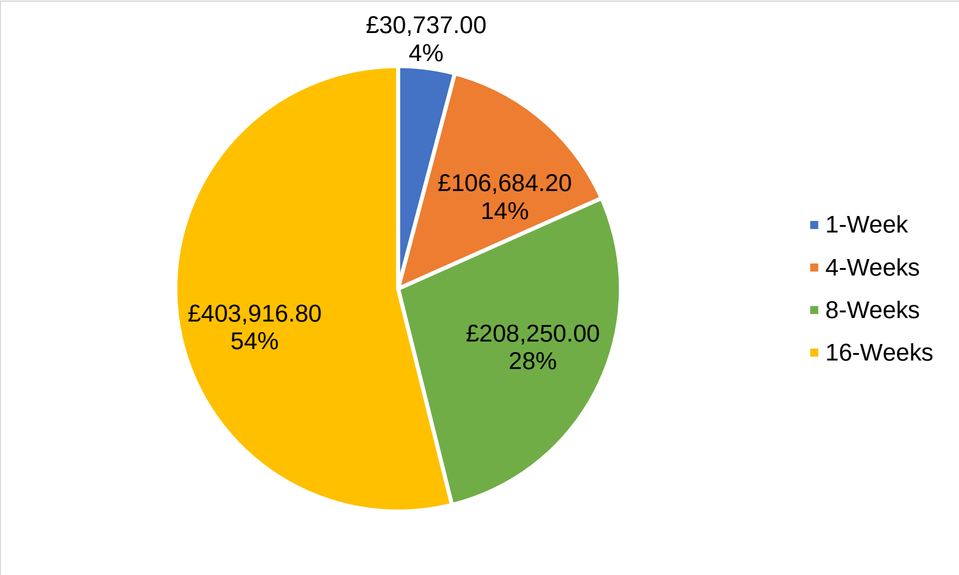
$$\begin{aligned} I_k = 77 - \sum_{i=2}^{k} \Big[& \sum_{j\in\{1,4,8,16\}} x_{i-1,j} \, I(i > 2) \\ & -x_{i-1,1} \qquad\qquad I(i > 2) \\ & -x_{i-4,4} \qquad\qquad I(i > 5) \\ & -x_{i-8,8} \qquad\qquad I(i > 9) \\ & -x_{i-16,16} \qquad\quad I(i > 17) \\ & -(1 + 10 + 10 + 4) \; I(i = 2) \\ & -(8 + 6 + 5) \qquad I(i = 3) \\ & -(9 + 8 + 2) \qquad I(i = 4) \\ & - \cdots \\ & -9 \qquad\qquad\quad I(i = 17) \Big] \end{aligned}$$

$$\forall k \in \{2, 3, \cdots, 51\}$$

where $I(i > 2) = \begin{cases} 1 & if\ i > 2 \\ 0 & otherwise \end{cases}$ is an indicator function.

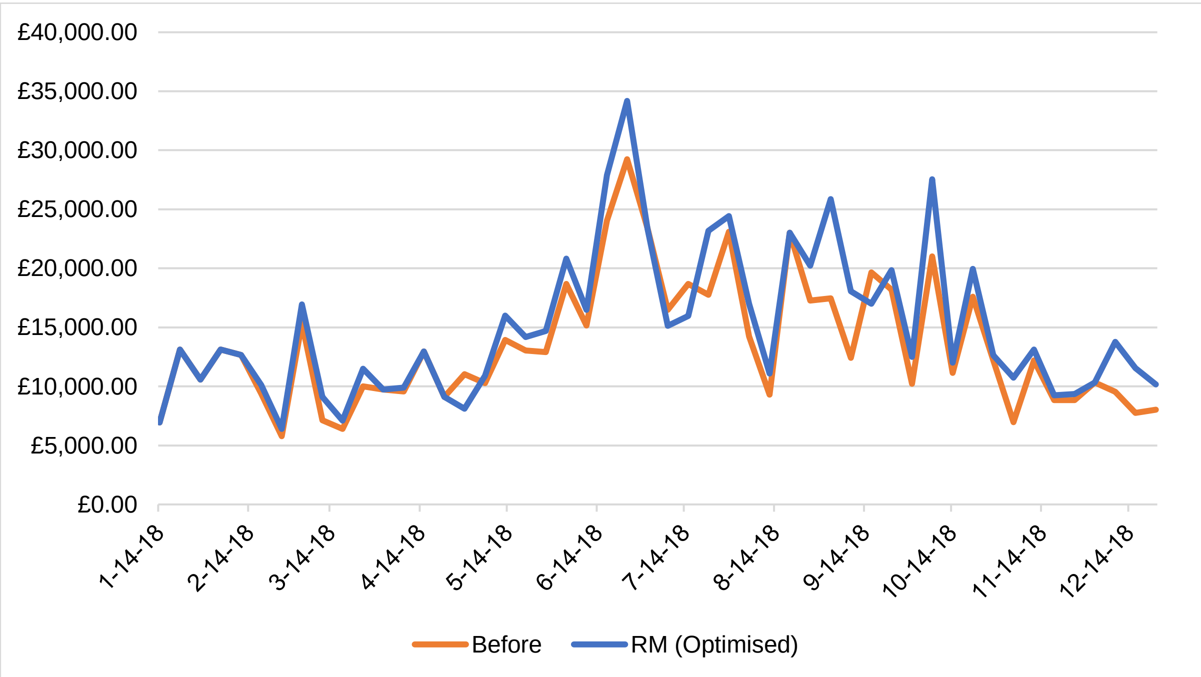
6.2 Total Revenue Breakdown

Figure 1. Total revenue breakdown after RM model is implemented



6.3 Weekly Revenue in Year 2018

Figure 2. Weekly Revenue in Year 2018



6.4 Total Accepted Breakdown

Figure 3. Total accepted breakdown after RM model is implemented

Lease Options	Total Accepted
1-Week	462
4-Weeks	445
8-Weeks	463
16-Weeks	479
Total	1849