**SUMMARY REPORT**

**Introduction**

The Lego car racing is a project which aims to design a lego car by using the parts which are suggested by a mathematical model which is designed by using different concepts. The Lego Car Racing Project embarked on a journey from identifying factors which are influencing on the distance of a Lego car to designing final car. This process also includes many learnings ,experiments and tasks. All these learnings , experiments and tasks are divided into 2 phases.

**Phase I**

**Learnings and Insights**

In Phase I, we looked into understanding the factors impacting the performance of a Lego car. Through a combination of brainstorming, experimentation, and research, the following significant factors were identified: Aerodynamics, Weight, Wheel Size, Surface Area.

Experimentation and research led to assigning numerical values to each Lego part based on its contribution to these factors. For instance, parts like the big wheel with treaded tire and bearing element received a high value due to their impact on both weight and wheel size. Conversely, decorative elements like flames had negligible impact on performance.

Let Vi be the number of parts required of ith part of Lego car.

**Phase II**

**Learnings and Insights**

Phase II focused on translating Phase I insights into a mathematical model for optimization. Decision variables, parameters, and constraints were defined to formulate an objective function aiming to maximize total contribution of the parts which helps to maximize the total distance travelled by the car within a specified budget.

**Decision Variables**

Our decision variables represent the quantities of each Lego part used in the car design. We denoted them as , where i represents the index of each part.

**Parameters**

Parts (Pi): List of Part\_names, Cost (Ci): Cost of each ith part, Value (Vi): Value of each ith part, Quantity (Qi): Quantity of each ith part

**Objective Function:** We calculated the total contribution by multiplying the value of each part by its quantity and summing across all parts.

**Constraints**

**1. Budget Constraint:** The total cost of Lego parts should not exceed $45.

**2. Quantity Constraint:** The quantity of each part used should not exceed the quantity available in the Lego car kit. This constraint ensures feasibility and practicality in the design.

**3. Essential Part Constraints:** Certain parts, such as the steering wheel, motor, and seat, are essential for the car's functionality. Constraints are imposed to ensure their inclusion in the design.

**4. Plate Constraint:** To arrange all the required parts like Steering wheel, Seat, Motor on plate ,we at least need a 2x8 or 2x10 plate.

**5. Part Combination Constraint:** Certain parts for wheels , like the small wheel with slick tire and bearing element, are considered as a single entity due to their functional combination. Constraints are imposed to control the quantity of these combined parts.

**Code Implementation with Cplex**

This is the important step in whole project where we transformed all the decision variables, parameters, constraints and objective function into cplex code which is written in OPL Language. This code returns the parts and its quantity that should be chosen to design the car.

**Obstacles**

We faced couple of obstacles in this project some of them are identifying the factors which influence the car, assigning values to the each part and transforming model to code. Then overcame this obstacle by understanding how and what are the factors that are affecting the car in real time ,assigned values by experimenting and its importance and by referring documentation of opl language we designed to model.

**Overall Lessons Learned**

Through our project journey, We learnt how to **identify factors** ,**assign values** to each part and **find constraint** to design car. In addition we also learnt how to **design mathematical model** using cplex. And another important lesson learnt i.e. **How to work in teams**. During competition we learnt that a single part can show more difference on distance travelled by car “**Ex. A car with flag moved more distance than a car without it**”. These are the things we learned during this journey.

**Conclusion**

The Lego Car Racing Project journeyed from conceptualizing design factors to formulating a mathematical model for optimization. Despite challenges, the project yielded valuable insights into the intricate interplay between design, performance, and cost considerations. Moving forward, continued refinement of models and methodologies will enhance the efficiency and effectiveness of Lego car design processes.

**A toy car on a table

Description automatically generated**

Fig: This is final car designed by using parts suggested by model.