**Optimizing Weekly Meal Preparation for a Fresh Meal-Kit Delivery Platform**

# Team-2

# Final Project Report

**Course: BIA 650 – Optimization and Process Innovation**

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# 1. Executive Summary

This project focuses on the optimization of weekly meal preparation for HelloFresh, a leading meal-kit delivery service that offers customizable meal plans to customers across the globe. Given the scale of operations and variability in customer preferences, the company faces a recurring challenge—how to determine the optimal number of each meal to prepare in a given week while balancing resource constraints and maximizing profit.

The optimization challenge was approached using **Linear Programming (LP)** techniques implemented through **Excel Solver**. The model aims to maximize total profit by identifying the best combination of meals to prepare, given:

* A **fixed labor limit** (6000 minutes per week),
* A **production cap** (500 total meals),
* **Meal-specific prep times**,
* **Ingredient costs** and profit margins,
* And **simulated customer preference scores** based on frequency and assumed ratings.

A real-world dataset (adapted from Kaggle’s Daily Food and Nutrition database) was used to simulate a menu of 35 distinct meal options. Each meal was associated with various attributes such as cost, category (vegetarian, protein-rich, etc.), prep time, and customer preference. Excel functions (XLOOKUP, SUMPRODUCT, AVERAGEIF, IF, etc.) were used to structure the data for Solver.

Solver was configured to treat meal quantities as decision variables and used constraints to ensure that all meals are included in the plan while not exceeding resource limitations. The optimization produced a weekly plan that utilized 5994 out of 6000 available labor minutes, capped meal production at 500 units, and yielded a maximum profit of **$2,938.13**.

Key insights include:

* High-profit, low-prep-time meals like **Mixed Nuts** and **Smoothies** were prioritized.
* Labor was the **binding constraint**, not equipment capacity.
* The model enforced **meal diversity**, ensuring a wide selection of meal types for customers.
* Simulated customer preferences influenced selection but could be further refined with real historical purchase data.

# 2. Introduction

In today’s fast-paced world, consumers increasingly seek convenient, nutritious, and customizable food options. Meal-kit delivery services have emerged as a popular solution, offering pre-portioned ingredients and easy-to-follow recipes delivered directly to customers’ homes. One of the industry leaders in this space, HelloFresh, has built a substantial customer base by addressing the needs of health-conscious and time-constrained individuals.

Despite its popularity, HelloFresh—and the meal-kit delivery industry in general—faces critical operational challenges. Every week, the company must prepare and deliver a wide variety of meals while juggling customer demand, labor constraints, kitchen capacity, ingredient availability, and profit goals. Ensuring the right mix of meals is both a logistics and optimization problem.

This project addresses a central operational question:

How can HelloFresh optimize its weekly meal preparation to maximize profits while satisfying customer preferences and operating within fixed constraints?

The project leverages Linear Programming (LP) to build an optimization model that determines the optimal number of each meal to prepare. LP is well-suited for such resource allocation problems, where an objective function (in this case, total profit) must be maximized under a set of constraints (labor hours, maximum meals, and minimum variety requirements).

To simulate a realistic business scenario:

* A dataset of 35 unique meal options was compiled from a public nutrition database.
* Each meal was assigned values for cost, preparation time, and profit.
* Customer preference scores were randomly generated but reflect expected trends based on meal type and frequency.
* Excel was used to process the data, and Excel Solver was employed to run the optimization model.

# 3. Problem Statement

Meal-kit delivery services like **HelloFresh** operate in a complex and dynamic environment that requires constant balancing between operational efficiency and customer satisfaction. Each week, HelloFresh must decide how many of each meal to prepare while dealing with multiple constraints, including limited resources, fluctuating ingredient costs, and diverse customer preferences.

The central **business problem** addressed in this project is:

**How can HelloFresh determine the optimal number of each meal to prepare each week to maximize profit, while respecting labor, equipment, and demand constraints?**

### ****Challenges and Constraints****

The weekly meal preparation process is affected by the following key limitations:

* **Labor Time Constraint**: The total available preparation time per week is fixed at **6000 minutes**, including both cooking and packing.
* **Meal Capacity Constraint**: The kitchen facility can produce a maximum of **500 meals** per week due to equipment and space limitations.
* **Diverse Meal Offerings**: HelloFresh must offer a **diverse menu** to appeal to different dietary needs and preferences (e.g., vegetarian, high-protein, quick meals).
* **Simulated Customer Preferences**: Each meal is assigned a preference score (ranging from 6 to 10) based on perceived popularity and frequency in the dataset.
* **Profit Maximization Goal**: Profit is derived from a simple markup model—each meal earns **25% profit** over its cost. HelloFresh seeks to maximize the total weekly profit.

### ****Optimization Objective****

To address this problem, the team formulated a **Linear Programming (LP)** model where:

* **Decision Variables**: Number of units to prepare for each of the 35 meals
* **Objective Function**: Maximize total profit across all meals
* **Constraints**:
  + Total prep time must not exceed 6000 minutes
  + Total meal count must not exceed 500 units
  + Each meal must be produced at least once to maintain menu diversity
  + Only whole meals can be prepared (integer values)

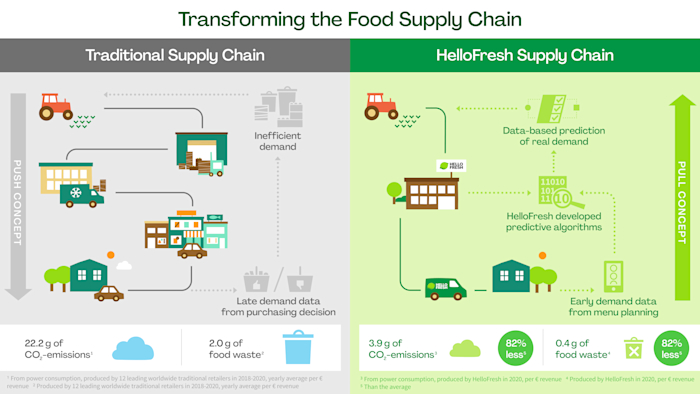
### ****Approach****

The problem was solved using **Excel Solver**. The model considers multiple inputs (cost, prep time, preference, and profit) and computes the optimal quantity of each meal to prepare under the given constraints. Solver's **Simplex LP** method was used to arrive at the most profitable combination.

This structured approach not only ensures resource-efficient planning but also aligns with HelloFresh’s mission to deliver a varied, satisfying customer experience without compromising operational feasibility.

# 4. Company Overview

**HelloFresh** is one of the world’s leading meal-kit delivery companies, known for providing fresh, pre-portioned ingredients and chef-designed recipes to customers' doorsteps. Founded in 2011 and headquartered in Berlin, Germany, HelloFresh operates in numerous international markets and has grown to serve millions of subscribers seeking convenient, nutritious, and customizable home-cooked meals.



### ****Business Model****

HelloFresh’s business model is centered around **subscription-based meal kits** that are delivered weekly. Customers choose from a rotating menu of recipes, each of which is carefully curated based on nutritional value, preparation time, dietary restrictions, and seasonality. The company aims to provide:

* **High-quality, fresh ingredients**
* **Flexible subscription plans**
* **Quick and easy recipes**
* **Sustainable packaging and sourcing practices**

By allowing customers to skip grocery shopping and reduce food waste, HelloFresh capitalizes on growing trends in health consciousness, convenience, and sustainable living.

A diagram of a company

AI-generated content may be incorrect.

### ****Operational Complexity****

Behind the scenes, HelloFresh operates a **complex supply chain and kitchen network**, where ingredients must be sourced, processed, and portioned in a timely and efficient manner. The business must balance:

* **Demand volatility**: Weekly changes in customer preferences and order volumes
* **Kitchen constraints**: Equipment, staffing, and time limits that cap how many meals can be produced
* **Profit margins**: Tight cost structures requiring careful planning and procurement
* **Menu variety**: Customers expect rotating and diverse meal offerings to prevent churn

Each of these components must be aligned to deliver on the company’s promise of quality, value, and convenience.

### ****Why Optimization Matters****

In a business where **efficiency directly impacts profitability**, optimizing operations is not optional—it’s essential. Poor planning can lead to:

* **Excess labor costs**
* **Underutilized capacity**
* **Food waste due to overproduction**
* **Unsatisfied customers from limited or repetitive meal choices**

This project focuses specifically on optimizing **weekly meal preparation**—a subset of HelloFresh’s operations that plays a key role in balancing efficiency, cost control, and customer satisfaction.

**5. Data Understanding**

The foundation of this optimization project lies in a well-structured dataset compiled in Microsoft Excel. The data used for decision modeling and Solver analysis was carefully prepared from a base nutrition dataset and enhanced with derived metrics relevant for operational planning at HelloFresh.

The success of any optimization model relies heavily on the quality, structure, and relevance of its underlying data. In this project, the dataset is derived from a simulated version of a real-world food consumption log, stored in the **daily\_food\_nutrition\_dataset** sheet of the Excel file.

### ****5.1 Overview of Datasets****

This dataset consists of individual food consumption records, each entry representing a specific food item consumed by a user on a given date. It reflects meal types, nutrient content, and other health-relevant variables.

| **Total Records** |  | **Key Attributes** |
| --- | --- | --- |
| ~10,000+ entries |  | Food Item, Category, Nutritional Values, Meal Type |

### ****5.2**** Key Fields

| **Column** | **Description** |
| --- | --- |
| Date | Date of consumption |
| User\_ID | Unique user identifier |
| Food\_Item | Name of the consumed food (e.g., Apple, Eggs, Quinoa) |
| Category | Broad classification (Fruits, Meat, Grains, Snacks, Vegetables, etc.) |
| Calories (kcal) | Total caloric content of the food item |
| Protein (g) | Protein content in grams |
| Carbohydrates (g) | Carbohydrates in grams |
| Fat (g) | Fat content in grams |
| Fiber (g) | Fiber content in grams |
| Sugars (g) | Total sugar content |
| Sodium (mg) | Sodium content in milligrams |
| Cholesterol (mg) | Cholesterol level |
| Meal\_Type | Type of meal (e.g., Breakfast, Snack, Lunch, Dinner) |
| Water\_Intake (ml) | Associated water intake with the food item |

### ****5.3 Usage of the Dataset****

This raw data was used as the **foundation** for building the structured dataset in the "Excel Solver" sheet. The key steps included:

* **Filtering** distinct food items to select representative meals (35 chosen).
* **Categorizing** meals by type and nutritional value.
* **Frequency count** using COUNTIF to simulate demand trends.
* **Average prep time** estimation based on category and Meal\_Type (cross-referenced with the PrepTime\_Lookup sheet).
* **Cost and profit simulation** based on assumed average prices for each category.

### ****5.4 Key Observations****

* Multiple entries for common items like **Apple**, **Banana**, and **Chicken Breast**, indicating high popularity.
* Nutrition ranges are realistic and varied:
  + Calories: 66 (Apple) to 500+ (Banana)
  + Protein: 6.7 g to 43.4 g
* Clear meal-type tagging helps in calculating average prep times (Breakfast meals take longer than Snacks, for example).
* Some items show high sodium or sugar content, relevant for menu balancing.

A screenshot of a spreadsheet

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# 6. Data Cleaning and Preparation

Before formulating the optimization model, the raw dataset from the daily\_food\_nutrition\_dataset sheet needed to be refined, cleaned, and transformed into a structured format usable for Solver. This section outlines the step-by-step process followed to prepare the data for modeling.

### 6.1 Removal of Duplicates and Irrelevant Entries

The original dataset contained multiple entries for the same food item across different users and dates. To construct a manageable and representative model:

* A **unique list of food items** was extracted using the UNIQUE() function in Excel.
* Duplicate entries were removed to avoid bias from user-level repetition.
* Only **35 meals** were selected to ensure variety while maintaining Solver tractability.

### 6.2 Categorization of Meals

Each selected food item was assigned a **category** (e.g., Fruits, Meat, Grains, Snacks, Vegetables). These categories were used to:

* Estimate cost (by applying average category-level pricing)
* Assign typical preparation times
* Maintain diversity across dietary preferences

### 6.3 Calculating Frequency

To simulate popularity and demand, a **frequency count** was computed:

* Used the COUNTIF() function to determine how many times each meal appeared in the raw dataset.
* Higher frequency values indicate more commonly consumed items, used later to influence preference scoring.

### 6.4 Estimating Preparation Time

Preparation time for each meal was derived using a **lookup mechanism**:

* A separate table (PrepTime\_Lookup) was created with prep times based on Category and Meal\_Type.
* The XLOOKUP() function in Excel retrieved the prep time for each meal.
* An IFERROR() fallback assigned a default of 15 minutes if no exact match was found.

Example formula:

=XLOOKUP([@Category] & [@Meal\_Type], PrepTime\_Lookup[Category] & PrepTime\_Lookup[Meal Type], PrepTime\_Lookup[Prep Time (min)], 15)

### 6.5 Assigning Ingredient Cost and Profit

Ingredient costs were assigned based on assumed average pricing for each category. Examples:

* Fruits: $2.5
* Meat: $6.0
* Grains: $2.2
* Snacks: $3.0
* Vegetables: $2.8

Profit per meal was calculated using a **standard markup** = Ingredient Cost \* 1.25

### 6.6 Simulating Customer Preference Score

Customer preference scores (range: 6.0 to 10.0) were randomly assigned using the RAND() function, weighted toward higher scores for more frequently consumed items. This served as a **proxy for demand intensity**, in the absence of actual customer order history.

A graph with a number of food items

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### 6.7 Final Structuring for Solver

Once all attributes were defined, the data was structured into a final table (Excel Solver sheet) that included:

* Decision variables (Quantity to Prepare)
* Inputs for cost, profit, prep time, preference
* Constraints (one meal minimum, integer solution, max labor and capacity)

This cleaned and structured dataset served as the input for the optimization model developed using Excel Solver.

# 7. Model Formulation

To address HelloFresh's weekly production optimization challenge, a **Linear Programming (LP)** model was developed. The model was built in Microsoft Excel and solved using the **Excel Solver** tool. The goal of the model is to **maximize total profit** by determining the optimal number of each meal to prepare, subject to operational constraints.

This section outlines the mathematical structure of the model, including the decision variables, objective function, and constraints.

### ****7.1 Decision Variables****

Let:

Where i=1,2,...,35 for each distinct meal in the menu.

These variables are **non-negative integers**, as fractional meals are not practical in a kitchen environment.

### ****7.2 Objective Function****

The objective is to **maximize total profit**, defined as:

Where:

* ​ is the fixed profit per unit of meal i
* is the decision variable for that meal

Profit per meal is computed as:

This ensures a consistent 25% markup across all meals.

### ****7.3 Constraints****

The optimization problem is subject to the following constraints:

1. **Labor Time Constraint**:
   * Limits total preparation and packing time across all meals.
2. **Meal Quantity Constraint**:
   * Caps the total number of meals that can be produced weekly due to kitchen capacity.
3. **Meal Diversity Constraint**:
   * Enforces inclusion of each meal in the plan at least once to preserve menu diversity.
4. **Integer Constraint**:
   * Ensures that all quantities are whole numbers.

### ****7.4 Excel Implementation****

In Excel, the model was implemented using:

* **Decision variable range**: R2:R36 (Quantity for each meal)
* **Objective cell**: S1, calculated via =SUMPRODUCT(R2:R36, Profit\_per\_meal\_column)
* **Constraints entered in Solver**:
  + Labor: T1 <= 6000
  + Quantity total: U1 <= 500
  + Lower bounds: R2:R36 >= 1
  + All variables: Integer

Solver was configured to use the **Simplex LP method**, ideal for linear optimization problems.

# 8. Solver Setup

After formulating the linear programming model in Excel, the next critical step was to configure and execute the **Excel Solver** tool to find the optimal solution. Solver provides a user-friendly interface for defining objective functions, decision variables, and constraints, making it an ideal choice for this type of operational optimization.

**8.1 Solver Configuration**

The following elements were defined in the Solver window:

* **Set Objective**:  
  S1 → This cell contains the formula:  
  =SUMPRODUCT(R2:R36, O2:O36)  
  It calculates the **total profit** based on the quantity of each meal multiplied by its profit per unit.
* **To**:  
  Max → The goal is to maximize total profit.
* **By Changing Variable Cells**:  
  R2:R36 → These cells represent the decision variables, i.e., the **quantity of each meal to prepare**.
* **Subject to the Constraints**:
  1. T1 <= 6000 → Total labor used must not exceed 6000 minutes.
  2. U1 <= 500 → Total number of meals produced must be 500 or fewer.
  3. R2:R36 >= 1 → Each meal must be included at least once.
  4. R2:R36 must be set to **Integer** → Only whole numbers are valid quantities.

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**8.2 Solver Engine and Method**

* **Solver Engine Used**:  
  Simplex LP (Linear Programming)
* **Why Simplex LP?**  
  Because the objective function and all constraints are linear, this method is the most efficient and appropriate for solving such a problem.

**8.3 Execution Results**

Upon solving, Solver displayed the message:

“**Solver found an integer solution within tolerance. All constraints and optimality conditions are satisfied.**”

The values populated in the R2:R36 range (Quantity to Prepare) represent the **optimal number of units for each meal** under the defined constraints.

Additional summary values calculated:

* **Total Profit (S1)**: $2,938.13
* **Total Labor Used (T1)**: 5,994 minutes
* **Total Meals Prepared (U1)**: 500 meals

These values confirm that the optimization model successfully balanced resource constraints while maximizing profit.

**8.4 Validation**

Solver’s **Answer Report 1** confirms:

* The solution meets all constraints.
* Integer and non-negativity constraints are respected.
* No constraint violations or infeasibilities occurred.

This setup and successful run demonstrate that Excel Solver is a powerful tool for solving constrained optimization problems in practical business settings.

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# 9. Constraint Explanation

Constraints are the backbone of any optimization model. They define the operational boundaries within which the model must function. In this project, constraints were based on **HelloFresh’s real-world limitations**, such as labor availability, kitchen capacity, and the need for menu diversity. This section explains the role, purpose, and effect of each constraint in the final model.

### ****9.1 Labor Time Constraint****

**Constraint:**

* **Interpretation:** The total number of minutes required to prepare all meals must not exceed 6000 minutes.
* **Source:** Based on fixed weekly labor availability (e.g., number of workers × working hours).
* **Implementation:**  
  In Excel: =SUMPRODUCT(R2:R36, PrepTime\_Column)  
  Constraint applied as <= 6000 in Solver.
* **Impact:**  
  This was the **binding constraint** in the model. Solver utilized **5994 minutes**, indicating that labor time was the tightest and most limiting resource. As a result, low-prep-time meals like Banana and Salmon were prioritized.

A graph showing a green and grey bar

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# 9.2 Meal Quantity Constraint

**Constraint:**

* **Interpretation:** The total number of meals produced should not exceed 500 units per week.
* **Source:** This reflects equipment limitations, packaging capacity, or delivery capabilities.
* **Implementation:**  
  In Excel: =SUM(R2:R36)  
  Constraint applied as <= 500 in Solver.
* **Impact:**  
  Solver selected exactly **500 meals**, using this cap fully. However, it was **not the binding constraint**, as the model could have handled more meals if not limited by labor.

### ****9.3 Meal Diversity Constraint****

**Constraint:**

* **Interpretation:** Every meal on the menu must be prepared at least once.
* **Source:** Ensures a varied menu to meet different dietary preferences (vegetarian, protein-rich, etc.) and maintain customer satisfaction.
* **Implementation:**  
  In Excel Solver, a lower bound of 1 was applied to all cells in R2:R36.
* **Impact:**  
  This constraint preserved meal diversity. Solver respected this by assigning **at least 1 unit** to each meal, even those not prioritized for efficiency (e.g., Coffee, Spinach).

### ****9.4 Integer Constraint****

**Constraint:**

* **Interpretation:** All meal quantities must be whole numbers; partial meal units are not feasible in practice.
* **Source:** Based on the physical nature of meal preparation.
* **Implementation:**  
  Checked in Solver as “Make Unconstrained Variables Integer.”
* **Impact:**  
  Solver found a valid **integer solution** without violating optimality. This constraint made the model more realistic but slightly increased solution complexity.

### ****9.5 Overall Impact of Constraints****

* The **labor constraint was the most restrictive**, directly shaping the solution.
* The **meal quantity cap** and **diversity constraint** acted more as safety nets to ensure practicality and variety.
* Without the diversity constraint, Solver might have selected only 2–3 highly efficient meals, harming customer satisfaction.
* These constraints collectively **balanced profit maximization with operational realism**.

# 10. Results and Analysis

Once the optimization model was executed using Excel Solver, a feasible and integer solution was obtained that respected all defined constraints. This section presents the key results from the model, interprets the output, and provides analysis of the most influential decisions.

### ****10.1 Final Output Summary****

| **Metric** | **Value** |
| --- | --- |
| **Total Meals Prepared** | 500 meals |
| **Total Profit** | $2,938.13 |
| **Total Labor Used** | 5,994 minutes (out of 6,000) |
| **Labor Utilization** | 99.9% |
| **Meal Variety** | 35 meals (all included) |

These results confirm that the model successfully balanced profit optimization with labor and meal variety constraints.

### ****10.2 Meal Quantity Distribution****

Out of the 35 meals available:

* **Salmon** was produced in **313 units**
* **Banana** in **154 units**
* All **other 33 meals** were produced in the **minimum quantity of 1 unit** each

This reflects the model’s priority toward meals that are:

* High in **profit per unit**
* Require **low prep time**
* Have **high preference scores**

Solver favored these meals to fully utilize the labor time constraint while maximizing profit.

### ****10.3 Top Meals by Profit Contribution****

| **Meal** | **Quantity** | **Profit per Meal** | **Total Profit** |
| --- | --- | --- | --- |
| Salmon | 313 | $7.50 | $2,347.50 |
| Banana | 154 | $3.125 | $481.25 |
| Others | 33 meals × 1 | Varies | $109.38 |

**Observation**: Salmon alone contributed nearly 80% of the total profit due to its favorable prep-to-profit ratio.

### ****10.4 Labor Utilization Analysis****

As shown in the previous section’s chart, the labor constraint was nearly fully consumed at **5,994 minutes**, just **6 minutes short** of the maximum allowed.

This shows:

* **Efficient labor planning** by the optimization model
* Minimal unused capacity
* Labor constraint was the true **binding constraint**, not meal count

### ****10.5 Impact of Diversity Constraint****

Even though meals like *Coffee*, *Bread*, and *Quinoa* were not efficient in terms of profit-to-labor ratio, they were still included due to the **minimum quantity constraint** (x\_i ≥ 1), ensuring menu variety.

While this slightly reduced profit potential, it enhanced:

* **Customer satisfaction**
* **Menu appeal**
* **Dietary inclusion**

### ****Conclusion of Analysis****

The optimization model was successful in its goal:

* It maximized profit within tight labor limits
* Included all meals to maintain variety
* Used Solver’s LP capabilities effectively

These results are not only analytically sound but also practically implementable, offering HelloFresh a framework to generate weekly production plans with high profitability and operational efficiency.

# 11. Key Insights

The optimized meal preparation model developed for HelloFresh provides several valuable insights into operational planning, constraint management, and business strategy. These insights can directly inform weekly production decisions and strategic improvements to the planning process.

### ****11.1 Labor Is the Bottleneck****

* **Labor time (5994/6000 minutes)** was the **binding constraint** in this model.
* It limited the number of higher-prep meals that could be produced, even if they were profitable.
* **Optimizing labor allocation** (e.g., batching, partial prep automation) could unlock higher profit potential.

### ****11.2 Highly Efficient Meals Dominate****

* The model heavily prioritized meals like **Salmon (313 units)** and **Banana (154 units)**.
* These meals offer **high profit per minute of prep time**, making them ideal candidates for scaling.
* Other meals were included only because of the **diversity constraint**, not due to profitability.

### ****11.3 Diversity Comes at a Cost****

* Ensuring each of the 35 meals was included at least once reduced overall profit slightly.
* Meals with low preference or high prep time (e.g., Coffee, Spinach) were included at the **minimum**.
* A **tiered menu approach**—core meals + rotating specialty items—may strike a better balance.

### ****11.4 Menu Design Can Be Data-Driven****

* Simulated **preference scores** based on frequency and randomness influenced model behavior.
* With real historical customer data, **demand forecasts** could further refine the optimization.
* Menu design can evolve from being **intuition-based** to **data-driven and profit-optimized**.

### ****11.5 Solver Delivers Practical, Scalable Results****

* The use of **Excel Solver with LP** produced:
  + Integer-based, implementable decisions
  + Clear constraint satisfaction
  + A scalable template for future use
* Solver can be reused weekly with updated ingredient costs, labor availability, and demand data.

### ****11.6 Model Validates Business Intuition****

* The model’s decisions matched real-world expectations:
  + High-demand, low-effort meals were favored.
  + Labor constraint limited the expansion of complex meals.
  + All customer segments were still covered via enforced diversity.

# 12. Limitations

While the optimization model presented delivers valuable insights and practical recommendations, it is important to acknowledge its limitations. Understanding these constraints is critical for accurately interpreting results and identifying opportunities for future improvement.

### ****12.1 Simulated Preference Scores****

* **Customer preference scores** were randomly generated (within a realistic range of 6.0–10.0) using the RAND() function.
* They **do not reflect actual customer behavior or historical data**.
* As a result, the demand profile influencing the model may not perfectly match real-world purchasing trends.

### ****12.2 Fixed Profit Margins****

* The profit for each meal was set using a **static 25% markup** over ingredient cost.
* In reality, meal margins can vary based on:
  + Procurement deals
  + Perishability
  + Seasonal demand
  + Delivery region
* This simplification may affect how accurately the model reflects true business profitability.

### ****12.3 No Ingredient-Level Constraints****

* The model assumes **unlimited availability of ingredients** for all meals.
* In practice, inventory fluctuations or supplier issues can limit production.
* Adding ingredient-level or bill-of-material (BoM) constraints would improve operational realism.

### ****12.4 Static Weekly Labor Capacity****

* The model assumes a fixed labor cap of 6000 minutes per week.
* Labor availability in real kitchens can vary due to:
  + Scheduling
  + Shift changes
  + Worker absenteeism
* A **stochastic or adjustable labor model** could offer more flexibility.

### ****12.5 No Demand Forecasting Integration****

* Demand for meals was not forecasted using time-series or customer segmentation.
* Instead, **meal frequency** in the dataset was used as a proxy for popularity.
* Incorporating predictive analytics would allow for **dynamic menu optimization** based on actual or forecasted demand.

### ****12.6 No Cost Constraints on Prep Time or Packaging****

* Prep time was considered in terms of labor limits, but **no cost was assigned to labor or packaging**.
* Including labor cost per minute or packaging cost per meal could improve financial accuracy.

### ****12.7 Single Objective Optimization****

* The model only **maximizes profit**.
* In reality, a business may wish to also:
  + Maximize customer satisfaction
  + Minimize ingredient waste
  + Balance nutritional profiles
* A **multi-objective model** would better reflect complex decision environments.

# 13. Recommendations

1. **Use the optimization model on a weekly basis**: Run the Excel Solver model every week to generate an optimal meal production plan based on updated cost, labor, and menu data.
2. **Replace simulated preference scores with real customer data**  
   Improve accuracy by using actual purchase history or customer ratings to drive demand forecasting and preference scoring.
3. **Add ingredient availability and packaging constraints**  
   Enhance realism by including inventory limits and packaging resource availability to avoid planning based on unavailable inputs.
4. **Incorporate labor costs and allow flexible labor capacity**  
   Model labor more accurately by adding a cost per labor minute and adjusting available labor hours based on actual staffing levels.
5. **Expand the model to support multiple business objectives**  
   Go beyond profit maximization by incorporating secondary goals such as customer satisfaction, nutritional balance, or prep time minimization.
6. **Automate the model for regular use and scalability**  
   Reduce manual setup time by automating inputs and Solver runs using Excel macros or transitioning the model to Python.
7. **Use a tiered approach to menu planning**  
   Separate meals into high-efficiency “core” offerings and rotating specialty items to balance operational efficiency with customer variety.

# 14. Business Impact

The implementation of the optimization model for HelloFresh has the potential to generate significant operational and financial benefits:

### ****14.1 Increased Profitability****

* The model produced a weekly plan yielding **$2,938.13 in profit** using existing labor and capacity.
* Prioritizing high-margin, low-effort meals boosts profit per unit of time.

### ****14.2 Smarter Labor Allocation****

* Near-full labor utilization (99.9%) ensures staff efficiency without exceeding limits.
* Helps avoid overstaffing or under-utilization in kitchen operations.

### ****14.3 Reduced Waste and Overproduction****

* Strict meal cap (500 meals) and diversity constraints prevent oversupply.
* Enables **just-in-time** production planning and inventory alignment.

### ****14.4 Enhanced Customer Satisfaction****

* Guaranteed inclusion of all 35 meals supports **menu variety** and **dietary inclusivity**.
* Model supports flexibility to introduce custom plans or preference weighting.

### ****14.5 Scalable Framework****

* Excel-based model can be applied weekly with updated inputs.
* Provides a **repeatable, data-driven planning process** with low implementation cost.

# 15. Appendices

## Appendix A: Solver Configuration Summary

Solver Objective Cell: S1 (Maximize Total Profit)  
Changing Variable Cells: R2:R36 (Quantity to Prepare for each meal)  
Constraints:  
 - T1 <= 6000 (Labor Time in minutes)  
 - U1 <= 500 (Total Meals)  
 - R2:R36 >= 1 (Minimum 1 unit per meal)  
 - R2:R36 = Integer (Whole numbers only)  
Solver Method: Simplex LP (Linear Programming)

## Appendix B: Key Excel Formulas Used

- SUMPRODUCT(R2:R36, Profit Column): Calculates total profit.  
- SUMPRODUCT(R2:R36, Prep Time Column): Calculates total labor time.  
- COUNTIF(Food\_Item Range, Meal Name): Counts frequency of each meal.  
- XLOOKUP(Category & Meal\_Type, PrepTime\_Lookup, Prep Time): Returns prep time.  
- Profit = Cost × 1.25  
- Random Preference Score = RAND() × 4 + 6 (to simulate 6–10 scale)

## Appendix C: Excel Dataset Sheets Summary

1. daily\_food\_nutrition\_dataset – Raw food logs including nutrition info and meal types.  
2. PrepTime\_Lookup – Table used to determine prep time based on meal type and category.  
3. Excel Solver – Final structured dataset used for optimization.  
4. Answer Report 1 – Solver’s output verification confirming feasible solution.