

DREAM TEAM SPORTS CONSULTANCY

OPTIMIZATION METHODS FOR ANALYTICS USING INTEGER PROGRAMMING MODEL

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# **Summary**

Soccer is the most popular game having a huge fanbase across the world. **DREAMTEAM SPORTS CONSULTANCY** is a leading team strategy provider and is known for its team building solutions in the field of soccer. For the upcoming season of Champions league, 3 teams have together decided to seek assistance from Dream Team Sports Consultancy to build their teams from a pool of 60 available players.

Every team has a certain budget (not the same for all teams) wherein they need to build a team consisting of 2 category players (star players and inexperienced players), a team manager and a physio. Also, every team has certain requirements when it comes to the type of players.

* Mid-fielders
* Defenders
* Strikers
* Goalkeepers

Each category players, managers and physios have a fixed price set to avail their duties. The franchise aims to build the team with minimal spending.

Our project strives to analyze and minimize the total allocation cost of the 3 teams.

# **Introduction**

## Overview

In this highly competitive world where both Sports and education are held equally important, it is necessary to have the exact resource allocation to utilize things in an efficient manner. Franchises across the globe want their teams to perform in the best possible way and hence often seek the help of consultancies to build the teams of their choice. Soccer playing clubs are no exception to that. Any team is built based upon the basic principles to win the games for their respective franchise. When planning and execution for building a team go hand in hand that is when victory seems feasible. A team being cost effective is also a part of the same process. In our case, we are trying to build three teams for the same franchise which is going with three different teams in the same championship based on their available purse value (budget). The goal is to build such teams within the given budget and will satisfy all the minimal constraints related to player quality, costing and efficiency. The methodologies proposed to deliver/build these teams are very much used in day to day life to solve complex problems with the help of optimization methods. Integer programming and Linear integer programming models are a part of this optimization process. Finally, a well-equipped team with a mixed pool of players, managers and support staff is built with minimum costing.

## Motivation

Considering the diversity in different nations in regard to popularity, resources and importance, it is not necessary that all the participating clubs have similar amounts of Money to be spent on their teams. Having said that, it is observed that the underdog teams often perform better with whatever resources they have and the key factor in this performance is optimized team models. It is seen that Team managements/franchises often seek help from outside experts to build the team of their choice, simply by providing a nominal budget and team requirement. While selecting this topic we were curious if a programming model can be utilized on a lower scale to provide optimized team building solutions with the help of various related techniques. Based upon the needs of a management if they are able to get at least 90% of their requirements fulfilled we felt that this can be considered as an optimization model for providing solutions to team building and issues related to it.

There are many consultancies currently available in the market which provide similar type of solutions not only for Soccer but for other sports such as Basketball, Hockey, Cricket etc. Considering the Entertainment, Popularity, Money involved in these sports, the technological aspect of using Analytical Methods to provide expertise in a sport with all the possible means is growing day by day. Since it is a dream of many fans, franchise and its owners to make a DREAM TEAM which will make them win the championship, that is where this idea of ‘DREAM TEAM Consultancy’ came from.

## About the game

Soccer is played between two teams on a large grass field with a goal at each end. The objective of the game is to get the soccer ball into the opposing team’s goal. The game lasts for 90 minutes which is divided into two halves of 45 minutes.

Each team consists of players, team manager and physio. 11 players of each team have to be on the ground during the match. Of the 11 players one has to be goalkeeper and the remaining 10 members are defenders, midfielders and strikers. The formation of defenders, mid fielders and the striker is decided by each team individually. Each team has 5 to 12 extra players of which a maximum of 7 extra players are allowed to sit on the bench during the match. Of the 7 extra players, 3 players are allowed to play in case any player is injured.

## Problem Statement

The problem here is about managements having to spend huge amount of money on buying players, managers and support staff without having a proper background research, DREAM TEAM as a consultancy has done its own research using its own analytical modules and has been providing solutions related team building issue by gathering the information from the franchise about their requirements in a team. The solution will be as follows:

**The Goal of the consultancy is to minimize the total cost to build three teams for the franchise, keeping the total cost to as minimum as possible while fulfilling all the specific constraints provided individually for each team by the franchise separately.**

# **Methodology**

## Optimization Method

An optimization model is a mathematical model that tries to optimize an objective function without violating the constraints. Optimization includes either maximizing or minimizing objective function. Optimization models are an important tool in many areas of decision making and analysis. Modelling an optimization model includes identifying the objective function, decision variables, constraints and then expressing them in mathematical terms.

### 2.1.1 Linear programming

An optimization model is said to be a Linear Optimization model if the constraints and the objective functions are to be linearly related i.e. the degree of variables should be maximum one. A Change in a variable result in a proportionate change in variable’s contribution to the value of the function. This model is used to find the best possible solution from a given set of parameters which are represented in a form of linear relation.

1. **Linear Programming Model**

* An Objective is the measure of the performance of the system that we want to maximize or minimize. This equation represents how decision variables affect the cost, like in a retail store we want to maximize the store's income or minimize the expenditure. Simply, the value that needs to be optimized. The objective function equation can be represented as:

Or

* The Decision variables are elements in the system which provide the decision maker with the inputs or values they need e.g. the number of laptops to be sold or amount that is needed to be invested in stocks. These are the quantities that are to be determined. The decision variables are represented using algebraic notation as follows:
* The Constraints govern the relation between the variables, constraints limit the maximum or minimum allowable values of variables. The constraints can be represented as follows:
* The Non-negativity criteria, the variables are required to have non-negative values. This criterion can be represented as:
* The Additivity property implies that the equation value is the sum of the contribution of each variable and even the contributions are independent.
* The Divisibility property in a linear programming model allows both non-integer and integer solution values.

All the above stated conditions are to be satisfied for it to be a linear optimization model, once all these conditions are satisfied the next step is to find the optimized results. The simplex method is used to find the optimized results. It is based on the corner point theorem. It begins with an initial feasible solution that satisfies all constraints, which may not be optimal but serves as a starting point then iterates continuously examining the corner points with each subsequent solution that is better than the previous one. It iterates and improves until the optimal solution is found. Optimized result means that we comprehensively choose the values that make the decision variables that either maximizes or minimizes the objective function as per the problem statement. These decision variables value that are obtained can be categorized into two categories as follows

* The feasible solution is the set of values of the decision variable that satisfy all the constraints and the set of all feasible solutions is called as a feasible region.
* The infeasible solution is the set of values of the decision variables that do not at least satisfy one constraint.

1. **Integer Linear Programming (LP) Model**

Integer linear programming is a branch of linear programming where the only restriction is all the variables of the model have to be only Integer. The divisibility requirement in this model is that the non-integer solutions are not allowed. All the other requirements of objective function, constraints, decision variables, non-negativity, Linear relationship and additivity remain constant.

There are three types of integer models

* Pure-integer model where all the decision variables are required to have integer values for the optimal solution.
* Zero-One integer model where the variables are restricted to either 0 or 1 (binary variables)
* Mixed-integer model involves variables where some are integers, while others can be non-integers i.e. binary.

The algorithm that is used to solve the integer models is the branch and bound method. This method searches for an optimal solution by examining only a small part of the total number of possible solutions. This method starts with solving the model using the Simplex Method (similar to that of the Linear programming method), in the process if the algorithm finds a non-integer solution, it breaks the area of the feasible solutions into sub problems until the optimal solution is found. If the solution of a sub problem has a total profit or cost worse than the current feasible bound, it is discarded, and only the remaining sub problems will be evaluated. At a point where no more subproblems can be created i.e. all variables are integers the optimal solution is reached. This model introduces the concept of feasible and infeasible bounds.

1. **Binary Integer Programming Method**

This is a type of the Integer Linear programming, which is implemented if we want to determine whether or not to engage in a certain activity like to build a new home or to start a new business or not. In both the cases we need to make a yes-or-no decision. This can be represented as follows:

A binary variable x is simply a general integer that is restricted to being either 0 or 1.

# Implementation Details

The Problem statement for this project is to build three teams for a franchise considering the inputs and requirements proposed by them while minimizing the total budget possible. In this process, the team may or may not get a player, e.g. team gets a star striker or not, its either 0 or 1 but there won’t be a situation where they get a fractional value of 1.5 player or a 0.75 player. To satisfy this condition we chose Integer Linear Programming as this ensures that the above-mentioned situation of getting decimal values doesn’t arise.

## Formulation of the model

The Team Allocation Model provides an optimal allocation of players, managers and physios to the 3 teams. The main decision that the model needs to make is to allot different category players of specific types to the 3 teams. These allocations are done in such a way that it minimizes the total allocation cost to build the 3 teams.

The Team Allocation Model is an integer linear program with binary values having a set of constraints which are mainly the requirements placed by the 3 teams and the mandatory allocation constraints. All these made the Model a large-scale application with 200 decision variables and 100 constraints hitting the maximum limit of the data solver.

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Figure 1 Portion of the Team Allocation Model spreadsheet.

*(Note: The fields highlighted in the input table marks the allocation of players to certain team)*

The input for the model would be the three teams and the price tag for individual players. Each category and type of players have a certain price tag for teams to obtain their services. The allocation is done by meeting the objectives below:

* Minimize the overall allocation cost for the 3 teams.
* Build a team within certain budget proposed by the 3 teams.
* Satisfy the team combination requested by the 3 teams.

The optimized result shows the allocation of players to different teams as highlighted in the spreadsheet, satisfying all the constraints and minimizing the total cost.

## Model Inputs

The initial step which goes in building the optimization model is to note down the inputs. In this case the input is as shown:

|  |  |
| --- | --- |
| **DESCRIPTION** | **VALUE** |
| Total Players | 60 |
| Star Players | 30 |
| In- Experienced Players | 30 |
| Managers | 3 |
| Physios | 3 |
| Teams | 3 |

Table 1 Model Inputs

Figure 2 Star Player subtypes

Figure In-Experienced Player subtype

Figure 4 Team Chart

**Inputs used in the model implementation:**

|  |  |
| --- | --- |
| **INPUT** | **DESCRIPTION** |
| *t* | Represents teams, t=1,…,3 |
| *s* | Represents star players, s=1,…,30 |
| *i* | Represents in-experienced players, i=1,…,30 |
| *m* | Represents managers, m=1,..,3 |
| *p* | Represents physios, p=1,…,3 |
| *Cst* | Represents cost per star-player for a team (in Millions) |
| *Cit* | Represents cost per in-experienced player for a team (in Millions) |
| *Cmt* | Represents cost per manager for a team (in Millions) |
| *Cpt* | Represents cost per physio for a team (in Millions) |

Table 2 Input Model Implementation

**Variables used on the model implementation:**

|  |  |
| --- | --- |
| **VARIABLE** | **DESCRIPTION** |
| *Xst* | Binary variable indicating whether star player *s* is assigned to team *t* |
| *Yit* | Binary variable indicating whether in-experienced player *i* is assigned to team *t* |
| *Mmt* | Binary variable indicating whether manager *m* is assigned to team *t* |
| *Ppt* | Binary variable indicating whether physio *p* is assigned to team *t* |

Table 3 Variable Model Implementation

## Objective

The objective for DREAM TEAM sports consultancy is to minimize the total allocation cost from a pool of 60 players, 3 managers and 3 physios to the 3 teams, satisfying all the requirements proposed by respective teams.

*MIN*

+ + +

## Constraints

Finally, we present the constraints which are subjected to different team combination requirements and budget limitations proposed by respective teams along with the assignment constraints.

**Assignment constraints:**

1. Assignment of 30-star players to any of the 3 teams.

For each star player *s = 1,…,30* :

Note: Assignment is not mandatory.

1. Assignment of 30 in-experienced players to any of the 3 teams.

For each in-experienced player *i*= 1,…,30:

Note: Assignment is not mandatory.

1. Assignment of 3 managers to any of the 3 teams.

For each manager *m*= 1,..,3:

Note: Assignment is mandatory to any of the 3 teams.

1. Assignment of 3 physios to any of the 3 teams.

For each physio *p*= 1,..,3:

Note: Assignment is mandatory to any of the 3 teams.

**Team Budget constraints:**

1. Maximum Budget limit for Team A
2. Maximum Budget limit for Team B
3. Maximum Budget limit for Team C

**Team Combination constraints:**

1. Maximum in-experienced players required for team A
2. Maximum in-experienced players required for team B
3. Maximum in-experienced players required for team C
4. Maximum Mid-fielders required for Team A: t=1, s=10,..,18 and i=10,..,18
5. Maximum Mid-fielders required for Team B: t=2, s=10,..,18 and i=10,..,18
6. Maximum Mid-fielders required for Team C: t=3, s=10,..,18 and i=10,..,18
7. Minimum Star players required for Team A:
8. Minimum Star players required for Team B:
9. Minimum Star players required for Team C:
10. Minimum in experienced players required for Team C:
11. Minimum Striker required for Team A: t=1, s=1,..,9 and i=1,..,9
12. Minimum Striker required for Team B: t=2, s=1,..,9 and i=1,..,9
13. Minimum Striker required for Team C: t=3, s=1,..,9 and i=1,..,9
14. Minimum Mid fielder required for Team A: t=1, s=10,..,18 and i=10,..,18
15. Minimum Mid fielder required for Team B: t=2, s=10,..,18 and i=10,..,18
16. Minimum Mid fielder required for Team C: t=3, s=10,..,18 and i=10,..,18
17. Minimum Defenders required for Team A: t=1, s=19,..,27 and i=19,..,27
18. Minimum Defenders required for Team B: t=2, s=19,..,27 and i=19,..,27
19. Minimum Defenders required for Team C: t=3, s=19,..,27 and i=19,..,27
20. Minimum Number of Players Required for Team A: t=1, s=1,…,30 and i=1,…,30
21. Minimum Number of Players Required for Team B: t=2, s=1,…,30 and i=1,…,30
22. Minimum Number of Players Required for Team C: t=3, s=1,…,30 and i=1,…,30
23. Minimum Goal Keepers required for Team A: t=1, s=28,..,30 and i=28,..,30

31- Minimum Goal Keepers required for Team B: t=2, s=28,..,30 and i=28,..,30

32- Minimum Goal Keepers required for Team C: t=3, s=28,..,30 and i=28,..,30

# **Results**

After applying the linear programming model, all the mentioned constraints get thoroughly satisfied and the rest of the parameters for the 3 teams are explained as follows.

**For Team A:** From the 1st lot of 30 players, Team A has been allotted with one midfielder who happens to be the star player number 11. The team has been allotted with 4-star defenders with numbers 19, 20, 23 and 24 respectively and one-star goalkeeper at number 28. From the lot of 30 inexperienced players even though, Team A has not received any Star strikers, they have been assigned with 4 inexperienced strikers, which pretty much balances the team’s overall strength. Also, along with a bunch of star midfielders, the team has also been assigned with 4 inexperienced midfielders. Two inexperienced goalkeepers have also been assigned to Team A, which makes the total number of Goalkeepers to be 3. At the end with 4-star defenders, 4 inexperienced strikers, 5 midfielders (1 star & 4 inexperienced) and 3 Goalkeepers (1 Star and 2 Inexperienced) Team A has got a total of 16 players which was the team’s basic minimum requirement. Having said that the team has been assigned a good mix of both Star and In-experienced players with comparatively a lower budget of $65 million as compared to other two teams. Due to the added constraints and basic requirements given by the management, the budget is fully utilized, and the consultancy has provided the best optimized solution within the same. If this budget value is further increased, we might see more star players being assigned to Team A  
The team had a purse value of $ 65 million and the entire budget value has been used to fulfill their requirement.

**For Team B:**  From the spreadsheet, it is clearly seen that Team B’s purse value is slightly higher than that of Team A which is $ 80 million ($15 million more) and this gives them the scope of having a good mixture of Star and In-experienced players overall. Even if the budget is higher in this case, the team is also wanting to have 17 players (i.e. 1 extra player than team A). After optimizing, the team has been provided with 1-star striker, 4-star midfielders, 3-star defenders and 1-star Goalkeeper from the 1st lot of 30 Star players. If we look at the 2nd set of players, the team has been allotted with 1 In-experienced striker 2 In-experienced midfielders, and 5 In-experienced defenders. It is clearly seen that all the defenders allotted to the team are from 2nd set of Inexperienced players. Furthermore, we can conclude that, after having a comparatively higher budget their focus is on buying Star strikers than that of Star Defenders. Team B has been provided with 9 Star players and 8 In-experienced players, whereas for Team A which had a little lower budget had 6-star players and 10 In-experienced players. Even though the total purse value for Team B is $80 million, the utilized value is $76.8 which is $3.2 million less than the actual total. The team has done good progress in terms of meeting all the requirements yet settling up for lesser cost than the actual availability.

**For Team C:** The given purse value for this team was $85 million, which is $5 million more than Team B and $20 million more than Team A. However, Team C had a requirement of 18 players in total, which is respectively more by 2 and 1 than Teams A & B. The team has been allotted with 1-star striker, 4-star midfielders, 2-star defenders and 1-star goalkeeper from the 1st lot of 30 players. There are 2 inexperienced strikers, 3 inexperienced midfielders, 4 inexperienced defenders and 1 inexperienced Goalkeepers allotted from the 2nd pool of players. Finally, we can see that there are total of 18 players being assigned, out of which 8 are Star players and 10 are inexperienced players, this allocation doesn’t completely suggest that more budget implies more star players and this trend was different for the 1st two teams. Out of the total given purse value of $85 million the budget utilized is $74.6, which is $10.6 million less than the availability. Team C has got all their requirements fulfilled in a much lesser value than what was given.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Team** | **Players Assigned** | | | **Purse Value** | **Used Value** |
| **Star** | **Inexperienced** | **Total** |
| A | 6 | 10 | 16 | $65 million | $65.0 million |
| B | 9 | 8 | 17 | $80 million | $76.8 million |
| C | 8 | 10 | 18 | $85 million | $74.6 million |

Table 4 Summary Table (Players Assigned & Purse Value utilized)

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Team** | **Player Category 1: Star** | | | | **Player Category 2: Inexperienced** | | | |
| **Goalkeeper** | **Midfielder** | **Defender** | **Striker** | **Goalkeeper** | **Midfielder** | **Defender** | **Striker** |
| A | 1 | 1 | 4 | 0 | 2 | 4 | 0 | 4 |
| B | 1 | 4 | 3 | 1 | 0 | 2 | 5 | 1 |
| C | 1 | 4 | 2 | 1 | 1 | 3 | 4 | 2 |

Table 5 Summary Table (Player Category wise Allocation)

**Managers and Physios:**

Team managers and support staff are an integral part of any team, along with the players the franchise also had the requirement of having one manager and physio each. Based on the budgets given by the respective teams, they have been allocated with respective managers and physios

**For Team A:** Team A has been allotted with Manager from category 2, whose value is $3.8 million, given the fact that Team A has less budget as compared to the other two teams and given the fact that the consultancy needs to accommodate both Players and support staff in a total of $65 million, hence M2 has been allotted to them which has the 2nd highest price for a manager. Physios were again divided into 3 different categories and Team A has been allocated with physio from category 1 with the least price i.e. $2.1 million.

**For Team B:** This team had the second highest budget which was $80 million. Out of the available lot of managers, this team has been allotted with the manager from the 3rd category which has the highest price of $4.2 million, the reason for this high value allocation for a manager could be the high purse value possessed by the team. A physio with a price of $2.2 million from category 2 was allocated to Team B. Given the scenario that the team has spent huge amount on Managers, hence it is feasible for them to get a Physio from category 2 to stay within the given budget.

**For Team C:** Team C had the maximum total purse value of $85 million, they have been allotted with Manager from Category 1 with a price of $4 million which is the second highest price in the category of managers. After utilizing moderate amount of money on a manager, the team has been allotted with a physio from Category 3 with the highest price of $2.3 million.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Teams** | **Purse Value** | **Category wise Money Spent (In million $)** | | | **Total Money Spent** | **Remaining purse Value** |
| **Players (Number)** | **Manager** | **Physio** |
| A | $65 million | 59.1 (16) | 3.8 | 2.1 | $65.0 million | $0.0 million |
| B | $80 million | 70.4 (17) | 4.2 | 2.2 | $76.8 million | $3.2 million |
| C | $85 million | 68.3 (18) | 4.0 | 2.3 | $74.6 million | $10.4 million |

Table 6 Summary Table (Team wise Purse Value Expenditure)

# **Analysis**

## One-Way Analysis

**Analysis 1:**

Figure 5 Minimized Total Cost to Assignment of Inexperienced Players to Team-C

The one-way analysis was carried out in order to understand if Team C could accommodate more number of inexperienced players which has been their approach since the beginning.

In the above one-way sensitivity analysis graph, by varying the number of minimum requirements of inexperienced players requested by Team-C, the effect on the minimized total cost can be deduced. The result shows that the optimal value stays at $218.4 million throughout, when the inexperienced players allotted to Team-C are varied from 1- 10. There is slight increase of $0.3 million in the optimal value when the 11th inexperienced player is allotted to Team-C. Beyond this point, any allotment of inexperienced players to Team-C is not possible.

## Two-Way Analysis

**Analysis 2**

A two-way solver table provides a way of systematically investigating the effect of simultaneously changing two different data cells. This kind of solver table shows the results in a single output cell for various trial values in two data cells.

A close up of a white background

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Figure 6 Two-way sensitivity analysis 1

(Effect on total minimal cost and number of players bought by change in total budget of Team A)

The above analysis provides the following insights:

1. To the management of Team A on how an increase in their budget (purse value) can result in increase in the total number of players being bought.
2. For the Dream Team Consultancy, how an increase in budget can vary their objective function which is the total minimum cost (sum of the three teams).

Team A has a budget of $65 million and they have used $64.9 million to get 16 players (which is their requirement). This analysis helps the team management to understand by how much should they increase their budget in order to increase the total number of players in their squad to 17or 18 players. From the analysis we can see that for Team A to be able to buy a 17th player they have to increase their budget to $68 million from the current budget of $65 million (increase by $3 million). This increase in budget will increase the total minimum cost (objective function) from $218.4 million to 224.7 million, an increase by $6.3 million. With this budget it is not feasible to secure any other player as shown in the analysis. A further increase of budget by $2 million will decrease the total minimum cost to $ 224.4 million, a decrease by $0.3 million but still they won’t be able to secure any new player (18th player) to their squad. The same is the case for a budget of $72 million, if the team management decides to get 18 players into their squad instead of 16 then they have to increase their budget to $ 74 million and this increase will have an effect on objective function (total minimum cost), taking it to $ 230.4 million (from initial 218.4 million), an increase of 12 million. With this budget of $ 74 million they will not be able to secure any additional player (more than 18) into their squad, same is the situation for a total budget of $76 million and $78 million as we can see from the report that it is not feasible. If the budget increases to $80 million then Team A will be able to get 19 players into their squad, this will increase the objective function (total minimum cost) to $236.4 million from $218.4, an increase by $18 million. With this budget of $80 million Team A won’t be able to secure any additional player to squad as we can see from the analysis that it is not feasible.

**Analysis 3**

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Figure 7 Two-way sensitivity analysis 2

(Effect on total minimal cost and number of players bought by change in total budget of team B)

The above analysis provides the following insights:

1. To the management of Team B on how an increase in their budget (purse value) can influence the total number of players being assigned.
2. For the Dream Team Consultancy, how an increase in budget can vary their objective function which is the total minimum cost (sum of the three teams).

Team B has a budget of $80 million and they have used $76.8 million to get 17 players (which is their requirement). Now this report helps the team management to understand by how much should they increase their budget in order to increase the total number of players in their squad to 18 or 19 players. From the analysis we can see that for them to be able to buy a 18th player they have to increase their budget to $82 million from the current budget of $80 million (increase by $2 million), this increase in budget will increase the total minimum cost (objective function) from $218.4 million to 224.4 million, an increase by $6 million. With this budget it is not feasible to buy any other player as shown in the report. A further increase of budget from $83 million to $ 85 million has no effect on the number of players being secured or on the objective function as we can see from the sensitivity analysis that it is not feasible. Here securing anymore players to the team is not feasible and the objective function (minimum total cost) remains insensitive for any further change in the total budget.

# Conclusion

In this analysis we have demonstrated how the Dream Team works with the franchises to help build their teams based on the available budget. Dream Team developed a Binary Integer programming model to formulate the allocation of the players to the 3 teams.

This model by Dream Team consultancy successfully solved and facilitated the team building process for 3 football teams from a pool of players. Due to the solver limitations, strategy for team building was developed to facilitate team building for only 3 teams, satisfying all their requirements individually that were put forth.

Further analysis was made using one-way and two-way analysis. One-way analysis was performed to see if additional number of inexperienced players could be allotted to Team-C. Given result shows that after 11th inexperienced player, allotting any inexperienced player further would not give a feasible solution.

Two-way analysis was conducted to see how variation in teams’ budget would vary the allotment of total number of players to each team and also to check its influence on the total minimum cost/ objective function.

# Future work

During the development of our model we were not able to incorporate more constraints to govern additional criteria as the maximum accommodated by the solver is 100 constraints and 200 decision variables. Due to this limitation we were not able to add any other additional constraints. With an access to full edition of solver we will try to furthermore optimize the model with additional features.

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