LUMS

On-Campus Meal Plan Optimization

Introduction To Management Sciences

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FINAL PROJECT REPORT

Group 10

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EXECUTIVE SUMMARY

The Lahore University of Management Sciences (LUMS) is home to thousands of people from all walks of life. To cater to their dietary requirements, there are 13 eateries scattered across campus, serving a variety of cuisines. However, owing to the abysmal devaluation in the Pakistani Ruppee that has prevailed since the beginning of 2023, we identified an increased financial stress influencing the already vexing "standard economic problem" of **resource allocation** faced by every consumer (mapping limited resources to maximally satisfy unlimited wants).

We observed that the knee-jerk reaction to the **price surge** has mainly consisted of cutting down on the daily number of meals or compromising on preferences. Additionally, this straw man solution has been a byproduct of incomplete information and/or misinformed socially driven choices. To curtail this problem, the group distributed itself across different areas on campus to collect menus of all eateries and compile a dataset with each data point representing a meal combination. Before deciding to go ahead with solving the problem, we verified the importance of the problem by running a thorough price analysis on the acquired data points (included in this report).

After rigorous data cleaning and manipulation, we transformed it into an interactive **linear programming model** to output a 5-day meal plan tailored according to **monetary and taste preference constraints**. To realise these constraints, we conducted a survey through the LUMS Discussion Forum and random distribution of QR Codes to the compute the average weekly budget, average number of daily meals, percentage of their budget consumers wish to save, and gauge the mean behaviour with respect to taste preferences (by obtaining ratings for each restaurant on a scale from 0 to 10. By computing these inputs, we were successfully able to solve our LP model for an **optimal 5-day meal plan** consisting of two daily meals.

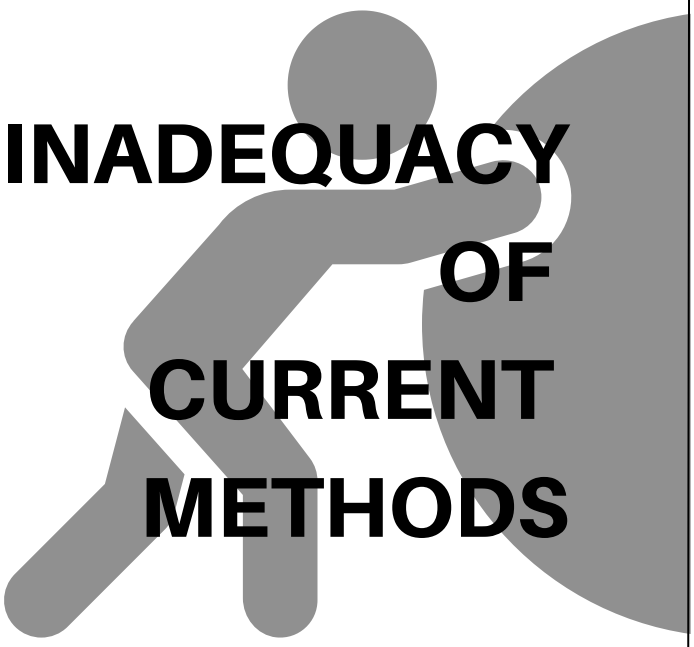
Problem Statement

Optimizing Weekly Meal Planning For LUMS Students Within A Limited Budget

THE WHY

A major section of a university student's time is consumed in planning their finances on a weekly basis in a manner that mitigates overspending. Through off-record spontaneous interviews, we tried to gauge the public sentiment regarding the surge in food prices across campus, in an attempt to learn about the narratives and emotions that quick surveys seldom capture. This approach helped us recognize the gravity of the problem and simultaneously, design a fairly simple yet objective survey to obtain a high number of responses.

The interesting tradeoff here is that one can either spend their entire budget by meticulously monitoring their daily spending on food or they can compromise on their preferences to succumb to social norms and save money from their weekly budgets for weekend outings. Wanting to delve deeper into analysing this dilemma and understanding the underlying players in this tradeoff using the concepts taught this summer in IMS has been the fuel that has driven us to collectively investigate the currently available data and devise a model that can alleviate this burden of financial constraint and weekly planning from our fellow students at LUMS.



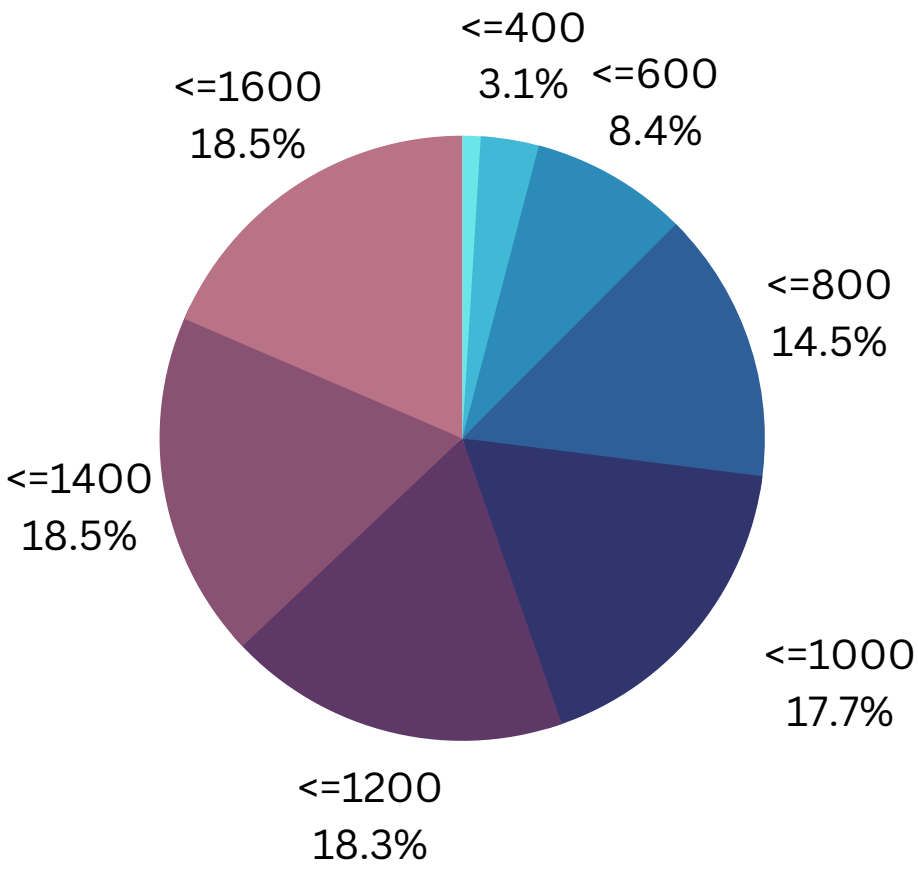
INADEQUACY OF CURRENT METHODS

Every student knows their budget, but most fail to properly allocate it in the most optimal way. There are several reasons for this: the academic year is absolute chaos, from deliverables wreaking havoc to social pressures that nudge consumers into making decisions that turn out to be unfeasible for them. Therefore, we chose to develop a mathematical linear programming model to curb the inadequacy of the current decision-making environment by introducing discipline, seamlessness, and activate a certain degree of independence by enabling users to charter their own 5-day meal plan, keeping in mind nothing but their budget and personal tastes and the complete knowledge of all meal options available to them across campus.

THE WHY

PRICE ANALYSIS

Prior to transforming the compiled price data into a formal model, we thoroughly understood the price variations across meal options on campus to substantiate the merit of our model. The mean price of a meal (both with and without drink) was **PKR 629**, with a standard deviation of approximately **PKR 240**. For a single meal, this price was an eye-opening indicator.

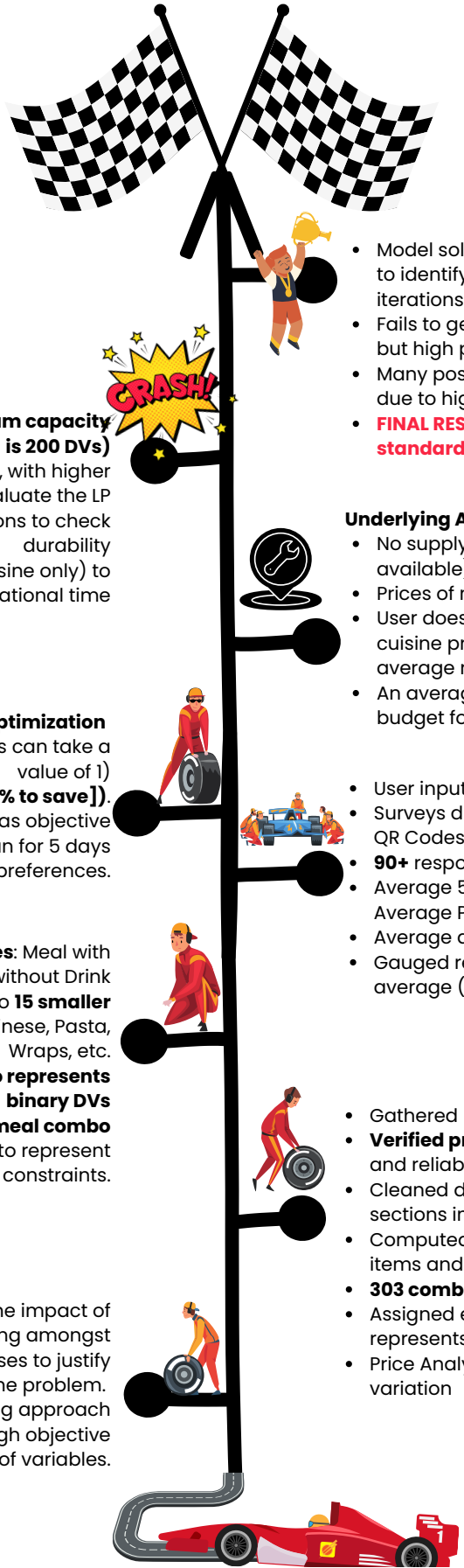


PRICE RANGE *VERSUS* MEAL OPTIONS

To contextualize the situation visualized in the pie chart above, the average 5-day budget for a student was calculated as roughly **PKR 5000**, amounting to **PKR 500 to spend per meal**. This means that they could only avail roughly **10%** of the meal options available on campus. The total data points used in generating this chart were **3652**, hence, **365 options** on average were feasible. Considering the variations in tastes, this was far from sufficient. These indicators necessitated the need for a model that could optimally allocate these limited resources.

THE HOW

METHODOLOGY & TREATMENT OF DATA



- Model solved for several iterations of randomized inputs to identify kinks in model. **80%** accuracy rate over 30 iterations.
- Fails to generate a solution on corner cases (low budget but high priced cuisine constraints
- Many possible solutions for a single iteration observed, due to high number of DVs
- **FINAL RESULT: Correct 5-day meal plan generated for standardized inputs (gathered from surveys).**

- **Excel unable to solve** the LP model **(maximum capacity is 200 DVs)**
- Incorporated a new software, **OpenSolver**, with higher computational capability to evaluate the LP
- Model tested on random input iterations to check durability
- **Constraints tightened** (1 meal from 1 cuisine only) to improve performance and computational time

Underlying Assumptions:

- No supply-side restrictions (all meals are always available)
- Prices of meals are not subject to volatile fluctuations
- User does not have a specific eatery preference if his cuisine preference is being met (supporting argument: average ratings of all restaurants were very close)
- An average LUMS student would want to save 10% of their budget for the weekend

- Objective function manipulation: **Maximal Optimization**
- Added a constraint of 10 meals (only 10 DVs can take a value of 1)
- Computed **Utilizable Budget (Total - Total*[% to save])**. Maximized use of the utilizable budget as objective function in generating 10 point meal plan for 5 days considering cuisine preferences.

- User input form created and linked with LP Model
- Surveys distributed to calculate mean behaviour (LDF + QR Codes)
- **90+** responses
- Average 5 day budget: **PKR 4750** (475 per meal < Average Price per meal)
- Average daily meal frequency: **2**
- Gauged restaurant ranking through **10 point scale rating** average (taste preferences)

- **Clustered data** set into **two main categories**: Meal with Drink & Meal without Drink
- **Further branched** both categories into **15 smaller groups** to represent different cuisines: Chinese, Pasta, Wraps, etc.
- Set up LP model. **3652 meal combo codes to represents binary DVs**
- **Coefficients of DV = Price of meal combo**
- **31 cross-linked conditional constraints** to represent taste and budget constraints.

- Gathered menus of all **13 eateries**
- **Verified prices** with managers to ensure data accuracy and reliability
- Cleaned data for spelling errors, segregated, sorted menu sections into vectors
- Computed all **3652 meal combinations** between food items and drinks
- **303 combos without drink + 3349 with drink**
- Assigned each meal combo/DV a special code (e.g. JJ129 represents Jammin Java Meal #129)
- Price Analysis carried out to verify egregiousness in variation

- Conducted off-record interviews to assess the impact of price surge on financial decision making amongst students of different socio-economic classes to justify the importance of the problem.
- Identified and designed a linear programming approach to optimize decision making through objective maximization, ensuring linearity of variables.