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**Project Report**

**Master’s degree in Business Analytics**

**Course:- Optimization Modeling**

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**Introduction**

Every workplace has its distinct characteristics, including unique operating costs and a specific set of requirements. As a result, workforce scheduling in such environments is constrained by numerous factors, which can significantly impact overall system performance. These constraints refer to any conditions that may impede the achievement of predetermined goals. The effective management of these constraints, through meticulous planning and the implementation of short-term look-ahead scheduling, is critical for the successful operation and control of a workplace. The schedule provides a detailed plan outlining operations and tasks that must be completed shortly. In this project, we will provide a comprehensive overview of Weathertech's workforce scheduling analysis and propose a conceptual framework to effectively manage these constraints. This framework aims to enhance overall operational efficiency by increasing scheduling flexibility, mitigating potential disruptions, and optimizing resource allocation. By incorporating advanced analytical tools and forecasting methods, the framework seeks to proactively anticipate and address challenges, resulting in a more resilient and adaptable scheduling system.

**Problem Statement**

WeatherTech Cafe operates daily with a mix of full-time and part-time staff, currently facing scheduling inefficiencies due to a lack of consideration for varying daily demands. This has led to either overstaffing during low-demand periods or understaffing at peak times, negatively impacting profitability and productivity. With budget constraints, the management is considering reducing staff hours or layoffs.

To address these challenges, this project analyzes WeatherTech Cafe's workforce scheduling and proposes a framework emphasizing effective planning and look-ahead scheduling. The cafe employs full-time staff, required to work a minimum of 40 hours with a higher wage, and part-time student staff with flexible hours based on their academic schedules. The analysis suggests employing linear programming for workforce optimization, an approach that could be extended to other shift-based work environments.

The optimization models aims to achieve the following for the WeatherTech cafe:  
1. Efficient Staff management and reducing costs hence, resulting in improving savings.

2. Balanced distribution of employees to handle peak and normal business hours of operation.

3. Better reporting and budget management therefore, improving planning strategies.

4. Improved customer service and customer retention.

**Data Collection**

|  | **Full-time** | **Part time** |
| --- | --- | --- |
| **Number of employees** | 4 | 19 |
| **Hourly wage** | $20/hr | $16/hr |
| **Shift length** | 8hr | 4hr |
| **Shift times** | "7am-3pm", "3pm-11pm" | "7am-11am", "11am-3pm", "3pm-7pm","7pm-11pm", |
| **Employee Requirement**  **(Mon - Friday)** | 2 employees | 3 employees |
| **Employee**  **Requirement**  **(Sat - Sun)** | 1 employee | 4 employees |
| **Days Off** | Min 1 per/week | No days off |

**Linear Programming Formulation**

## **Decision Variables**

The decision variables for the optimization model include:

**Full-Time Employees' Work Schedule**:

Xft,i,d,s​: Binary variable, 1 if full-time employee i works on day d during shift s, 0 otherwise.

**Part-Time Students' Work Schedule**:

Xpt,j,d,s​: Binary variable, 1 if part-time student j works on day d during shift s, 0 otherwise.

## **Objective Function**

The objective of the model is to minimize total wage costs, considering both full-time employees and part-time students. The cost is calculated based on the product of hourly wages, duration of the shift length, and the binary work schedule variables for each employee category.

**Minimize Total Wage Costs**

​\* fulltime\_hourlywage \* ShiftLength(s) + \* fulltime\_hourlywage \* ShiftLength(s) +

**Constraints**

1. **Staffing Requirements for Each Shift (Fall/Spring):**

**Purpose:** To ensure the cafe has the required number of full-time and part-time staff for each shift.

**Formulation:** For each day d and shift s:

≥ FT\_requirement [d, s]

≥ PT\_requirement [d, s]

2. **Minimum and Maximum Hours for Part-Time Students (Fall/Spring)**

**Purpose:** To regulate the working hours of part-time students, ensuring they work enough but not too much.

**Minimum Hours:** Each part-time student should work at least 10 hours per week.

**Maximum Hours:** Each part-time student should not exceed 20 hours per week.

**Formulation:**

3. **Minimum Hours for Full-Time Employees**

**Purpose:** To ensure that full-time employees work the required minimum hours.

**Minimum Hours:** Full-time employees must work at least 40 hours per week.

**Formulation:**

\* ShiftLength(s) ≥ 40, ∀i

4. **Day Off for Full-Time Employees**

**Purpose:** To guarantee that each full-time employee has at least one day off per week.

**Formulation:**

​ ≤ Number of Working Days per Week− 1, ∀i

Counts the number of days each full-time employee works in a week, ensuring it is one less than the total number of days in the week.

## **Implementation and Results**

The model is implemented using the Gurobi Optimization library, and the solution is obtained through optimization. The resulting schedule is outputted, providing shift timings and hours worked for both full-time employees and part-time students.

In optimal solution, the output includes detailed schedules for each employee, listing their shifts on each day of the week. However, if no optimal solution is found or the model is infeasible, appropriate messages are displayed.

## **Conclusion**

The presented optimization model serves as a powerful tool for café workforce scheduling, considering various constraints and adjustments to ensure efficient staffing, cost-effectiveness, and adherence to operational requirements. By utilizing binary decision variables and a comprehensive set of constraints, the model offers flexibility and adaptability to different operational scenarios, thereby assisting café managers in optimizing their workforce scheduling processes.