Use of operations research in football

Janki Hariani, Harshita Malladi, Jash Mehta, Manthan Dedhia, Kaushik Bhutka
Student, SVKM's Narsee Monjee Institute of Management Studies, Mumbai, Maharashtra

ABSTRACT

This paper presents the use of operations research in football and the FIFA world cup. Football is getting popular day by day and so is the use of Operations Research in it. Operations Research is used in football for designing football, designing goal lines and goal posts, proper selection and distribution of teams, knowing the probability of win-lose and optimizing the overall costs. There are a few limitations of Operations Research like hiring an Operations Research expert for analysing. The implementation is also a drawback. But, Operations Research has proved very useful for the football industry.

Keywords — Operations Research, Football, Probability, Selection

1. INTRODUCTION

“Professional Game Match Officials Limited (PGMOL) denies Halsey's claims that officials have been told to lie”. (Stevens, 2016) PGMOL is a body of selected individuals which appoints referees in English football matches based on experience, current form, the importance of the match, which team they individually support, and any future appointments.

Operations research is a scientific method used by companies to assist them in the decision-making process. It helps the organization to optimize results by fulfilling the required objectives while accommodating for the constraints. Use of operations research lets the executives compare various outcomes of alternative options, decisions and suggest the best possible solution. (Nikhila, n.d.)

Application of operations research is vast and its presence is felt in most fields of the world economy. Amongst them the sports industry being one of the latest to apply operations research. In football, it can be applied to appoint referees, distribute teams into groups, and others explained further in the paper.

This paper will talk about how operations research can be applied in football and more particularly, in the FIFA World Cup. This will help shed light on its various contributions to the beautiful game and its effectiveness.

2. OVERVIEW

As we know Operations Research is the use of various analytical techniques and methods for effective decision making in various areas such as marketing, finance, logistics, sports etc.

Sports events include numerous logistics and monetary issues like competition arranging, club administration, promotion policies, and security issues and so on. Today sports is a major business, Forbes said that the Major League Baseball groups at over $15 billion, with the Yankees alone worth $1.7 billion. With such high worth, it isn't surprising that there is an extraordinary interest in using information and OR models to make more economical decisions. Sports leagues have high economic effects around the world making them a significant part of the overall economy. This year FIFA world cup costed an estimate of 11.8 billion making it the most expensive world cup till date. (Sheetz, 2018)

Over the years various individuals have looked into approaches to streamline the techniques for various games. Models for choosing playoff end are exceptionally valuable instruments for group executives, the press and the fans. They are very effective in redressing basic deceiving explanations made by the press and group directors. (Urrutia) A few models include Freeze (1974) who used simulations to locate the best batting order for a baseball group, Boon and Sierksma (2003), who designed a decision support system to help football coaches and administrators survey contributions of specific players to their groups, thus helping in group determination as well as in scouting and buying new players, Scarf and Grehan, (2005) decided the ideal course to pick while cycling.

OR has made numerous contributions to predicting research and practice. Last 25 years have seen a quick development of specialist forecasting research. The one of a kind contribution that OR is making and can keep on making to predicting is through designing models that connect the viability of new forecasting techniques to the organizational setting in which the models are applied. In a lot of real-life games, observers are keen on foreseeing the results and watching the games to confirm their predictions.
Gambling has been a major element of most sports. Due to the high amounts of money involved, it is likely that a wide range of OR models is being used which are viewed as highly classified. There are various specialists that added to this zone and given below are some important scientists and their commitments. (Prusty M.)


Besides betting, two researchers designed techniques for anticipating success at the Olympic Games: Condon et al (1999), who utilized relapse and neural nets to conjecture national achievement, and Heazlewood (2006), who gave an account of non-linear models used to predict winning times and distances for athletics and swimming. This application could be imperative for nations hoping to build increase their success rates at the Olympics. (Prusty)

Hence, O.R. strategies have a vast capability of uses in sports. Better tournament schedules can significantly decrease travel costs. There are numerous utilizations of optimization methods to timetabling in various games, for example, soccer, baseball, football, b-ball, hockey and rugby, leading decreases in travel costs and to more fairness. (Prusty, A Study on the application of Operation Research in Sports and Sports Management)

3. LITERATURE REVIEW
Football is fast becoming one of the most popular sports across the globe. The game has really promising and competitive players, a huge fan base and an extravagantly high budget which has attracted the attention of many researchers. There are quite a few intriguing studies in OR which are based on Football.

The very first being the scheduling process. Each Football league has a schedule that is developed after tedious research keeping in mind several constraints. At least 100 permutations and combinations are created before selecting one. (Cay)

The scheduling problem’s solution is developed using several techniques like integer programming, constraint programming, local search heuristic, decomposition approaches and combinations thereof. The process generally involves mathematical derivation of objectives and requirements put forth by the stakeholders to obtain a solution that is presented to the stakeholders for their opinions which are then taken into consideration to develop other optimal schedules. (Fry)

Previous research shows that, while developing a schedule for the Brazilian Football Tournament, an integer program was devised to obtain schedules. The major aspect that was focused upon while devising the schedules was the maximization of game attendances and TV audiences. First, several feasible patterns of home and away games were developed. Then, the home-away patterns were assigned to the teams then, a reduced integer program was solved to schedule the matches accordingly. (Fry)

Very similar methods were used for devising Chile’s Second Division League and Canadian Football League’s schedules as well. In Chile, there are only two professional soccer leagues namely, the First and Second Division League. Previously, schedules were developed by coupling each game date with two numbers that were randomly assigned to teams. A research shows that in 2005, ANFP asked a few Operations researchers to help develop the First Division Schedule. An integer programming model was developed that took into consideration the constraints put forth by the ANFP, the teams, and the broadcasters. After the First Division’s Schedule’s success, another ILP model was developed for the Second Division based on basic, break and geographical constraints. The major focus, while developing both the schedules, was on the improvement of public sentiment and economic viability for Chile. The research concluded that the schedules developed by OR methods have had a positive qualitative and quantitative impact. There has been a significant financial saving for the teams, now there’s more equitable distribution of trips across the tournament allowing the teams to manage their expenses better. The OR techniques also enabled the modification that was suggested to reduce the travel and budget strains for the teams and make the tournament more attractive for the fans. (Guillermo Durán)

In Canada, the CFL was hesitant to incorporate OR techniques at first but then a season ticket holder once wrote a letter suggesting that an analytical method to devise schedules would be beneficial. Here, an explicit objective function was not defined, unlike in the other cases. They considered maximizing the number of Friday games or minimizing the Sunday games or maximizing the interdivisional games played in the last four weeks of the season. Later on, a need to balance the home and away contests in the respective halves of the season was seen and hence it was put down as a requirement. The several objective functions helped develop several optimal schedules providing the decision makers with a wide array of choices. The research concludes that usage of OR reduced the labor hours invested in developing the schedule as it was done manually earlier. (Willoughby)

The use of Operations Research for developing schedules is praised because it ensures transparency, the requirements of the stakeholders are taken into consideration and most importantly, it’s relatively easier to devise alternative schedules using OR as compared to other methods. (Fry)

Another study stated that much of the previous research work was done based on the assumption that the football teams move around on road trips which is very common in the States but not in the United Kingdom. This study focused more on minimization of distance commuted for two whole fixtures (games). The study compares the schedules then devised and those developed before to conclude that by minimizing the distance traveled, a significant reduction can be brought about. (Kendall)
The next study in OR on Football is the Referee assignment problem. Referee assignment is an important element of the Football Leagues. Each game requires four referees; 1 center (chief authority of the game), 2 assistants (linemen) and a 4th referee (keeps a record of red and yellow cards and is a substitute for the center referee). Riots and disagreements between Clubs (teams) and the referees are a common sight. This gives rise to unnecessary tension between them and hence fair referee assignment is extremely important. (Mesut Yavuz, 2008)

The research paper states the constructive heuristic method developed to obtain the initial feasible solution (IBFS) along with a local search procedure employed to improve the solution obtained. The research paper suggests that the bases of assignment be two criteria namely, Fairness and Performance. The paper concludes that the referee assignment problem is periodic in nature. It states that to avoid short periods, it is necessary to have a number of referees than the total games in the season. (Mesut Yavuz)

The third study is the measurement of the effectiveness of Football teams. A research states that the purpose of teams competing in the tournament is to win while the ultimate goal is to survive. Both these objectives go hand-in-hand. A club can survive only and only if it ensures its profits by winning games. Hence, the study takes into consideration anyone Champions League and analyses the teams on the basis of their efficiency. It uses the Data Envelopment Analysis (DEA) to measure the efficiency. (García-Cebrián)

The study states that the two finalists are efficient in each season but, there are also a few teams that get eliminated early in the season but have utilized their resources with utmost efficiency. It also states that the winning team is not always the most efficient team in the season. The three main conclusions that were put forth by the study were that:
- Efficient use of resources is extremely necessary to attain good satisfactory results
- Efficiency can be used to more accurately define the results of various teams on the basis of resources available to them
- The inefficiencies recognized during the study can be attributed to wastage or resources and not the usage of different tactics. (García-Cebrián)

4. SIGNIFICANCE
Operations research uses mathematical and statistical tools to:
1. Have increased productivity by reducing the cost of the finding referees and hiring the most responsible referees.
2. Have control over non-bias selection and division of referees and teams according to the necessary requirement.
3. Make better decisions in deciding which referee manages a game.
4. Simplify the problem but make sure that loss of accuracy is low.
5. Better marketing of the games by figuring out where and when to advertise the football match and who will be the target audience.
6. Help determine the scheduling of football matches.
7. Point out necessary security positions inside and around the stadiums based on previous incidents but mainly through computer programs.
8. If the FIFA World Cup is held in a nation for the first time, like in 2018 in Russia, operations research also helps in choosing locations for building stadiums.
9. Deciding the cities where the matches will be held while keeping in mind the transportation system.
10. Figure out the routes by the team buses to reach the stadium.
11. Determine formation of the team which will increase their chances of winning the tie, based on the past record and performance of the opposition and the formations they seemed to struggle against.
12. Reduce the cost and maximize the profit while manufacturing the football team jerseys.
13. Operations research is used for the pre-match, pre-decided processes like deciding the match time, place, referees to be appointed, transport system, security system but not really during the football match. Although it can also be used to study the pattern of the tactics used by a certain manager or a team and how to reduce or increase its productivity, depending on who is study the tactics- opposition or the team themselves.

5. ANALYSIS
As it is repetitively emphasized in this research paper before we know that operations research is extensively used in sports but not all sports use scientific methods for allocation of team players, preparation of match schedules, ground arrangements, coach assignment as well as other requisite decisions needed in the sport discussed therein. However, football (soccer) has the necessary resources and the backing in form of public enthusiasm to go forward with using scientific methods for determining various variables of the sport’s decision and attempting to maximize the value related to them. It has become a necessity in some manners for football to be scientifically approached.

It is due to this fact that there is not a dearth of literature available on the subject. Various questions like how to decide whether teams play on foreign grounds or home grounds, fruitful team selection, coach assignment as well as performance measurement, player performance assessment, referee assignment, pitch selection, weather analysis for getting an uninterrupted game schedule, team performance assessment, valuation of clubs as well as players, etc. have been answered in various research papers and some of them have been discussed above. The fact that new literature comes up every day on these subjects goes to show how keen people are on improving the whole soccer experience.

When soccer itself evolves at a rapid pace and the literature makes the study too vague, we decided to study the kingpin in the soccer market for finding out the extent and quality of operations research used in the field - Federation Internationale de Football Association (FIFA). Studies on FIFA are as huge in volume as the subject itself and outranks the studies on major cricket association BCCI (board of control for cricket in India) by margins.
FIFA agrees that it uses OR techniques for determination of design of football, goal posts as well as goal lines and uniforms of teams, determination of teams as well as the groups, making FIFA as disseminable as possible to a particular country, weather forecasts and some other decisions publicly as is seen by the numerous articles as published by recognized news agencies like economic times who recently published a 7 items list article mentioning the OR techniques used for bettering the various paraphernalia used in FIFA 2018. Besides the association itself, many recognized sports brands as well as streaming agencies like Puma, Adidas, Nike and Sony, Airtel TV, etc. respectively use OR technique to drive their sales and increase revenue via maximum viewership during FIFA respectively.

We had already seen how a fruitful number of models have been designed by various people for different decision variables like scheduling, referee assignment, team performance assessment and the like in the literature provided herein.

FIFA uses OR techniques like the basic linear and nonlinear linear programming tools for determining the grounds and audience arrangements as well as higher models of OR like the stochastic programming as well as a continuous time Markov chains to determine the various social factors as well as economic weather and geographical weather that may/not affect the federation. Consider the following example in football showing the use of Markov chains to predict whether a goal can extend the match to extra-time.

A team is backed into a 4th-and-26 from their own 25, down 3 points. What are the odds that drive ends in a field goal? In the 2003 playoffs, Donovan McNabb and the Eagles scoffed at such a probability as they converted and ultimately kicked a field goal to send the game into overtime. This study creates a mathematical model of a football drive that can calculate such probabilities, labeling down, distance, and yard line into states in an absorbing Markov chain. The Markov model provides a basic framework for evaluating play in football. With all the details of the modelâ€”“absorption probabilities, expected time until absorption, expected pointsâ€” we gain a much greater situational understanding for in-game analysis. (Keith Goldner)

6. CONCLUSION
From the previous researches carried out, we can conclude that Operations Research was used very effectively and extensively in FIFA world cup 2018. The entire FIFA world cup 2018 was carried out very smoothly with negligible or zero error. It also helped greatly to reduce overall costs and plan out and design the stadiums, tournament schedules, destination etc. extremely efficiently. Even though there are limitations to the use of operations research, its advantages overcome them all. This shows us that operations research is an extremely versatile subject and can many used in numerous fields to find the most effective and optimal solutions.

7. LIMITATIONS
While researching on this topic, we faced some challenges along the way and they can be broadly classified into the following:
1. Lack of prior studies in the field- Though there has been the application of OR in football, it is not extensive and hence forming the basis of the study was troublesome.
2. Lack of reliable data- As the field has not been explored and researched upon to its full potential, the literature review's scope was narrowed down to only assignment problems in football.
3. Pre-requisite Knowledge- Being only elementary operations research students, we have a lack of understanding and knowledge of the various operations research methods and the models developed and used in this field.
4. Competitiveness- Due to the nature of the football industry, when a lot of studies have been done on the sport, no league willingly imparts knowledge of the methods they use due to which the paper fails to go in depth as to which methods are used herein.
5. Lack of time- Our research was limited to a period of approximately 45 days and there was only so much about the application of operations research in football that we could dig up.

8. REFERENCES


