**SCM 518 – ANALYTICAL DECISION MODELING**

**FINAL PROJECT REPORT**

**Crafty Brews Brewing Company – Profit Optimization**

**A logo of a crafty brews company

Description automatically generated**

**By**

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# **Background:**

Crafty Brews Brewing Company, a renowned producer of craft beer, has established itself as a key player in the beer industry, catering to a diverse clientele that includes bars, restaurants, and retail stores. With a focus on optimizing its production and distribution strategy, the company is geared towards maximizing profit while adhering to various constraints and client preferences.

Crafty Brews offers an array of craft beer types including IPA (India Pale Ale), Stout, Lager, Pilsner, Wheat Beer, and Saison. These varieties cater to a broad range of tastes, ensuring that the company meets the diverse preferences of its clients. The pricing strategy of Crafty Brews is meticulously structured, offering different prices for each beer type based on the client. For instance, the IPA is priced at $4.10 for bars, $3.60 for restaurants, and $3.10 for retail stores. Similarly, other types like Stout, Lager, Pilsner, Wheat Beer, and Saison have their unique pricing tiers for each client type, reflecting the company's strategic approach to market segmentation.

The production side of Crafty Brews involves specific costs for brewing each beer type. For example, the brewing cost per unit for IPA is $1.55, Stout is $1.75, Lager is $1.45, and so on for the other types. These costs are critical in determining the overall profitability of each beer type. Additionally, the company has established maximum brewing capacities per week for each beer type, ensuring a balanced production that aligns with market demand and operational capabilities.

Operating under a weekly budget of $105,000 for brewing and transportation, Crafty Brews efficiently manages its financial resources to optimize production and distribution processes. The transportation of their products is facilitated through a fleet of small, medium, and large trucks, each with varying costs and capacities. Small trucks have a capacity of 1000 bottles at $0.20 per unit, medium trucks can carry 2000 bottles at $0.15 per unit, and large trucks can transport 3000 bottles at $0.10 per unit. This diversified transportation strategy allows Crafty Brews to effectively reach its wide range of clients.

In terms of delivery and client receiving capacity, Crafty Brews adheres to specific requirements. Bars and restaurants can accept a maximum of four types of beer and at least two types each week, ensuring a variety of options for their customers. Retail stores, on the other hand, demand a diverse selection, requiring at least four different types of beer in their orders each week. The company also has set maximum delivery capacities per week for each client type: 20,000 for bars, 17,000 for restaurants, and 28,000 for retail stores. These capacities are calculated to meet client demands while maintaining efficient distribution.

Crafty Brews Brewing Company, through its strategic pricing, production planning, and distribution logistics, exemplifies a business model that not only meets the varied tastes of its clientele but also maximizes operational efficiency and profitability. This approach highlights the company's commitment to quality, customer satisfaction, and sound business practices in the competitive craft beer industry. Consider that there is no inventory, and everything must be sent to the clients.

# **Scenario Details:**

**Pricing:**

|  |  |  |  |
| --- | --- | --- | --- |
| Beer Type | Price for Bars | Price for Restaurants | Price for Retail Stores |
| IPA | $4.10 | $3.60 | $3.10 |
| Stout | $4.30 | $3.80 | $3.30 |
| Lager | $3.90 | $3.40 | $2.90 |
| Pilsner | $4.00 | $3.50 | $3.00 |
| Wheat Beer | $4.20 | $3.70 | $3.20 |
| Saison | $4.40 | $3.90 | $3.40 |

**Production Costs:**

|  |  |
| --- | --- |
| Beer Type | Brewing Cost |
| IPA | $1.55 |
| Stout | $1.75 |
| Lager | $1.45 |
| Pilsner | $1.50 |
| Wheat Beer | $1.60 |
| Saison | $1.70 |

**Production Capacity:**

The company has a maximum brewing capacity per week for each beer type:

|  |  |
| --- | --- |
| Beer Type | Max Capacity |
| IPA | 12500 |
| Stout | 12000 |
| Lager | 10000 |
| Pilsner | 12000 |
| Wheat Beer | 11500 |
| Saison | 9500 |

**Budget:**

Crafty Brews has a weekly budget of $105,000 for brewing and delivery(transportation).

**Transportation cost and capacities:**

Transportation to these clients is done by three types of trucks. Costs and capacities are:

|  |  |  |  |
| --- | --- | --- | --- |
| Transportation cost | cost | cap per truck  (no of bottles) | max no of trucks |
| small truck | $0.20 | 1000 | 20 |
| medium truck | $0.15 | 2000 | 12 |
| large truck | $0.10 | 3000 | 7 |
|  |  |  |  |

**Delivery and Client receiving Capacity:**

All Bars and restaurants can accept at most four types of beer and at least two types per that week.

Retail Stores require a diverse selection, demanding at least four different types of beer in their order in every week.

Crafty Brews has maximum delivery capacities per week for each client type:

|  |  |
| --- | --- |
| Client Type | Max Delivery Capacity |
| Bars | 20000 |
| Restaurants | 17000 |
| Retail Stores | 28000 |

Build an optimization model for this to maximize the profit of Crafty Brewing company.

# **Questions that will be addressed with the model:**

1. How can Crafty Brews optimize its production and distribution strategy to maximize weekly profit while considering pricing, production costs, and capacity constraints?

2. What is the maximum profit Crafty Brews can achieve each week under the given constraints?

3. How can Crafty Brews meet the minimum order quantities for each client type while maximizing profit?

4. Which beer types should Crafty Brews produce and deliver to bars, restaurants, and retail stores to satisfy their preferences and maximize profit?

5. How should Crafty Brews allocate its budget for brewing and delivery to optimize its operations?

# **Model Formulation:**

## **Inputs:**

* i {1, 2, 3, 4, 5, 6}, index representing type of beer, (e.g.: 1= IPA, 3 = Lager)
* j {1,2,3}, index representing type of client, (e.g.: 2- Restaurant)
* k {1,2,3} – index representing truck type, (e.g.: 1- Small truck)
* Pij = Price per beer of type ‘i’ sending to client ‘j’, (e.g.: P23 = $ 3.3)
* Fi = Brewing Capacity for beer type i, (e.g.: F3 = 10000)
* Ci = Brewing cost per beer of type ‘i’, (e.g.: C2 = $1.75)
* MXj = Maximum number of types of beer to shipped to client ‘j’, (e.g.: MX2 = 4)
* MNj = Minimum number of types of beer to shipped to client ‘j’, (e.g.: MN3 = 4)
* Dj = Maximum delivery capacity to client ‘j’, (e.g.: D3 = 28000)
* B= Total Budget available for this week, (B = $105000)
* CTk = Capacity of number of bottles per truck type ‘k’, (e.g.: CT2 = 2000)
* Nk = Maximum number of trucks available per truck type ‘k’, (e.g.: N1 = 20)
* Tk = Transportation cost per bottle per truck type ‘k’, (e.g.: N1 = 20)
* M = 1000000, large number

## **Decision Variables:**

* Xij = Binary Decision variable for beer type ‘i’ and client type ‘j’. (1 – if that Beer type ‘i’ should be shipped to Client ‘j’, is chosen, 0 – otherwise),

i {1,2,3,4,5,6}, j {1,2,3}

* Yij = Quantity of beer type ‘i’ to be shipped to client type ‘j’,

i {1,2,3,4,5,6}, j {1,2,3}

* Zk = Quantity of beer to be shipped using truck type ‘k’,

k {1,2,3}

## **Objective Function:**

Maximize Total Profit for Crafty Brewing Company

(Total Revenue – Brewing Cost – Transportation Cost)

(ΣiΣj (Yij \* Pij) - Σi (Ci \* Σj Yij) – Σk (Zk \* Tk))

* i {1,2,3,4,5,6}, j {1,2,3}, k {1,2,3}

## **Constraints:**

* (Σi (Ci \* Σj Yij) + Σk (Zk \* Tk)) B,
* Budget Constraint – Total cost cannot cross total budget
* Σj Yij  Fi , i {1,2,3,4,5,6}
* Brewing Capacity Constraints per Beer type ‘i’
* Σi Yij  Dj , j {1,2,3}
* Delivery Capacity Constraints for Client ‘j’
* MNj  Σi Xij  MXj , j {1,2,3}
* Number of types of beers to be sent to client ‘j’ should be in the specified limits.
* Yij  M \* Xij, Connecting Yij and Xij – M is a large number
* Σk Zk  ΣiΣj Yij
* Total number of bottles transported using all truck types should match total number of bottles shipped to each client.
* Zk  CTk \* Nk, k {1,2,3}
* Xij  {0,1}
* Binary Constraint
* Yij 0
* Non-negative shipping
* Yij  {Integers}
* Number of bottles should be integer
* Zk  0
* Non-negative transportation

# **Answers to the Questions :**

**1. How can Crafty Brews optimize its production and distribution strategy to maximize weekly profit while considering pricing, production costs, and capacity constraints?**

Crafty Brews can optimize its production and distribution strategy by:

* **Focusing on the most profitable beer types.** Saison, wheat beer, and IPA are the most profitable beer types, so Crafty Brews should prioritize producing and distributing these beers.
* **Targeting the most profitable client types.** Bars are the most profitable client type, followed by restaurants and retail stores. Crafty Brews should prioritize delivering to bars whenever possible.
* **Using the most efficient transportation methods.** Large trucks are the most efficient transportation method, followed by medium and small trucks. Crafty Brews should use large trucks whenever possible to deliver beer to its clients.

**2. What is the maximum profit Crafty Brews can achieve each week under the given constraints?**

The maximum profit Crafty Brews can achieve each week under the given constraints is $114,583.75. This is achieved by producing and distributing the following quantities of beer:

* **Saison:** 9500 bottles
* **Wheat beer:** 11500 bottles
* **IPA:** 12500 bottles
* **Stout:** 5525 bottles
* **Pilsner:** 12000 bottles
* **Lager:** 10000 bottles

**3. How can Crafty Brews meet the minimum order quantities for each client type while maximizing profit?**

Crafty Brews can meet the minimum order quantities for each client type by prioritizing deliveries to bars. Bars have the highest profitability, followed by restaurants and retail stores. Crafty Brews should also consider using multiple truck types to make deliveries to different client types. For example, Crafty Brews could use a large truck to deliver beer to bars and a medium truck to deliver beer to restaurants.

**4. Which beer types should Crafty Brews produce and deliver to bars, restaurants, and retail stores to satisfy their preferences and maximize profit?**

Crafty Brews should produce and deliver the following beer types to bars, restaurants, and retail stores:

* **Bars:** Saison and IPA
* **Restaurants:** Wheat beer and pilsner
* **Retail stores:** IPA, Stout, Lager, and Wheat Beer

**5. How should Crafty Brews allocate its budget for brewing and delivery to optimize its operations?**

Crafty Brews should allocate its budget approximately for brewing and delivery in the following way:

* **Brewing:** 90%
* **Delivery:** 10%

This allocation will allow Crafty Brews to produce the most profitable beer types without exceeding its budget.

# **Additional Considerations:**

* **Retail stores have slack (full capacity is not used).** This is due to the lower profit margins for retail stores. Crafty Brews should prioritize deliveries to bars, followed by restaurants whenever possible as they have met boundary condition (full capacity used).
* **The highest priority is to satisfy the minimum order quantities for bars, followed by restaurants, and then retail stores.** Crafty Brews should also consider using multiple truck types to make deliveries to different client types.
* **Saison, wheat beer and IPA are the most profitable beer types**. Crafty Brews should prioritize producing and distributing the more profitable beer types. Stout also has high profitability, but solver solution shows stout has a slack. So, the company should try to produce less of these.
* **Large trucks are the most efficient transportation method.** Small trucks are less efficient. So, they should be used only to meet the requirement constraint, and also whenever the shipment size is small.

# **Conclusion:**

Crafty Brews Brewing Company can maximize its weekly profit by focusing on producing and distributing the most profitable beer types, targeting the most profitable client types, and using the most efficient transportation methods. The company should prioritize Saison, wheat beer, and IPA, as these are the most profitable beer types. Additionally, Crafty Brews should prioritize delivering to bars and restaurants, as these are the most profitable client types. When making deliveries, Crafty Brews should use large trucks whenever possible, as they are the most efficient transportation method. By following these recommendations, Crafty Brews can achieve its maximum profit potential while meeting the minimum order quantities for each client type.