

TCOSU  
Team 18

# **BobaCo's Production and Customer Allocation Optimization Project**

## **TCOSU**

### **Project Team**

Alpar İkinci  
Kutay Ekinci  
Mehmet Erkan Bakırlioğlu  
Selin Alkazan  
Talya Yalçın  
Özgür Can Bektaş  
Utku Becer  
Industrial Engineering  
Bilkent University  
06800 Ankara

### **Industrial Advisor**

Nazlı Esen Ümmansu, BobaCo, TeaCo,  
Founder

### **Academic Advisor**

Bahar Yetiş, Bilkent University  
Department of Industrial Engineering

20 December 2023

### **Abstract**

This report provides information about BobaCo, a leading company in Turkey renowned for its production of Bubble Tea. It outlines a strategy to address the issue of product shortages, focusing on optimizing production, scheduling shifts, and acquiring machinery to meet demand efficiently. Additionally, the report incorporates mathematical model optimization to mitigate customer issues and avoid penalties. Finally, it will include an approximate timeline and explicit outlines of the responsibilities of each group member.

**Keywords:** Customer allocation, production planning, scheduling system

# Contents

|                                                          |    |
|----------------------------------------------------------|----|
| Title and Abstract                                       | 1  |
| 1 Description of the System                              | 3  |
| 2 Current System Analysis and Problem Definition         | 3  |
| 3 Review of Resources                                    | 4  |
| 4 Proposed Solution Strategy                             | 6  |
| 4.1 Critical Assumptions and Major Constraints . . . . . | 6  |
| 4.1.1 Critical Assumptions . . . . .                     | 6  |
| 4.1.2 Major Constraints . . . . .                        | 7  |
| 4.2 Objectives . . . . .                                 | 7  |
| 4.2.1 Optimum Production Plan . . . . .                  | 8  |
| 4.2.2 Optimum Customer Allocation . . . . .              | 8  |
| 4.3 Solution Approach . . . . .                          | 8  |
| 4.3.1 Conceptual Model . . . . .                         | 8  |
| 4.3.2 Mathematical Model . . . . .                       | 9  |
| 4.3.3 Solution Method . . . . .                          | 14 |
| 4.4 Verification . . . . .                               | 14 |
| 4.5 Validation . . . . .                                 | 14 |
| 5 Outcome and Deliverables                               | 14 |
| 5.1 Outcome . . . . .                                    | 14 |
| 5.2 Deliverables . . . . .                               | 14 |
| 5.3 Benchmarking and Benefits to the BobaCo . . . . .    | 15 |
| 6 Project Plan and Work Packages                         | 15 |
| Bibliography                                             | 16 |

# 1 Description of the System

BobaCO, established by TeaCO, originated as a second-generation tea house and has since expanded its presence in numerous markets across Turkey. Specializing in the Bubble Tea sector, a genre that originated in Taiwan during the 1980s, BobaCO engages in two primary product sales within this industry. The first encompasses the extracts utilized in ice tea production, a product whose manufacturing is outsourced to BobaCo. The second product, Bubbles, is internally produced at BobaCo's factory located in Ankara, offering a variety of 21 different flavors. Distinguishing itself as the exclusive Turkish manufacturer with BRC, IFS, HALAL, VEGAN, and FDA certifications, BobaCO not only operates under its own brand but also engages in contract manufacturing for numerous coffee chains ([Bobaco LTD., 2022](#)).

The ongoing production activities are conducted in the existing factory, operating 15 hours a day, six days a week, with two machines, resulting in a monthly production volume of 57,600 boxes. Estimated to cater to approximately 40 percent of the market, BobaCO channels its sales through three primary avenues. Firstly, it leverages designated dealers located across 15 different provinces in Turkey, who play a crucial role in supplying products to retail customers. Additionally, BobaCO engages in wholesale sales to chain cafes and restaurants. The final distribution channel involves wholesale markets. Moreover, the company extends its reach to end users through its official website and various online sales platforms.

## 2 Current System Analysis and Problem Definition

Bubble Tea is a seasonally consumed product, with heightened demand experienced during the summer months. In the previous season, BobaCO encountered a challenge in meeting the increased demand, resulting in only half of the market requirements being fulfilled. Despite doubling production capacity to two machines during the season to cope with increased demand, the additional output still wasn't enough to meet market needs. The root cause of this problem can be attributed to unmet demand.

BobaCO acknowledges the anticipated rise in demand due to increased seasonal consumption. With two machines and sufficient storage space in the upcoming season, the company aims to sustain production for its high-demand products during the off-season. This strategy is expected to contribute to meeting a larger percentage of the demand. Consequently, the company believes that two machines will suffice for this season, eliminating the need for a third machine.

During the previous season, to safeguard its market share, BobaCO distributed the products it could manufacture on a weekly basis based on customer priorities in Saturday meetings. In these meetings, customers were initially prioritized according to penalty costs, if any, and deadlines. Subsequently, production plans were crafted manually. However, the entirely manual nature of these plans resulted in insufficient efficiency and a lack of a fully trust-

worthy system. Simultaneously, daily alterations in production plans became necessary due to communication gaps between the sales team and production.

Based on the information obtained from the company and their historical production planning practices, it becomes evident that the primary problem of the BobaCO is the inability to formulate dependable long-term production plans utilizing existing capacities while accurately prioritizing customers.

### 3 Review of Resources

The literature review was conducted to gain a better understanding of the problem at hand and to identify any previous applications. It was carried out according to the criteria outlined in the problem definition. The sources scanned encompass similar production systems, production plans, and customer prioritization methods. Additionally, if BobaCO requested the use of an open-source solver in conjunction with the mathematical model, we investigated the performance of potential solvers.

To comprehend BobaCO’s production system, we initially explored various production management systems, with a primary focus on pull and push systems. Drawing insights from the article by ? , the push system involves products being pushed through distribution channels from production to retailers. In contrast, the pull system, characterized by consumers demanding products, results in reduced lead times, decreased uncertainty in demand, and more efficient operations. Considering the company’s alternating production for stock and custom orders, it can be assumed that BobaCO employs a hybrid of push and pull systems seasonally. BobaCO undertakes production on behalf of other companies, and although the packaging of the products is uniform, the labels differ. This scenario qualifies as a customized product. As these products are manufactured upon order placement, the production system employed is the pull system. Given BobaCO’s intention to generate stock in the upcoming offseason, it can be inferred that the company alternates between push and pull systems seasonally. Regrettably, despite an exhaustive search, an example illustrating a production plan aligned with this system could not be found. Consequently, the decision was made to concentrate on the production plan criteria associated with the pull system, with the belief that this approach would yield a more effective solution to the identified problem.

As stated in the problem definition, prioritizing customers plays a key role in solving this problem. As discussed in the article (Abbasi, Hosseinifard, Alamr, Thomas, and Minas, 2017), it is given three related basic heuristic allocation policies: Per commit, Myopic service-level-based allocation policy (MSLAP), and Myopic penalty-based allocation policy (MPAP). Under the per-commit approach, customers receive their allocations based on their expected share of the total demand. In MSLAP The objective is to minimize deviations from fill-rate targets at the end of the review period, without accounting for differences in penalties across customers. In this approach, the allocation decision is made 4 after the manufacturer knows the demands of all customers. Their findings suggest that, for this objective and setting, a myopic policy that minimizes per-period deviations from the fill-rate targets performs

well. In addition, MPAP aims to minimize penalty-weighted deviations from service-level targets in each period. Similar to MSLAP, MPAP is myopic but takes into account different penalties.

Additionally, the article argues that (Powell, 2011) there are four different Advanced allocation policies currently used in the literature. These include Deterministic allocation policy (DAP), Randomized deterministic allocation policy (RDAP), Myopic stochastic allocation policy (MSAP), and Stochastic time-aggregated allocation policy (STAP). These alternative policies rely on established approximate dynamic programming techniques and are based on "value function approximation".

Determining penalty costs at BobaCo is crucial, as some companies have specified fixed prices in contracts, while others do not. In situations where demand cannot be met, the financial loss resulting from lost customers and dissatisfaction poses a significant risk to the company. Consequently, a decision has been reached to establish penalty amounts for customers without defined penalty costs, incorporating perspectives from the per-commit approach and advanced allocation policies. This decision aims to formulate a comprehensive formula that considers potential financial losses incurred by the company in scenarios where customer satisfaction is not achieved or where demand cannot be fulfilled. We propose utilizing methods such as (XYZ, KLM) in our research. During the data verification stage, the objective is to gauge performance by determining penalty costs through various methods. These sources have provided us with insights into formulating penalty costs and have offered examples of methods that can be utilized.

Finally, in the research conducted to determine which solvers can be included in the output to be presented to the company, the article "Analysis of Commercial and Free/Open Source Solvers for Linear Optimization Problems" was referenced. According to the research, the popular and well-known free and open-source solvers GLPK, LP SOLVE, CLP, SCIP, and SoPlex were compared with prominent commercial Lp-Solvers Cplex, Xpress, and Gurobi in terms of their problem-solving capabilities and solution times. Although the paid solvers clearly outperform in both categories, it is noteworthy that SCIP-C and SCIP-L solvers, despite being free, deliver commendable results. In the subsequent stages of the process, further work will be conducted based on a presentation that includes price analyses and the pros and cons of solvers, aligning with the decision to be jointly made with the company. DoCplex can currently be utilized freely for developing and testing models; therefore, we are currently employing it for testing purposes.

In conclusion, through this literature review, we have acquired valuable insights into various production management systems and have learned about policies that are pivotal for devising a comprehensive approach, taking into account both customer satisfaction and financial losses. Furthermore, the research on solvers for linear optimization problems suggests that while paid solvers excel in terms of both problem-solving capabilities and solution times, free and open-source solvers like SCIP-C and SCIP-L also yield commendable results. This information will steer our decision-making process as we progress

with the project, incorporating price analyses and weighing the pros and cons of solvers in collaboration with the company.

## 4 Proposed Solution Strategy

Previous sections have defined the problem at hand. In proposed solutions, several strategies have been proposed to address the challenges faced by BobaCo. The initial solution strategy involves meticulously identifying the major constraints within the company’s operations. Establishing effective communication with the company’s manager was crucial in determining the most significant constraints in the factory’s working system. Beyond deciding major constraints, it is necessary to grasp the details of the factory concerning the real-life system. This entails making critical assumptions governing the anticipated outcomes and potential deviations in the proposed solutions compared to real-life systems. Furthermore, to validate and verify the proposed solutions, obtaining parameter values closely aligned with reality from the company is essential. This process ensures that the proposed solutions align with the system’s operating principles. A pivotal step in the proposed solution strategy is building a conceptual model. This model illustrates inputs’ entry, circulation within the system, and resultant outputs. Additionally, the conceptual model outlines how the system operates under various conditions. A vital element of the proposed solutions is the foundation of mathematical modeling, focusing on Mixed Integer Modeling. This mathematical model is the initial system, optimizing the company’s production plans and customer allocations. Despite the strength of mathematical modeling, challenges may arise during the solution phase. Particularly with large inputs, there is a risk of prolonged execution times when using optimization solvers. To mitigate this issue, various potential heuristic methods will be developed alongside the mathematical model, offering alternative paths for resolution. In conclusion, the proposed solutions encompass a comprehensive approach, ranging from understanding constraints and validating solutions to implementing mathematical modeling and heuristic methods. Collectively, these steps aim to enhance the operational efficiency of BobaCo and pave the way for optimal production planning and customer allocation.

### 4.1 Critical Assumptions and Major Constraints

#### 4.1.1 Critical Assumptions

Tea Co operates with two machines within its factory, with observable performance distinctions between them. While the latest information from Tea Co. indicates that these machines’ capacities and daily production rates are comparable, for the mathematical model, equal efficiency between the two machines will be assumed. It is important to note that any changes in machine efficiency will prompt a subsequent update to the model in the future. Tea Co is contemplating including a potential new machine in its plans. The mathematical model presented in this report assumes that Tea Co. currently operates with two machines. In the event of an increase in the number of machines, the relevant indices in the model will be adjusted accordingly.

The mathematical model has established a maximum allowance of two types of production per day. However, due to the absence of specific information on flavor compatibility for consecutive productions in the main Bubble Tea machine, the model assumes that any two types can be produced consecutively.

The products generated according to the mathematical model's algorithm are assumed to be immediately available for sale at the end of each day. This implies no waiting period; products are either sent to inventory or delivered to customers promptly after daily production. It is crucial to note that the assumption of a non-existent waiting period may be subject to change if such periods are introduced in the future. Another notable assumption is that no sales occur on Sundays. Given that the factory operates for six days a week, the mathematical model spans a total period of 24 days. Consequently, the model does not account for order quantities arriving on Sundays, leading to a lack of sales on that specific day.

In the mathematical model, the foundational assumption of zero inventory holding costs is made. This strategic choice stems from the company's specific challenge, which revolves around its inability to meet order fulfillment rather than concerns related to inventory maintenance. The primary emphasis of this mathematical model lies in addressing customer allocation and optimizing production planning decisions. We focus on increasing the supply chain's efficiency and precision by disregarding inventory holding costs. This approach enables a more detailed exploration of customer demands and production schedules.

#### **4.1.2 Major Constraints**

Tea Co. faces several critical constraints within its production line, each significantly influencing the overall manufacturing process. The primary constraint revolves around daily production hours. With the factory operational for 16 hours a day, the final hour is allocated to thorough cleaning. Effectively, the production capacity of 2 machines amounts to 30 hours per day. Another noteworthy constraint is the factory's limitation to produce a maximum of 2 types of products on a single production line. Tea Co.'s representative has directly communicated this information. The mathematical model reveals that the production process can accommodate 2 product types. However, it's essential to note that each transition between product types incurs a 1-hour setup waiting period.

The balance between the produced units, customer sales, and inventory constitutes a vital aspect of Tea Co.'s operational constraints. The system includes backlog, demand, and sales, with decision variables for backlog and inventory accumulating incrementally. Maintaining harmony in these aspects is required for the smooth functioning of the production and sales processes.

## **4.2 Objectives**

The mathematical model encompasses two primary objectives. One major goal is to formulate optimal production scheduling, while the second objective addresses the critical task of determining the priority and timing of customer



allocation. It achieves this by optimizing the difference between revenue generated from sales and penalties incurred due to backlogs.

#### **4.2.1 Optimum Production Plan**

Within the established mathematical model, a sophisticated mechanism exists to notice the ideal type of product to be manufactured by each machine, each hour, and each day. This decision-making process results in daily determinations of the optimal production quantities for each product type. The effectiveness of this system in making such decisions reflects its capacity to generate an optimal production schedule. Key decision variables influencing the mathematical model include the quantities of products sold, and the backlog amounts incurring penalties. Essentially, these variables directly impact the objective function of the mathematical model, thereby giving it the capability to formulate an optimum production plan.

#### **4.2.2 Optimum Customer Allocation**

The mathematical model includes decision variables that allocate specific products to customers on designated days. Concurrently, backlog amounts also serve as decision variables within the model. Through a similar relationship with production planning, the system holds the potential to operate the most logical end-of-day sales. In essence, it can optimize the selection of products sold to individual customers and the timing of these actions.

### **4.3 Solution Approach**

One of our main goals is to meet customer demand effectively. To achieve this, our modeling process will include historical demand schedules, and we will conduct forecasting for the upcoming year's demands. In addition, our goal is to employ both integer and continuous decision variables in the modeling process. Even in the case of a non-linear model, our approach is utilizing linear methodologies.

#### **4.3.1 Conceptual Model**

A comprehensive model is developed to conceptualize the proposed solution strategy, incorporating multiple interconnected components. It facilitates a solution by optimizing the mathematical model through a defined series of steps. The Conceptual Model comprises three key components: Input, Mathematical Model, and Output.

Initial inputs from the company are vital for the established conceptual model. Daily life data serves as the feeder for these inputs. The first set of inputs includes order quantities, where the system requires information on the quantities of orders, the respective customers, and associated deadlines to identify incoming demands. Additionally, revenue and penalty costs play a crucial role; the income generated from each unit order sold and penalties for delayed orders need to be inputted into the system. Similarly, the anticipated output from a one-hour production is another essential input. Microsoft Excel will integrate all these data points into the system.

The mathematical model, responsible for processing incoming system inputs, comprises several integral subcomponents. The initial one is the production component, which generates diverse products as an outcome of the production process. The second subcomponent is the inventory module. Furthermore, the model incorporates sales, demand, and objective components. The detailed flow of these components will be outlined in the following paragraphs.

The final component of the conceptual model encompasses the outputs: Total Revenue and Total Penalty Costs. The following paragraphs will clarify the detailed procedures for generating and presenting these components. The optimal production plan and customer allocations will also be among the outputs, each carefully outlined for comprehensive understanding.

Inputs entering the conceptual model will be directed to the mathematical model, with the Unit Production Amount input feeding into the production component of the system. Within the production process, this input will be translated into the total quantities produced within the Product component. The products resulting from production will have two pathways: move into inventory or be directed toward sales by integrating with the Sales component. Simultaneously, the Product component will function as the variable determining the optimal production output.

The Order input will enter the model to create the Demand component. Later, the demands can go to two components—they will either be backlogged or proceed to sales. Since the Sales component specifies which product will be sold, it is the primary entity executing customer allocation output.

The Backlog and Sales Components, in conjunction with penalty cost and revenue inputs, will collectively serve the goal of the mathematical model. This combination of components contributes to the Objective Component, which, in turn, directly produces the Total Penalty Cost and Total Revenue Outputs.

#### **4.3.2 Mathematical Model**

Indexes:

Customer index represents each different customer type:

$$C \in (1....21)$$

Type index represents the different types of Bubble Teas:

$$T \in (1....21)$$

Hour index represents the specific hours for production in a day:

$$H \in (1....15)$$

It represents the day in 1 month, excluding Sundays:

$$D \in (1....24)$$

It represents the type of machine used for production.

$$M \in (1, 2)$$

Parameters:

The mathematical model incorporates a parameter to denote demand quantities, encompassing each customer and product type, with associated deadlines for each demand quantity. The specification of the demand parameter in the mathematical model is outlined as follows:

$D_{C,T,D}$  = Demand amount for customer C, type T and day D

The amount of output resulting from the hourly production of both machines is another parameter. Its definition in the mathematical model is as follows:

$Yield$  = The amount of product resulting from one hour's production of each machine

The model will allow for the addition of pre-existing inventories. Its definition in the mathematical model is as follows:

$DayzeroInv_T$  = The amount of day 0 inventory for each type T

The mathematical model will additionally integrate backlog amounts from previous periods into the system. Its definition is expressed as follows:

$DayzeroBack_{C,T}$  = Day 0 Backlog amount for customer C and type T

The model should include the Big M and Small M parameters for some constraints. Their definition is outlined as follows:

$m_b$  = a very large positive number  
 $m_s$  = a very small number greater than 0

Revenue represents the revenue to be earned per product sold. Its definition is as follows:

$R_C$  = Revenue amount from unit sales for each customer C

Penalty cost represents the cost incurred for each product that enters the backlog. The mathematical definition is as follows:

$Pen_C$  = Penalty cost to be paid per unit backlog amount for customer C

Decision Variables:

X binary decision variable determines whether a specific type of bubble tea will be produced on a particular machine at a designated time on a given day. The mathematical definition is as follows:

$$X_{T,H,D,M} = \begin{cases} 1, & \text{If machine } M \text{ produce type } T \text{ at hour } H \text{ on day } D \\ 0, & \text{otherwise} \end{cases}$$

Y binary decision variable determines whether a specific product type is produced from each machine daily. The mathematical definition is as follows:

$$Y_{T,D,M} = \begin{cases} 1, & \text{If production occurs for type } T \text{ on machine } M \text{ and day } D \\ 0, & \text{otherwise} \end{cases}$$

K binary decision variable denotes whether a specific hour serves as the setup time on a designated day and machine. The mathematical definition is as follows:

$$K_{H,D,M} = \begin{cases} 1, & \text{If there is a setup on machine } M, \text{ on day } D \text{ at hour } H \\ 0, & \text{otherwise} \end{cases}$$

Product integer decision variable represents the total quantity of products from manufacturing of a particular type at the end of the day and is defined as:

$P_{T,D}$ : Total quantity produced of type T on day D

Inventory integer decision variable represents the end-of-day inventory of each type of product and is defined as:

$I_{T,D}$ : T type products' inventory at D day

Sales integer decision variable shows the amount of a product type sold to a particular customer at the end of each day. It is shown as:

$S_{C,T,D}$ : Sales to C'th customer T type product at D day

Backlog integer decision variable shows the amount of product type that cannot be sold to a particular customer and is backlogged at the end of each day:

$B_{C,T,D}$ : C'th customers backlog T type product at D day

The mathematical model is as follows:

$$\sum_{H=1}^{15} \sum_{M=1}^2 (Yield * X_{T,H,D,M}) = P_{T,D} \quad \forall T, D \quad (1)$$

$$\sum_{H=1}^{15} X_{T,H,D,M} \geq m_s - (1 - Y_{T,D,M}) * b_m \quad \forall T, D, M \quad (2)$$

$$\sum_{H=1}^{15} X_{T,H,D,M} \leq m_b * Y_{T,D,M} \quad \forall T, D, M \quad (3)$$

$$\sum_{T=1}^{22} Y_{T,D,M} \leq 2 \quad \forall D, M \quad (4)$$

$$\sum_{T=1}^{22} X_{T,H,D,M} + K_{H,D,M} = 1 \quad \forall H, D, M \quad (5)$$

$$\sum_{H=1}^{15} K_{H,D,M} \leq 1 \quad \forall H, D, M \quad (6)$$

$$K_{15,D,M} = 0 \quad \forall H, D, M \quad (7)$$

$$X_{T,H-1,D,M} - X_{T,H,D,M} \geq m_s - (1 - K_{H,D,M}) * m_b \quad H \in (2..15), \forall T, D, M \quad (8)$$

$$X_{T,H-1,D,M} - X_{T,H,D,M} \leq K_{H,D,M} * m_b \quad H \in (2..15), \forall T, D, M \quad (9)$$

$$I_{T,D} = I_{T,D-1} + P_{T,D} - \sum_C S_{D,T,C} \quad \forall D, T \quad (10)$$

$$I_{T,0} = I_{D \text{ anyone}} \quad \forall T \quad (11)$$

$$S_{D,T,C} + B_{D,T,C} = D_{D,T,C} - B_{D-1,T,C} \quad \forall D, T, C \quad (12)$$

$$P_{T,D} \geq 0 \quad \text{integer} \quad \forall T, D \quad (13)$$

$$B_{D,T,C} \geq 0 \quad \text{integer} \quad \forall D, T, C \quad (13)$$

$$S_{D,T,C} \geq 0 \quad \text{integer} \quad \forall D, T, C \quad (13)$$

$$I_{T,D} \geq 0 \quad \text{integer} \quad \forall T, D \quad (13)$$

Production Constraints:

Constraint 1 : It represents a constraint reflecting the quantity of product produced by the end of the day. The Yield parameter is multiplied by the daily total X amounts to equate it with the daily product amount.

Constraint 2 and Constraint 3: These two constraints are formulated to enforce binary values for the variable Y. In the event of production for a particular product type from a selected machine on a specific day, these constraints compel Y to assume a value of 1. Conversely, without such production, they mandate Y to be 0.

Constraint 4: This constraint restricts the maximum daily production of two specific types from each machine.

Setup Constraints:

Constraint 5: This constraint ensures that a product type change during production on any machine triggers a 1-hour setup time. Simultaneously, it guarantees that the system produces a maximum of one type of product on a specific machine during a particular hour.

Constraint 6: This constraint limits the system to undergo setup at most once on each machine per day.

Constraint 7: This constraint is designed to prevent the system from initiating setup during the final hour of production on each day.

Constraint 8 and Constraint 9: These two constraints allow and compel the system to correctly position the setup binary decision variable  $K$  when the system undergoes setup. Without these constraints, the system has the freedom to decide whether to perform the setup, but it lacks the precision to determine the specific location of the setup.

Inventory and Sales Balance Constraints:

Constraint 10: Specifically, this constraint maintains balance in the circulation of products within the system. It ensures that the total quantity of products produced, the inventory level, and the quantity of products sold remain balanced.

Constraint 11: This constraint facilitates the incorporation of day 0 inventory into the system for each product type.

Demand, Sales and Backlog Balance Constraints:

Constraint 12: This constraint assists in guaranteeing that unsold products are defined as backlogged. Backlogs accumulate incrementally, just like inventory.

Constraint 13: This constraint enables the inclusion of a day 0 backlog into the system for each product type and each customer.

Greater Than Zero, Integer, and Binary Constraints:

Constraint 14: These constraints establish the decision variables as greater than 0, integer, and binary.

Objective Function:

$$\text{Maximize } \sum_D \sum_T \sum_C (S_{D,T,C} * R_C) - \sum_D \sum_T \sum_C (Pen_{D,T,C} * B_{D,T,C})$$

### **4.3.3 Solution Method**

## **4.4 Verification**

## **4.5 Validation**

# **5 Outcome and Deliverables**

## **5.1 Outcome**

As stated in the problem definition section, our objective is to deliver a reliable and optimized production plan for BobaCo. The culmination of our project aims to present a user-friendly program tailored for BobaCO. This program will feature an interface for entering demand, our primary input. Alongside this interface, we aspire to incorporate a page where key parameters such as hourly production quantity or the number of machines, accessible only to administrators, can be updated. Once the necessary demands are input, our program is designed to operate in the background to solve the model we've created and provide the target production plan in a visualized format.

We envision reporting our results in three distinct ways. Firstly, a comprehensive production plan will be generated for managerial consideration. This plan will visualize the production schedule, specifying which products are to be manufactured for each customer, on which day and at what time. Additionally, a dedicated page will display income and penalty amounts derived from our model. This feature enables managers to assess the anticipated returns at the end of the month and the potential income foregone.

Secondly, a report tailored for the sales manager will outline the schedule for producing each customer's product on specific days. This facilitates the sales manager in providing customers with accurate delivery dates without becoming entangled in intricate details. Simultaneously, in cases of spontaneous orders, the sales manager can ascertain the feasibility of meeting desired deadlines by inputting data into the model.

Lastly, a detailed report will be generated for the production manager and their team. This report will elucidate the entire production plan, specifying the flavors to be produced and when machine setups are scheduled. This ensures the production department is well-informed about the intricacies of the production schedule.

## **5.2 Deliverables**

As the output section highlights, our plan involves delivering an intuitive interface for BobaCO. This user-friendly interface is designed to enable users to navigate the program without any programming knowledge. Additionally, we will provide a separate program facilitating the transfer of Excel sheets—utilized for bulk entry of requests—directly into the database. We will furnish BobaCO with concise training videos to enhance users' understanding of the system.

Moreover, contingency plans have been devised for instances where key constraints may need modification. For example, if one of the machines requires maintenance, it may necessitate the creation of a model with a single machine.

In such cases, instructional videos will be prepared to elucidate the steps to be followed. This comprehensive approach ensures that BobaCO's users can effectively utilize the program and address any potential adjustments seamlessly.

### **5.3 Benchmarking and Benefits to the BobaCo**

Upon receiving and verifying the data, our objective is to assess the effectiveness of our model in comparison to the real-life production plan. This evaluation aims to measure the extent of benefit our model can offer to the company. Historically, production planning at BobaCO occurred every week. We will employ two methods to compare weekly plans with our model.

The first method involves assessing our performance on a weekly basis. We will compare the historical data for the past weekly production plan, as much as discernable, by inputting this information into our model.

The second approach entails creating monthly production plans by consolidating the four-week production plan with demands obtained from incoming data. We will generate a production plan by inputting the same demands into our model and subsequently compare the resulting data. In evaluating performance, we intend to use various parameters. The primary metric will be the net income generated, accounting for inflation differences. Additionally, understanding customer satisfaction will be reflected in our analysis by considering the penalties incurred.

## **6 Project Plan and Work Packages**

At this project stage, we have completed developing and verifying our mathematical model. We are contemplating heuristic modeling into our model to enhance its performance, considering potential scenario variations. We have set a deadline of January 3 for this addition. The heuristic modeling involves several sub-tasks, with the initial phase encompassing coding, verification, and performance testing of conceptual heuristic models. Following this, the validation process will commence concurrently with data acquisition, and the steps of placing the data into appropriate databases and classifying them will progress in parallel. We aim to conclude the validation process by the end of February. Subsequently, we will proceed to the benchmarking step, with a designated timeframe of 15 days for completion.

Simultaneously, we have scheduled the commencement of the interface design, constituting the second phase of our project, by the end of January. This phase will initiate a meeting with BobaCO, during which we will discuss their desired details in the interface design. We anticipate that this process will take approximately two months. All the steps outlined in the output section of this phase can be considered sub-tasks. Additionally, our testing processes related to the codes constitute another sub-task. Following this process, we will continue testing and demonstration processes involving the company.

It is pertinent to mention the progress made thus far from the proposal report. The objective function, decision variables, and parameters initially presented were shared with the company representative during a November 29,



2023 meeting. At this meeting, feedback was obtained from the company representative regarding the model we developed, and updates were implemented accordingly. Before the meeting, a brainstorming session was conducted to identify the constraints of the model, and questions were prepared to be posed to the company representative.

## Bibliography

Bobaco LTD. (2022). Hakkimizda. <https://www.thebobaco.com.tr/Hakkimizda> [Online; accessed 10-september-2023].