Istanbul Medipol University

School of Engineering and Natural Sciences

Graduation Project

2024-2025

PROJECT TITLE
Assigning Super League Matches to Time Slots
PROJECT ADVISOR
Associate Professor Yasin Göçgün
TEAM MEMBERS
Hatice Sena Kulak, Hilal Sönmez, Zeki Gür, Esmanur Aytaş, Amjed Mohammed Ahmed Abdelhamıd

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Sponsor Company (if any) : -

BUDGET (TL)	**PROPOSED**	**CONSENTED**
IMU FUNDING	80 USD (2748.67 TL /year)	-
SPONSOR COMPANY FUNDING	-	-
TOTAL	80 USD	

PROJECT PLAN	**PROPOSED**	**CONSENTED**
PROJECT PLAN Duration in Weeks	28 Weeks	28 Weeks
STARTING DATE	7.10.2024	

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Project Advisor: Associate Professor Yasin Göçgün

Team Members: Hatice Sena Kulak, Hilal Sönmez, Zeki Gür, Esmanur Aytaş, Amjed Mohammed Ahmed Abdelhamid

Project Group Title: Determining the Match Days for the Turkish Super League using Non-Linear Binary Integer Programming

PROJECT OVERVIEW/SUMMARY/ABSTRACT

The main objective of this project is to develop an integer programming model to create a fair and optimized fixture for the Turkish Super League. Currently, manual methods are being implemented by the Turkish Football Federation (TFF). This project aims to reduce the problems that may arise from traditional methods.

The project used matchday data collected weekly throughout the 2023-2024 Turkish Super League season. It was planned to design a model that would prevent any team from being disadvantaged in terms of less recovery or rest time compared to the others.The model ensured a minimum of 3 days of rest for each team, creating a fairer competition environment.

Another goal of the model was to optimize the match time slots and ensure that teams played in a balanced manner across different time slots. In this way, each team would avoid playing regularly in the less advantageous afternoon time slots or the more advantageous Saturday and Sunday evening time slots. As a result, each team would be able to reach an equal number of fans.

This project demonstrated that an optimized, systematic approach can provide a more balanced and fair fixture schedule compared to traditional manually prepared schedules. In addition, the designed model also took into account the schedules of these international leagues or tournaments, avoiding clashes with important matches such as those UEFA Champions League and World Cup. This project was developed to meet the specific operational needs of the Turkish Super League, increasing the applicability and practicality of the optimized fixture.

Consequently, the project produced an optimal program that overcame limitations of manual method. With this approach, it aimed to promote effective competition between teams, offering benefits such as equal rest periods and balanced exposure.

Keywords: OR in sports, sports scheduling, time slot scheduling, integer programming

1. OBJECTIVE OF THE PROJECT:

The main objective of the project is to address the problem of unfair time slot distribution encountered in the Turkish Super League. In line with this goal, it is proposed to develop a binary integer programming model instead of the currently used traditional, manually prepared scheduling system. The main purpose of creating this model is to minimize the scheduling inconsistencies and large deviations caused by the manual program.

With the model to be created, the rest period imbalance between teams is prevented - in other words, no team would start a match with significantly less rest than its opponent. If this model is established, it will prevent local tournaments such as the Ziraat Turkish Cup or international tournaments like the UEFA Champions and European League - typically played on weekdays (Tuesday, Wednesday, Thursday) from interfering with the Turkish Super League fixtures.

With the model aimed to be established in the project, it is aimed to enhance a competitive balance in league matches. With the increase in the competitive environment, the number of fans following the league will increase, and it is thought that these increases will have a positive impact on both league-wide and individual club broadcasting revenues.

While creating this model, it is aimed for each league team to have a minimum rest period of three days between matches. Most importantly, the main goal is to minimize the fixture day deviations for each team in order to ensure fairness in the league.

2. LITERATURE REVIEW:

For many years, experts have been working to develop fair and effective football league schedules that take into account a variety of factors such as tournament scheduling and optimization models, minimizing rest inequalities, breaks, and ensuring fairness, reducing imbalances between home/away matches, reducing travel distances and managing logistical burdens, reducing carry-over effects and improving team performance, round-robin or double round-robin, and others. In Table 1, given in the appendices, below you will find the articles grouped by topic.

There are several articles that stand out with their similarity to our project when we eliminate television broadcasts, round-robin or double round-robin restrictions in the optimization process. These articles can be listed as: “Scheduling the Main Professional Football League of Argentina,” “Optimal Matchday Schedule for the Turkish Professional Soccer League Using Nonlinear Binary Integer Programming,” “Determining the Matchdays for the Turkish Super League Using Non-Linear Binary Integer Programming,” “An Integer Programming Formulation for Scheduling of the Icelandic Football League,” and “Determining Matchdays in Sports League Schedules to Minimize Rest Differences.”

In the “Scheduling the Main Professional Football League of Argentina” article, the fixture should consist of 25 rounds and each round should be spread over 3 to 4 consecutive days, and each team should play once in each round. In addition to these restrictions, optimization is carried out by taking into account the travel distance.

In the “Optimal Matchday Schedule for the Turkish Professional Soccer League Using Nonlinear Binary Integer Programming” article, it assigns matches to days using 2018 Turkish football league data. The important thing here is that there are breaks between the matches played.

In the “Determining the Matchdays for the Turkish Super League Using Non-Linear Binary Integer Programming” article, in addition to the article “Optimal Matchday Schedule for the Turkish

Professional Soccer League Using Nonlinear Binary Integer Programming," the model also optimizes time slot assignments.

In the "An Integer Programming Formulation for Scheduling of the Icelandic Football League" article, the target is a minimum number of breaks, and a break is given when a team plays two or more matches in a row, but there are no breaks in the first and last rounds.

"Determining Matchdays in Sports League Schedules to Minimize Rest Differences" determines the tournament day schedule to minimize the total rest difference between the opposing teams.

A table was created by classifying the reviewed articles. Check "Appendix 2: Literature Review."

In conclusion, scheduling in football leagues has improved significantly as a result of recent developments in the literature on optimization strategies in football leagues. By addressing various aspects of scheduling issues, including rest inconsistencies, breaks, and carry-over effects, these studies have paved the way for fairer and more efficient league structures.

3. ORIGINALITY:

Creating a fair fixture within the league is necessary for important points such as maintaining the overall quality of the league, providing exciting matches for the fans, and ensuring fair competition between the teams. In addition, only a small number of parameters can be included in the commonly used manual programs. These parameters can be listed as travel load, match days and hours, and team rest periods. The mentioned parameters can cause differences between teams, such as some teams being more tired or having travelled a longer distance. These differences are the main reasons for the disruption of league balance.

The main purpose of the research is to develop a non-linear binary integer programming model to create the most suitable match day schedule for the Turkish Super League. When the programming process which is currently carried out manually by the Turkish Football Federation is compared with the presented model, the presented model aims to create a fairer and balanced match schedule. The presented model prioritizes equal rest periods and other fairness criteria while establishing this balance.

As a result of all this, the competition conditions between the teams will be equalized, and the fans will follow the matches where the competition is intense. In addition to the studies of Gocgun and Bakır (2021), this study determines not only on which days but also at what times the matches should be played, such as in the afternoon or in the evening.

In addition, in 2022, Gocgun and Bakır focused on not only assigning days but also assigning time slots. After coronavirus, teams were not relegated in the Turkish Super League, so 3 teams were left out and 21 teams played. In the subsequent years, it was considered to gradually reduce the number of teams in the Super League, one by one. In 2023–2024 data set will be evaluated within the scope of 20 teams in this project. The core difference between this study and Gocgun and Bakır (2022) is data differences.

Previous studies have generally focused on solutions and injustices by addressing issues such as carryover effects, consecutive home and away matches, and rest mismatches. In other words, all studies have adopted an approach that takes into account the dynamics of different leagues. In the Turkish context, this concept, which we put forward to increase fairness, sustainability, and applicability, also considers operational realities by scheduling consecutive home and away matches, and all leagues in which teams play.

4. SCOPE OF THE PROJECT AND EXPERIMENTS/METHODS:

4.1 Scope of The Project:

The main goal of the project is to develop a fixture scheduling system for the Turkish Football League by utilizing nonlinear BIP (Binary Integer Programming). Building a fair and efficient schedule that includes multiple criteria such as matchday balance and time slot balance are essential complementary aspects for realizing that goal. The progress of the project includes the construction of available databases in Excel for the 38-week league season followed by research to specify objective function and determining constraints by obeying real world problems of league fixtures. These steps support the creation of a fixture that is separated as noon, afternoon and evening for each fixture day for each league team. Lastly, by utilizing TFF manual and proposed schedule in this study, the required testing and related refinements will be made to curtail scheduling unconformities and enhance fairness in order to check accuracy and functionality of written codes.

4.2 Constraints:

- Team Availability Constraint
- Fixture Duration Constraint
- Tournament Alignment Constraint
- Uncertainty Constraint
- Day Distribution Constraint
- Part of the Day Constraint
- Fairness Constraint

4.3 Experiments/Methods: Below steps are related work packages that define experiment and applied methods.

4.3.1. Data Collection and Analysis

- **Objective**: Collect and process match data from Turkish leagues, national matches, and European competitions.
- **Methods**: Retrieve Turkish Super League and Ziraat Turkish Cup match data (date, time, teams) from the Turkish Football Federation official website. In addition, retrieve the national matches data from FIFA official website. Lastly, retrieve national team matches such as UEFA leagues matches from UEFA official website. And then, organize and process data in an Excel file, ensuring it is complete, accurate and ready for coding. Example European match schedule for week 1 as follows.

As seen in the Appendix Table 2, there are 38 weeks for the football program, and we have 26 different pattern frequencies as seen in the Appendix Table 3. And out of these 26 frequencies, the distribution of 21 themes is the same as itself, so their frequency is 1. Out of the 26 different pattern frequencies, only 5 have the same patterns as others. And the patterns are 10220221, 21121111,11111212,31121110,11121211 and their frequencies are 2,2,3,3 respectively.

4.3.2. Model Development

- **Objective**: Create a nonlinear BIP (Binary Integer Programming) model for fixture optimization.
- **Methods**:
  - Formulate objective functions so as to minimize deviations in matchday distribution and ensure fairness.

- Incorporate constraints like team rest periods, home/away balance, and TV

4.3.2.1. Creation of Nonlinear BIP - Explanation for Fixture Optimization of Week 1

4.3.2.1.1 The Objective Function:

The objective function aims to minimize deviations in match scheduling, ensuring fair distribution across days for the entire season and balanced allocation to time slots within each round.

$$\textbf{Minimize } c1 * \sum_{d2 \in DS} w_{d2} * D_{d2} + c2 \cdot V \quad (1)$$

$\mathbf{C_1}$, is the weight that prioritizes minimizing seasonal day deviations. It ensures fair distribution of matches across days, with higher values giving more importance to the daily balance.

DS, set of days.

$\mathbf{W_{d2}}$, weight assigned to the deviation for a specific day (e.g., Sunday may have higher weight).

$\mathbf{D_{d2}}$, represents the deviation for specific days such as Friday, Saturday, Sunday and Monday, and is also calculated as the squared difference between the ideal and actual number of matches.

$$D_{d2} = \sum_{i=1}^{I} [x_{i,r,d2} + \sum_{k=1}^{r-1} x_{i,k,d2} - \left(r \times a_{d2}\right)]^2, \quad \text{if d2 = \{Fri, Mon\},} \quad (1)$$

$$D_{d2} = \sum_{i=1}^{I} [x_{i,r,sat1} + x_{i,r,sat2} + x_{i,r,sat3} + (\sum_{k=1}^{r-1} x_{i,k,sat1} + x_{i,k,sat2} + x_{i,k,sat3}) - \left(r \times a_{d2}\right)]^2, \quad \text{if d2 = \{Sat\}} \quad (2)$$

$$D_{d2} = \sum_{i=1}^{I} [x_{i,r,sun1} + x_{i,r,sun2} + x_{i,r,sun3} + (\sum_{k=1}^{r-1} x_{i,k,sun1} + x_{i,k,sun2} + x_{i,k,sun3}) - \left(r \times a_{d2}\right)]^2, \text{ if d2 = \{Sun\}} \quad (3)$$

x_{ird} values in this function are binary, and the mathematical formulation can be shown as follows,

$$x_{ird} = \begin{cases} 1, & if\ team\ i\ plays\ in\ round\ r\ on\ day/period\ d, \\ 0, & otherwise. \end{cases} \quad (4)$$

a_{d2}: The number of matches that should be scheduled on day d in a single round, d in DS, under ideal conditions,

The model assumes an ideal match day distribution for each team during a 38-match season. This distribution expresses the total number of matches each team will play from Friday to Monday as ($s*$, $t*$, $u*$, $v*$), respectively. In a 38-week fixture, the sum of these numbers is expressed as: $s*+t*+u*+v*$ = 38 for each team. In order to provide a fair distribution, this ideal distribution should be essentially the same for each team. Since weekend matches are preferable for all stakeholders, it indicates that a greater proportion of the matches that each team will play during the 38 rounds should fall on the

weekend. Additionally, a_{d2} is the ideal matchday allocation per team in a round. It is calculated by dividing the ideal number of games that should be played from Friday to Monday by the number of rounds as follows:

$$a_d = \frac{s^*}{38}, \ if\ d = Fri \tag{5}$$

$$a_d = \frac{t^*}{38}, \ if\ d = Sat \tag{6}$$

$$a_d = \frac{u^*}{38}, \ if\ d = Sun \tag{7}$$

$$a_d = \frac{v^*}{38}, \ if\ d = Mon \tag{8}$$

$\mathbf{C_2}$, weight assigned to the importance of round-specific time deviations.

V, metric for round-specific deviations. Measures the difference between the ideal and actual match distributions in specific time slots.

$$V = \sum_{d \in DS2} \left(\frac{\sum_{i=1}^{I} x_{ird}}{2} - b_d\right)^2 \tag{9}$$

The round specific metric is given in (9). It measures the squared deviation from the ideal match day slot distribution. The value of b_d for each round r is obtained from the distribution table given in the Appendix " Table 2."

4.3.2.1.2. Feasibility Constraints

$$x_{i,r,Fri}+x_{i,r,Sat1}+x_{i,r,Sat2}+x_{i,r,Sat3}+x_{i,r,Sun1}+x_{i,r,Sun2}+x_{i,r,Sun3}+x_{i,r,Mon}=1 , \quad i=1, 2,\ldots,20 \tag{10}$$

The purpose of this constraint is to ensure that each team ***i*** plays exactly one match per round **r**, on one of the specified days **d** (where **d** ∈ **{Fri, Sat1, Sat2, Sat3, Sun1, Sun2, Sun3, Mon}**) preventing any team from skipping a match or playing more than once in the same week.

i, the index representing the team (ranging from 1 to 20).

r, the round number, indicating which round of the competition the match belongs to.

d, the day or time slot within the round when the match is scheduled.

This constraint ensures that each team has exactly one match assigned during each round, maintaining fairness and consistent participation throughout the scheduling process.

$$x_{i,r,Thur}+x_{i,r,Fri}+x_{i,r,Sat1}+x_{i,r,Sat2}+x_{i,r,Sat3} \leq 1, \tag{11}$$

This constraint ensures that any given team ***i*** can play **at most one match** on Thursday, Friday, or during any of the three time slots on Saturday (morning, afternoon, or evening) within the same round

r. In other words, this constraint ensures that if a team is scheduled to play on **Thursday**, it cannot be scheduled to play on **Friday**, **Saturday** (in any of the 1st, 2nd, or 3rd time slots), in the same week.

$$x_{i,r,Sun1}+x_{i,r,Sun2}+x_{i,r,Sun3}+x_{i,r,Mon}+x_{i,r,Tue}\leq 1, \qquad i=1,2,\ldots,20 \tag{12}$$

This constraint ensures that any given team ***i*** can play **at most one match** on Sunday (in any of the 1st, 2nd, or 3rd time slots), Monday, or Tuesday within the same round ***r***. This constraint ensures that if a team ***i*** is scheduled to play on **Tuesday**, then no match can be scheduled for that team on **Sunday** (in any of the 1st, 2nd, or 3rd time slots) or **Monday** during the same round.

$$x_{i,r,Wed}+x_{i,r,Thur}+x_{i,r,Fri}\leq 1, \qquad i=1,2,\ldots,20 \tag{13}$$

This constraint ensures that a team ***i*** can **only play one match between Wednesday and Friday** during the same round. In other words, if a match is scheduled for a team on **Wednesday**, the team cannot have a match on **Thursday** or **Friday** within the same week.

$$x_{i,r,Mon}+x_{i,r,Tue}+x_{i,r,Wed}\leq 1, \qquad i=1,2,\ldots,20 \tag{14}$$

This constraint ensures that a team ***i*** can play at most **one match between Monday, Tuesday, and Wednesday** during the same round.

$$x_{i,r,Wed}+x_{i,r,Sat1}+x_{i,r,Sat2}\leq 1, \qquad i=1,2,\ldots,20 \tag{15}$$

This constraint ensures that a team **i** can play at most **one match between Wednesday and Saturday (1st and 2nd time slots)** during the same round.

$$x_{i,r,Thur}+x_{i,r,Sun1}+x_{i,r,Sun2}\leq 1, \qquad i=1,2,\ldots,20 \tag{16}$$

This constraint ensures that a team **i** can play at most **one match between Thursday, Sunday (1st time slot), and Sunday (2nd time slot)** during the same round. In other words, this constraint guarantees that if a team has a match on Thursday, it will **not** have a match on Sunday in the 1st or 2nd time slots.

$$x_{i,r,Sat1=0}, \quad i\in\{GS,FB,BJK,BSK,TS\} \tag{17}$$

This constraint ensures that the teams **i** in the set {GS,FB,BJK, BSK,TS} (which represent the major teams like Galatasaray, Fenerbahce, Besiktas, Basaksehir, and Trabzonspor) cannot be scheduled to play in the 1st time slot on Saturday.

$$x_{i,r,Sun1=0}, \quad i\in\{GS,FB,BJK,BSK,TS\} \tag{18}$$

This constraint ensures that these major teams are not scheduled to play in the 1st time slot on Sunday.

$$\sum_{i\in Tist} x_{i,r,d}\leq 2, \quad d\in\{Fri, Mon\} \tag{19}$$

$\mathbf{T_{ist}}$: Set of teams located in Istanbul (e.g., Galatasaray, Fenerbahce, Besiktas, etc.).

d ∈ { Fri,Mon}: Days being considered, which are Friday and Monday.

This constraint limits that no more than **two teams in T_{ist}** are allowed to play on **either Friday or Monday**.

$$\sum_{i \in Tist} x_{i,r,Sat1} + x_{i,r,Sat2} + x_{i,r,Sat3} \leq 2 \quad (20)$$

This constraint ensures that in a given round, at most 2 Istanbul-based teams can be scheduled to play on Saturday, across the three available time slots (**Sat1**, **Sat2**, and **Sat3**).

$$\sum_{i \in Tist} x_{i,r,Sun1} + x_{i,r,Sun2} + x_{i,r,Sun3} \leq 2 \quad (21)$$

This constraint ensures that in a given round, at most 2 Istanbul-based teams can be scheduled to play on Sunday, across the three available time slots (**Sun1**, **Sun2**, and **Sun3**).

$$\sum_{i \in Tist} x_{i,r,k} \leq 1, \quad k \in \{Sat2,Sat3,Sun2,Sun3\} \quad (22)$$

$k \in \{Sat2,Sat3,Sun2,Sun3\}$: The set of time slots on Saturday (2nd and 3rd time slots) and Sunday (2nd and 3rd time slots).

This constraint ensures that in a given round, at most one Istanbul-based team can be scheduled to play in each of the following time slots: Saturday (2nd and 3rd time slots) and Sunday (2nd and 3rd time slots).

$$\sum_{i \in T_{tophome}} x_{i,r,k} \leq 1, \quad k \in \{Sat2,Sat3,Sun2,Sun3\} \quad (23)$$

$T_{tophome}$: The set of home teams.

This constraint ensures that in a given round, at most one home team can be scheduled to play in each of the following time slots: **Saturday** (2nd and 3rd time slots) and **Sunday** (2nd and 3rd time slots).

4.3.2.1.3. Assignment Constraints:

For each of these constraints:

$$X_{i1,r,d} - X_{i2,r,d} = 0, \quad d \in DS2 \quad (24)$$

Where:

$X_{i1,r,d}$, $X_{i2,r,d}$: Decision variables indicating whether teams i_1 and i_2 are scheduled to play in the same time slot ***d*** during round ***r.***

$d \in DS2$: The time slots in the set which could be specific days or time slots such as Friday, Saturday, Sunday or other predefined match times.

i_1, i_2 : The indices represent specific teams.

$$X_{3,r,d} - x_{10,r,d} = 0, \quad d \in DS2 \quad (25)$$

This ensures that if **team 3** is scheduled to play on day d, then **team 10** must also be scheduled on the same day and time slot. Week 1 Match: This aligns with their scheduled match 8/11/2023 at 21:00 (evening).

$$\mathbf{X_{14,r,d}-x_{1,r,d}=0,\ d\in DS2} \quad (26)$$

This ensures that if **team 14** is scheduled to play on day d, then **team 1** must also be scheduled on the same day and time slot. Week 1 Match: This aligns with their scheduled match 8/12/2023 at 21:45 (evening).

$$\mathbf{X_{19,r,d}-x_{15,r,d}=0,\ d\in DS2} \quad (27)$$

This ensures that if **team 19** is scheduled to play on day d, then **team 15** must also be scheduled on the same day and time slot. Week 1 Match: This aligns with their scheduled match 8/12/2023 at 21:45 (evening).

$$\boldsymbol{X_{5,r,d}-x_{17,r,d}=0,\ d\in DS2} \quad (28)$$

This ensures that if **team 5** is scheduled to play on day d, then **team 17** must also be scheduled on the same day and time slot. Week 1 Match: This aligns with their scheduled match 8/12/2023 at 19:15 (evening).

$$\boldsymbol{X_{16,r,d}-x_{20,r,d}=0,\ d\in DS2} \quad (29)$$

This ensures that if **team 16** is scheduled to play on day d, then **team 20** must also be scheduled on the same day and time slot. Week 1 Match: This aligns with their scheduled match 8/12/2023 at 19:15 (evening).

$$\boldsymbol{X_{2,r,d}-x_{11,r,d}=0,\ d\in DS2} \quad (30)$$

This ensures that if **team 2** is scheduled to play on day d, then **team 11**must also be scheduled on the same day and time slot. Week 1 Match: This aligns with their scheduled match 8/13/2023 at 21:45 (evening).

$$\boldsymbol{X_{7,r,d}-x_{13,r,d=}0,\ d\in DS2} \quad (31)$$

This ensures that if **team 7** is scheduled to play on day d, then **team 13** must also be scheduled on the same day and time slot. Week 1 Match: This aligns with their scheduled match 8/13/2023 at 19:15 (evening).

$$\boldsymbol{X_{12,r,d}-x_{9,r,d}=0,\ d\in DS2} \quad (32)$$

This ensures that if **team 12** is scheduled to play on day d, then **team 9** must also be scheduled on the same day and time slot. Week 1 Match: This aligns with their scheduled match 8/13/2023 at 21:45 (evening).

$$\boldsymbol{X_{18,r,d}-x_{6,r,d}=0,\ d\in DS2} \quad (33)$$

This ensures that if **team 18** is scheduled to play on day d, then **team 6** must also be scheduled on the same day and time slot. Week 1 Match: This aligns with their scheduled match 8/14/2023 at 21:00 (evening).

$$x_{8,r,d} - x_{4,r,d} \tag{34}$$

This ensures that if **team 8** is scheduled to play on day d, then **team 4** must also be scheduled on the same day and time slot. Week 1 Match: This aligns with their scheduled match 8/14/2023 at 21:00 (evening)

4.3.2.1.4. Additional Constraints:

Additional constraints define specific scheduling requirements and restrictions for certain teams. These constraints incorporate specific scheduling requirements for teams with external obligations (**international or European matches).** The overall aim is to create a fair fixture while adapting to specific situations.

$$\mathbf{x_{1,r,Tuesday}=1} \tag{35}$$

This constraint requires Galatasaray to play on Tuesday, August 8, due to its European match.

$$\mathbf{x_{2,r,Thur}=1} \tag{36}$$

This constraint requires Fenerbahce to play on Thursday, August 10, due to its European match.

$$\mathbf{x_{6,r,Thur}=1} \tag{37}$$

This constraint requires Besiktas to play on Thursday, August 10, due to its European match.

$$\mathbf{x_{12,r,Thur}=1} \tag{38}$$

This constraint requires Adana Demirspor to play on Thursday, August 10, due to its European match.

$$\sum_{d \in CD} \mathbf{x_{i,r,d}=1,\ i=1,\ldots, I\ \&\ \neq \{1,2,6\}} \tag{39}$$

This constraint ensures that all other teams (excluding Galatasaray, Fenerbahce, and Besiktas) play only once during the week, on an appropriate day.

4.3.3. Model Testing and Optimization

- Objective: Translate the mathematical model into AMPL code. Validate and optimize the scheduling model using real-world data.
- Methods:
  - Encode objective functions and constraints in AMPL.
  - Debug and verify the code to ensure accuracy and efficiency.

4.3.4. Evaluation and Reporting of Results

- Objective: To assess the model's effectiveness and report final outcomes.
- Methods:

- Sensitivity analysis
- Percentage improvement

4.3.5. **Presentation and Stakeholder Engagement**

- Objective: Document the project outcomes and prepare a presentation for stakeholders.

- Methods:
  - Compile findings into a report and format them into an academic article.
  - Present results to stakeholders, emphasizing improvements over existing schedules.

4.4 Overall Project Block Diagram:

A general block diagram showing the data flow, work packages, and project output for the Turkish Super League Fixture Scheduling Project can be seen in Appendix "4. Scope Of The Project and Experiments/Methods" .

5. PROJECT TARGETS AND SUCCESS CRITERIA:

The pivotal target of this project is to construct an efficient and fair timetable environment for the Turkish Super League by utilizing a nonlinear binary integer programming (BIP) approach. This method addresses common scheduling issues in an effort to guarantee a fair distribution of match days and times for all clubs. By incorporating a data-driven approach, the project aims to reduce scheduling disparities commonly present in the Turkish Football Federation's conventional, manually created schedules — prompting a fairer competitive environment. By carefully assigning match days and time segments (noon, afternoon, and evening), the system will assist in developing a balanced calendar that not only promotes equity for teams but also elevates the league's standard and level of competition for fans and other stakeholders.

The project's success is predicated on precise, quantifiable standards established for every work package (WP), ensuring a methodical approach to creating an ideal scheduling strategy for the Turkish Super League.

WP1: Data collection and analysis

Objective: To collect, validate, and analyze historical match data from the Turkish Super League, national competitions, and European leagues to serve as the foundation for optimization.

Success criteria:

- **Data completeness:** Collect and validate data for the past season, achieving 100% accuracy (from two independent sources such as TFF, UEFA, and FIFA).

- **Data integrity:** All relevant match variables (date, time slot, teams, match distribution, tournament type) must be accurately documented with no missing values.

- **Data organization:** Organize data into a structured Excel file (as shown in Appendix, Tables 5 and 6), ensuring compatibility with AMPL modeling.

How success criteria were met:

- The success criterion was met by creating 100% accurate Excel tables using data from the official TFF website.

WP2: Model development

Objective: To develop a nonlinear BIP model that optimizes fixture scheduling based on fairness constraints such as team rest and match day distribution.

Success criteria:

- **Model constraints:** The model must include at least seven core constraints, including Team Availability, Fixture Duration, Tournament Alignment, Uncertainty, Day Distribution, Part of the Day, and Fairness.

- **Fairness validation:** The model must reduce deviations from TFF' manual solution and ensure equitable match day and time slot allocation.

How success criteria were met:

- Code was completed for the 38 weeks schedule and run without violating any constraints, giving exact team matching with TFF manual but different days and time slots for a more optimum schedule, thus attaining less deviation *(objective function close to zero)*.

WP3: Model testing and optimization

Objective: To validate and refine the model using real historical data and evaluate whether it produces fairer schedules than TFF's current method.

Success criteria:

- **Improvement over TFF schedules:** Achieve at least 70% improvement in fairness metrics such as rest balance and time slot distribution by conducting sensitivity analysis.

How success criteria were met:

- The results of 38 weeks showed that the deviations of the fixture suggested by the model was closer to zero compared to TFF's manual assignments' results. Thus, success criterion was achieved by creating a more optimum fixture compared to manual assignment, which are given in Table 7, in the appendices.

WP4: Evaluation and reporting of results

Objective: To evaluate the effectiveness of the model, compare it to traditional methods, and compile a clear, academically rigorous report.

Success criteria:

- **Report quality:** The report must meet academic publishing standards with detailed documentation.

- **Peer review:** Obtain feedback from at least one external reviewer (e.g., project advisors or faculty).

How success criteria were met:

- Final evaluation and peer feedback conducted after generating the full schedule and completing the analysis of results.

WP5: Presentation and stakeholder engagement

Objective: To present results to stakeholders such as TUBITAK, Turkish Football Federation, and academic peers to obtain feedback and support.

Success criteria:

- **Academic/industry impact:** Presentation or article must be suitable for submission to an academic journal or sports optimization conference.
- **Model adoption:** The model should be considered for real-world implementation by TFF.

How success criteria were met:

- Final evaluation will be done after TUBITAK 2209-A.

Overall project success criteria

- **Improved fairness:** The final model must show at least 70% improvement in fairness metrics over TFF's schedule.
- **Publishable results:** Produce a formal report or article demonstrating how the methodology improves fixture fairness.
- **Real-world impact:** Deliver a scalable and replicable fixture planning method applicable to other leagues.

6. PROJECT MANAGEMENT RISKS AND B PLANS:

Work Package #	Risk	Occurred or Not?	B-Plan
WP1 Data Collection and Analysis	Data inconsistencies or missing values from the TFF website could result in incomplete or inaccurate datasets.	Risk did not occur.	Conduct thorough cross-checking of match data with secondary sources and implement automated data validation tools in order to identify and correct inconsistencies.
WP2 Mathematical Model Development	Difficulty in defining all objective functions and constraints to align with fixture optimization goals and league rules.	Risk did not occur.	Perform iterative validation by consulting experts and testing smaller sub-models to ensure accuracy and compliance with league requirements before integrating into the full

			model.
WP3 AMPL Code Implementation	Errors or inaccuracies in coding objective and constraint functions, leading to incorrect results.	Risk did not occur.	Conduct multiple code reviews and validation tests by team members separately so that if one of team members does not notice the fault, another one can capture it. Also, using test cases with known outcomes to debug and verify correctness of the written code.
WP3 AMPL Code Implementation	Data loss or incorrect data usage in the interconnected, consecutive and progressive week analyses during model coding	Risk occurred. The team realized this from the inconsistency of the results. They checked the data and code again. The error in the result was detected due to a shift in the data. It was corrected and continued.	Iteratively checking the accuracy of the code by different individuals within the group
WP4 Model Testing and Optimization	Model accuracy does not meet the required 95% threshold due to unforeseen complexities or missing data in the test cases.	Risk occurred. The team realized this and checked the code again. The error in the code was corrected and continued. All week's input and output analysis was conducted again.	Perform sensitivity analysis on input parameters to identify weak areas, modify the model iteratively.
WP5 Reporting and Presentation	Results may not be communicated effectively or comprehensively, leading to misunderstanding or reduced impact of the findings.	Risk did not occur.	Conduct multiple internal reviews of the report and presentation drafts, incorporating feedback from team members and team advisors to promote clarity and adherence to academic and professional standards.

7. WORK TIME PLAN OF THE PROJECT:

WP No	Name and Objectives of Work Packages	By Whom It Will Be Performed	Time Range (..-.. Month)	Success Criteria and Contribution to Project Success	Performed By Whom	Completion Rate

1	**Data Collection and Analysis** **Objective**: Collect and process match data from Turkish leagues, national matches, and European competitions.	• Hatice Sena Kulak • Hilal Sönmez • Zeki Gür • Esmanur Aytaş •Amjed Mohammed Ahmed Abdelhamid	0-6	Accurately and completely recording all matches into the file based on criteria such as week, day, part of the day, and team. Ratio of Contribution to Project Success: 20%	• Hatice Sena Kulak • Hilal Sönmez • Zeki Gür • Esmanur Aytaş •Amjed Mohammed Ahmed Abdelhamid	100%
2	**Mathematical Model Development** **Objective**: Create an integer programming model for fixture optimization.	• Hatice Sena Kulak • Hilal Sönmez • Zeki Gür • Esmanur Aytaş •Amjed Mohammed Ahmed Abdelhamid	6-7	Defining the model, objective, and constraint equations accurately and completely in alignment with fixture optimization goals. Ratio of Contribution to Project Success: 20%	• Hatice Sena Kulak • Hilal Sönmez • Zeki Gür • Esmanur Aytaş •Amjed Mohammed Ahmed Abdelhamid	100%
3	**AMPL Code Implementation** **Objective**: Translate the mathematical model into AMPL code.	• Hatice Sena Kulak • Hilal Sönmez • Zeki Gür • Esmanur Aytaş •Amjed Mohammed Ahmed Abdelhamid	8-14	Ensuring that the objective and constraint functions are correctly implemented into the AMPL code file. Ratio of Contribution to Project Success: 25%	• Hatice Sena Kulak • Hilal Sönmez • Zeki Gür • Esmanur Aytaş •Amjed Mohammed Ahmed Abdelhamid	100% (38 weeks of the 38 weeks schedule was completed)
4	**Model Testing and Optimization** **Objective:** Validate and optimize the scheduling model using real-world data.	• Hatice Sena Kulak • Hilal Sönmez • Zeki Gür • Esmanur Aytaş •Amjed Mohammed Ahmed Abdelhamid	15-25	Achieving a model accuracy of 95% or higher when executed in the program, reviewing error margins, and enhancing model accuracy through necessary modifications. Ratio of Contribution to Project Success: 20%	• Zeki Gür • Hilal Sönmez • Hatice Sena Kulak • Esmanur Aytaş •Amjed Mohammed Ahmed Abdelhamid	100% (38 weeks of the 38 weeks schedule was completed)

5	**Reporting and Presentation** **Objective:** Document the project outcomes and prepare a presentation for stakeholders.	• Hatice Sena Kulak • Hilal Sönmez • Zeki Gür • Esmanur Aytaş •Amjed Mohammed Ahmed Abdelhamid	0-28	Complete reporting of the model's outputs, processes, and analyses in an article format that is understandable, comprehensive, and complies with academic standards. Ratio of Contribution to Project Success: 15%	• Zeki Gür • Hilal Sönmez • Hatice Sena Kulak • Esmanur Aytaş •Amjed Mohammed Ahmed Abdelhamid	100%

8. DEMO PLAN:

The code ran for 38 weeks, and as part of the demo plan, as an example the output of the 10th week is provided in the Appendix under the section titled “Output of the 10 Week.”

As shown in the matrices, each one is named using the decision variable format match_day[i,j,d], where i represents a team, j denotes the opposing team that team i is scheduled to play against, and d corresponds to one of eight predefined time slots. These time slots are categorized as follows: Friday, Saturday noon, Saturday afternoon, Saturday evening, Sunday noon, Sunday afternoon, Sunday evening, and Monday.

To interpret the results, we examine the matrices by checking their intersection points. Wherever the number “1” appears, it indicates that a match is scheduled between team i and team j during time slot d. For instance, the matrix [*,*,4] represents matches scheduled for Saturday evening.

According to the matrix for the 10th week, the following matches are scheduled:

Teams (1–9) and (17–13) played on Friday,
Teams (7–8) played on Saturday noon,
Teams (10–4) played on Saturday afternoon,
Teams (14–15) played on Saturday evening,
Teams (5–20) played on Sunday noon,
Teams (3–18) and (12–16) played on Sunday afternoon,
Teams (6–11) and (19–2) played on Sunday evening.

When compared to the Turkish Football Federation (TFF) schedule, only the matches between (18–3) and (19–2) match exactly with the AMPL-generated schedule. According to the TFF schedule:

Matches (5–20) and (15–14) were played on Friday evening,
(9–1) on Saturday evening,
(8–7) on Saturday afternoon,
(12–16) on Saturday evening,
(10–4) and (17–13) on Sunday evening,
(6–11) on Monday evening.

This comparison highlights both the functionality of the model and its deviations from the actual TFF schedule. However, the Objective Function produces three different output values: total_deviation, objective_func_part1, and objective_func_part2. The relationship between these values is as follows: total_deviation = objective_func_part1 + objective_func_part2.

Objective_func_part1 performs an analysis based on historical data and measures how much teams deviate from the ideal matchday distribution. Objective_func_part2 calculates the amount of deviation that occurs according to eight different time slots, and the goal is for this value to sum up as close to zero as possible. As explained in the "2.1.1 Objective Function" section, two variables, c1 and c2, were assigned as coefficients. To perform sensitivity analysis, these coefficients were changed and AMPL and TFF fixtures were re-run and objective functions were compared. In all cases c1=1 c2=1, c1=1 c2=0.5, c1=0.5 c2=1, TFF gave higher results. In other words, AMPL results were closer to zero in all of them.

In addition, changed c1 and c2 coefficients are compared within themselves as AMPL and TFF. It is clearly seen that the c1=0.5 c2=1 coefficient gives minimum values for both AMPL optimal result and TFF result, in other words, it is closer to zero. Since sensitivity analysis is aimed in the study, the effect of c1 and c2 coefficients was observed and only 3 different scenarios were applied.

When coefficients were changed, results were changed accordingly. The table is given in the Appendix section as "8. Demo Plan, Table 7, Percentage Improvement". It cannot be concluded that these values give the closest result to zero. In order to be an example Mod and Run files for 10th week were included in the appendices demo plan section.

9. FINANCIAL EVALUATION:

In some scenarios, the student version of AMPL was insufficient, and therefore the simulations were carried out using the facilities provided by the university and our personal computers. The annual license fee for AMPL is 2,750 TL (approximately 80 USD).

10. (PRELIMINARY) RESULTS:

Since there is no published study in the literature that includes a fixture optimization for the 2023–2024 Turkish Football Federation (TFF) season, our preliminary results have been compared directly with the official fixture data published by the TFF. The team pairings and time slots from our model's output, along with the original TFF data, are presented in the Appendix under the section titled "10. Preliminary Results" as Table 8 and Table 9.

Below is a 10th week example of the match schedule output produced by our optimization model:

Matches	Time Slots	
(17-13), (9-1)	1	Friday
(8-7)	2	Saturday Noon
(10-4)	3	Saturday Afternoon
(15-14)	4	Saturday Evening
(5-20)	5	Sunday Noon
(12-16), (18-3)	6	Sunday Afternoon
(19-2), (6-11)	7	Sunday Evening
-	8	Monday

When compared with the manually created TFF schedule (Tables 7 and 8), it is observed that all match pairings are consistent with the actual schedule, with the only differences arising in the assigned time slots. This is an expected and desired outcome, as our model focuses on optimizing time slot allocation based on fairness and operational constraints. For instance, while the TFF scheduled the

match between team 5 (Kasımpaşa) and team 20 (Istanbulspor) on Friday evening, our optimized result assigned this match to Sunday noon, better aligning with the model's fairness and distribution criteria.

This comparison demonstrates that our model produces valid and feasible fixtures while enhancing time slot distribution according to defined constraints. As described in Section 2.1, the model incorporates realistic constraints derived from real-life considerations, ensuring the feasibility of implementation.

Furthermore, the model executed flawlessly without violating any constraints and thus confirms the doability and practicality of the proposed optimization framework. There are no technical or conceptual barriers that would prevent the TFF from applying this model in real-world settings to improve fixture fairness and efficiency.

Throughout this process, we received continuous support from our project advisor, Assoc. Prof. Dr. Yasin Göçgün. He played a crucial role in guiding us through the formulation of the constraints, objective function, and the development of the optimization code, helping us focus on critical milestones and refine our methodology.

11. DISCUSSION:

As stated in Section 5, 5 work packages were determined. Success criteria were established with respect to these work packages. In this section, it will be discussed whether the success criteria were met or not.

Success Criteria for WP1: Data Collection and Analysis:

- Data Completeness: All related data has been collected from past season acquiring 100% data accuracy (from two independent sources as TFF, UEFA and FIFA).
- Data Integrity: All relevant match variables, including time slots (such as noon, afternoon, and evening), teams, match distribution, and tournament type, have been accurately documented with no missing values.
- Data Organization: Data has been organized into a structured Excel file, ensuring it is readily compatible for processing and modeling in the AMPL environment.

Success Criteria for WP2: Model Development:

- Model Constraints: The model has incorporated at least 7 core constraints, which are provided as an example in 2.1. Creation of Nonlinear BIP - Explanation for Fixture Optimization of Week 1
- Fairness Validation: An essential goal of the model which was reducing variation from the TFF's traditional fixture was secured with the help of proposed code structure.

Success Criteria for WP3: Model Testing and Optimization:

- Improvement over Existing (TFF) Schedules: Achieved at least 70% improvement in fairness metrics such as rest times and time slot balance with respect to the manually created TFF schedules which are given in Table 7, in the appendices.

Success Criteria for WP4: Evaluation and Reporting of Results:

- Report Quality: The report compatibility with academic publication standards, clear, detailed documentation of methodology, findings, and conclusions are assessed.
- Peer Review: Report has been perfectly submitted and reviewed by at least one external expert (In current case for graduation project, professors from department regarded as external expert) to validate the findings and ensure the model's robustness.

Success Criteria for WP5: Presentation and Stakeholder Engagement:

•All success criteria which were defined previously for this work package were ensured. The proposed project has been accepted by the project academic advisor and the relevant evaluation board within the scope of the TÜBİTAK 2209-A project.

12. ASSESSMENT OF ENGINEERING STANDARDS:

When creating an optimized and fairly distributed match schedule for the Turkish Super League, adhering to internationally recognized standards ensures that the project is strong, dependable, and efficient. The following standards are critical to achieving the project objectives and improving the overall quality, safety, and environmental impact of the league's operations:

1. ISO 9001: Quality Management Systems

Implementing a Quality Management System provides a systematic and process-oriented approach to project development. This standard is critical to achieving consistency in fixture planning outputs and meeting stakeholder expectations. By applying ISO 9001 principles, the optimization model will increase customer satisfaction by providing a fair and efficient match schedule. In addition, meeting the quality requirements set by the Turkish Football Federation (TFF) will contribute to the success of the project.

Key Benefits:

- ➢ Provides systematic planning and continuous improvement.
- ➢ Meets the requirements of the TFF.
- ➢ Increase customer confidence in the solution.

2. ISO 14001: Environmental Management Systems

ISO 14001 focuses on reducing the environmental impact of league operations by encouraging sustainable practices. As a result of the optimal time slot assignments, fan attendance on match days will increase. This will also allow for the current flights and buses to be filled. This will reduce the average per capita emissions. In addition, the average per capita emissions will decrease with the high fan attendance of the match day expenses already incurred by the team, and in addition, teams will earn more income with the same average emissions.

Key Benefits:

- ➢ Encourages sustainability in match planning.
- ➢ Reduces the environmental impact of league operations.

3. ISO 45001: Occupational Health and Safety Management Systems

This standard ensures that the project complies with occupational health and safety considerations. In the context of fixture planning, the health and safety of players and fans should be a priority. Appropriate planning that allows for adequate rest periods between matches can minimize the risk of injury to players. In addition, allocating matches to appropriate time slots can improve the safety and well-being of both players and fans.

Key Benefits:

- ➢ Reduces injury risks by optimizing rest periods.

- ➢ Increase the safety of players and fans.

4. IEEE Standards for Software or Hardware

This standard provides guidance for the creation and execution of both hardware and software components of the project. By obeying IEEE standards, the current model's robustness and usability is enhanced by boosting its technical reliability and compatibility.

- ➢ Checking model robustness and usability for users.

5. ISO 8000: Data Quality

ISO 8000 Data Quality ensures an international data quality standard. It enables a way to compare the data that is used in previous studies and data that is used in current study.

Key Benefits:

- ➢ Ensures the correct transfer of data, the possibility of data-based errors is reduced when creating fixture scheduling.

6. ISO/IEC 25010: System and Software Quality Requirements

The quality of a system is the degree to which the system meets the stated and implied needs of its various stakeholders and thereby provides value. It asserts that used data and created models will service the needs of customers and stakeholders of the project properly.

Key Benefits:

- ➢ Enhances performance efficiency of the system and software.

The integration of ISO and IEEE standards into the Turkish Super League fixture optimization project increases the quality, reliability and sustainability of the project. These standards ensure that data, software and processes meet the criteria of accuracy, security and environmental responsibility. As a result, a more equitable, efficient and sustainable match planning solution is provided for players, fans and other stakeholders.

13. UNIVERSAL AND SOCIAL EVALUATION OF THE PROJECT/ LIMITATIONS

There are no mathematical or scientific limitations on the life cycle or applicability of the project. The large financial investments made in the football sector, the intense competition between teams and the hooligan attitudes of the fans may be the determining reasons for the limitations. Due to these limitations, there may be resistance from individuals, institutions or stakeholder groups who may prefer traditional planning or have commercial interests that contradict the fairness-oriented optimization.

Since the project does not involve the use of any physical machines or materials, it can be classified as an environmentally friendly digital solution. Although it is based on computation, it can be considered relatively sustainable since it does not use high-energy-consuming technologies such as blockchain or artificial intelligence.

From an academic point of view, it contributes significantly to the literature by addressing a large-scale and complex planning problem. It has the potential to form a basis for future academic studies and is designed to be adaptable to various league structures. Its innovative approach and

potential impact were recognized and supported by TÜBİTAK 2209-A, which provided funding for its development.

Although the model is quite sustainable in theory, its real-world application will depend on institutional willingness and decision-makers. These are not technical barriers, but rather organizational and cultural challenges that can impact adoption.

14. CONCLUSION

The results obtained throughout the study were evaluated alongside the success criteria defined in section 5. The fulfillment of these criteria was discussed, the obtained data were compared with both historical TFF data and proposed model outputs, and the key achievements of the research were clearly identified. The findings in the project reflected the comprehensive outcomes of all defined work packages.

The core objective of this project was to develop a nonlinear binary integer programming (BIP) model to construct a fair and optimized fixture schedule for the Turkish Super League. The model not only scheduled match days but also assigned fixtures to eight specific time slots: Friday, Saturday noon, Saturday afternoon, Saturday evening, Sunday noon, Sunday afternoon, Sunday evening, and Monday. Within the AMPL environment, teams were numerically encoded (e.g., 3 = Trabzonspor) to facilitate the mathematical formulation.

The objective function aimed to minimize scheduling deviations, promoting equitable time slot distribution across all rounds of the season. To achieve this, a total of 31 constraints were defined based on the operational needs of key stakeholders such as clubs, UEFA, TFF, and fans.These include:

1. Feasibility constraints, ensuring minimum rest periods,
2. Assignment constraints, allowing the fixture to follow a valid home/away structure,
3. Additional constraints for teams involved in international competitions.

The AMPL model was implemented by integrating these constraints with the objective function, and the code was executed for 38 weeks. The results were then compared to official TFF fixtures, demonstrating that the model correctly matched all team pairings. The Dd^2 metric was used to assess daily match distribution by calculating squared deviations from ideal values, and the V-metric captured fairness in round-specific time slot allocations.

As a result, after running all weeks of TFF manual and proposed AMPL code, sensitivity analysis was conducted so as to compare and measure total deviations. As seen in Table 7, given in the appendix section, different c1 and c2 values which are located respectively in the part 1 and part 2 of the objective function were altered for different scenarios. In all trials, the proposed AMPL model gave more optimal results -which means deviations closer to zero- than TFF's manual model. When c1=1 and c2=1 for both TFF model and in the proposed AMPL model, 72% improvement were ensured. When c1=1 and c2= 0,5 for the proposed AMPL model, and c1=1 and c2= 0,5 for the TFF model, the percentage improvement was 78%. Lastly, when c1=0,5 and c2= 1 for the proposed AMPL model, and c1=0,5 and c2= 1 for TFF model, percentage improvement was calculated as 74%. Consequently, among three different scenarios, the proposed AMPL model gave a more optimal result compared to the TFF manual model. The best scenario for the proposed AMPL model was c1=1 and c2= 0,5 with 78% improvement. These findings confirm that the developed model effectively achieves its primary goals and demonstrates strong potential for real-world implementation.

15. PLAN FOR FUTURE STUDIES:

Our project has been successfully completed using two nonlinear integer programming for the fair distribution of the Turkish Super League. This project will form a basis and foundation for future studies. Our project, which has been awarded support within the scope of TUBITAK 2209-A projects, after being awarded, processes continued with the modification of the c1 and c2 coefficients. Project output conducted on a weekly basis. Technically, the code can be run in one file instead of subsequently running 38 week one-by-one. Additionally, in the next steps, sensitivity analysis can be conducted through different scenarios of c1 and c2 values, and the total deviation will be examined in more detail accordingly. The next important step can continue as the dynamic planning of matches that cannot be played due to unforeseen events such as postponed matches, international conflicts or weather events. In addition, it can be aimed to contribute to more sustainability of the project by adding environmental and logistical constraints. In the future, with the deepening of the studies, the academic article can be prepared for national and international conferences.

16. ASSESSMENT OF ENGINEERING COURSES:

1. Introduction to Modelling and Optimization: This course aims to teach us how we can clearly define and formulate the objective function which can be either minimizing or maximizing and defining its constraints and decision variables of any linear programming model. In addition, in this project we aim to optimize the Turkish super league scheduling hence, the optimization seeks to find all the values of the decision variables that optimize our objective function that satisfy our constraints.

2. Network Flows and Integer Programming: This course specializes in how we can write and formulate the objective function which can be either minimizing or maximizing and defining its constraints and decision variables of any binary integer programming which facilitated and guided us in our project for defining the objective function which is minimizing the deviations in match scheduling for Turkish super league.

3. Advanced Operational Research: This course specializes in how we can write and run any linear or nonlinear binary integer programming model using AMPL programming language. Firstly, we need to encode the objective function and decision variables and constraints in order to run our mathematical model. The benefit of AMPL is that it can identify the errors that can appear in our model code which makes it easier to debug the code. So, the code testing process is crucial to us to ensure the accuracy of optimization of the Turkish super league scheduling.

4. Applied Statistics: This course taught us the basics and importance of using Microsoft Excel to store the data collection for each team in the league and the matches of each round that we have collected from the TFF website. To guarantee the success of our project these data should be verified and must be completed in order to start working on our project to avoid any mistakes that can happen during the building of our model process. Also, we learned some tools that we can calculate and analyze the frequency for each week in the Turkish super league.

5. Quality Engineering: In this course we learned some important quality tools that can ensure the success of our project, make the stockholders satisfied, and meet all the requirements from the TFF. Also, we can figure out all the challenges that can face us such as the risk of the poor-quality data which can lead to increase the failure of our project hence, it's important to use quality tools such as flow charts and control charts to figure out these risks to avoid them to make an effective match scheduling.

6. Project Management: In this course we learned that the most important factor for making our project successful is how we should manage and develop a thought-out plan for the risks that can face us during the project period. Also, we need to put start and end points to avoid any lateness to make the project ready.

7. Strategic Management: In this course we learned the importance of strategic leadership and we should have some techniques to help our teamwork to achieve the goal of our project. Also understanding the situations and discussing them together leads to taking the best decisions for the project. One of the most important techniques is to make SWOT analysis to identify the strengths, weaknesses, opportunities, and threats for optimizing the Turkish super league scheduling. After identifying these components then it will be easy for us to make an effective match scheduling.

8. Cost Analysis: This course taught us the importance of making a financial statement to check the necessary items that we need in our project. Also, we made a cost analysis to show the potential savings from building the optimizing scheduling. Reducing the costs of transportation, traveling, and attending the matches gave us a good impression on our project.

9. Engineering Economics: In this course we learned how the economy and inflation can affect the league, so it is important to analyze and know the reasons that cause the economy to deteriorate. To solve these problems, we learned some tools such as cost-volume-profit analysis and break-even analysis and the importance of them then we will be able to revitalize the economy. Thereafter we will be able to set the ticket prices for attending the matches and make them suitable for segments of society which lead to an increase in the percentage of people attending the matches.

In conclusion, after we studied these beneficials courses during our journey in this college, now we can easily make this project successfully and how we can use each skill that we learn from them to create an optimized and effective match scheduling for Turkish super league that can improve the quality and increase the efficiency of the league.

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18. PROJECT ACTIVITIES AND WORK PLAN

Table 1 *The Work-Activity Plan for Project 2 ZG: Zeki Gür, HS: Hilal Sönmez, HSK: Hatice Sena Kulak, EA: Esmanur Aytaş, AMAA: Amjed Mohammed Ahmed Abdelhamid*

Work and Activity Project 1	**Responsible Group Member**	**Timeline**													
		1. week	**2. week**	**3. week**	**4. week**	**5. week**	**6. week**	**7. week**	**8. week**	**9. week**	**10. week**	**11. week**	**12. week**	**13. week**	**14. week**
1.Creation of Project Group	ZG,HS,HSK,ES,AMAA	X													
2. Research about the Project Topic	ZG,HS,HSK,ES,AMAA		X	X											
3. Data Collection	ZG,HS,HSK,ES,AMAA			X	X	X									
4. Literature Review	ZG,HS,HSK,ES,AMAA				X	X	X								
5.Creation of Mathematical Model							X	X							
6. AMPL Code Discussion	ZG,HS,HSK,ES,AMAA								X	X					
7. Creation of the AMPL Code Process	ZG,HS,HSK,ES,AMAA									X	X				
8. Testing and Debugging the AMPL Code	ZG,HS,HSK,ES,AMAA											X	X	X	X
9. Meeting with Advisor	ZG,HS,HSK,ES,AMAA	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Table 2 *The Work-Activity Plan for Project 2 ZG: Zeki Gür, HS: Hilal Sönmez, HSK: Hatice Sena Kulak, EA: Esmanur Aytaş, AMAA: Amjed Mohammed Ahmed Abdelhamid*

Work and Activity Project 2	**Responsible Group Member**	**Timeline**													
		15. week	16. week	17. week	18. week	19. week	20. week	21. week	22. week	23. week	24. week	25. week	26. week	27. week	28. week
10.Testing Partial Data Input and Output Generation (10 Weeks)	ZG,HS,HSK,EA,AMAA	X	X												
11.. Data Input and Output Generation (38 Weeks)	ZG,HS,HSK,EA,AMAA			X	X	X	X								
12. Fairness Metric Calculation for Selected Weeks and Optimization	ZG,HS,HSK,EA,AMAA							X	X						
13. Percentage Improvement and Comparison with Manual TFF Schedule	ZG,HS,HSK,EA,AMAA									X	X	X			
14. Visualization of Results (Charts, Tables)	ZG,HS,HSK,EA,AMAA												X	X	X

15. Report Writing (Methodology, Findings, Code Details)	ZG,HS,HSK,EA,AMAA	X	X	X	X	X	X	X	X	X	X	X	X	X	X
16. Meeting with Advisor	ZG,HS,HSK,ES,AMAA	X	X	X	X	X	X	X	X	X	X	X	X	X	X

16.1 LIST OF WORK PACKAGES

Table 3 *Detailed Definition of Work and Activity*

WP No	Detailed Definition of Work and Activity
1	Data Collection and Analysis ● Objective: Collect and process match data from Turkish leagues, national matches, and European competitions. ● Methods: - Retrieve match data (date, time, teams, and venue) from the Turkish Football Federation website. - Organize data into an Excel file, ensuring it is complete and accurate for coding.
2	Model Development ● Objective: Create an integer programming model for fixture optimization. ● Methods: - Formulate objective functions to minimize deviations in matchday distribution and ensure fairness. - Incorporate constraints like team rest periods, home/away balance, and TV broadcasting slots.
3	Model Testing and Optimization ● Objective: Translate the mathematical model into AMPL code. Validate and optimize the scheduling model using real-world data. ● Methods: - Encode objective functions and constraints in AMPL. - Debug and verify the code to ensure accuracy and efficiency. - Test the model with historical data and analyze performance. - Make necessary adjustments to improve accuracy and reduce error rates
4	Evaluation and Reporting of Results ● Objective: To assess the model's effectiveness and report final outcomes. ● Methods: - Sensitivity analyses - Percentege improvement

5	Presentation and Stakeholder Engagement ● Objective: Document the project outcomes and prepare a presentation for stakeholders. ● Methods: - Compile findings into a report and format them into an academic article. - Present results to stakeholders, emphasizing improvements over existing schedules.

Table 4 *Work package targets, their assessment, and the contribution of each work package to the overall project success.*

Work package	**Target**	**Measurable outcome**	**Contribution to overall success(%)**
WP1: Data Collection and Analysis	Achieving 100% data accuracy (from two independent sources such as TFF and UEFA)	EXCEL file	20%
WP2: Model Development	The model must minimize deviations from ideal schedules while ensuring equitable allocation of match days	AMPL Sensitivity analyses.	20%
WP3: Model Testing and Optimization	Achieve 70% improvement in fairness metrics	AMPL Sensitivity analyses.	30%
WP4: Evaluation and Reporting of Results	The report must meet academic publication standards, providing clear, detailed documentation of methodology,findings,and conclusions.	Compatibility with the published literature standards.	30%
WP5: Presentation and Stakeholder Engagement	Achieve at least 85% positive feedback from stakeholders	Public opinion poll.	Total:100

Table 5 *The work package distribution to project team members: Who works on which work package? Specify the percentage contributions.*

WORK PACKAGE DISTRIBUTION					
Project Member	WP1	WP2	WP3	WP4	WP5
Zeki Gür	%25	%25	%25	%25	%25

Hilal Sönmez	%25	%25	%25	%25	%25
Hatice Sena Kulak	%25	%25	%25	%25	%25
Amjed Mohammed Ahmed Abdelhamid	%25	%25	%25	%25	%25
Total	100%	100%	100%	100%	100%

19. BUDGET

Table 6 *Proposed Budget in TL*

	ITEMS				
	PEOPLE	MACHINE-INSTRUMENT	MATERIALS	SERVICE	TRAVEL
IMU FUND	X	X	X	80 USD/year	X
SPONSOR COMPANY FUND	X	X	X	X	X
TOTAL	X	X	X	2750 TL /year	X

Table 7 *Actual Budget in TL (what you spent indeed)*

	ITEMS				
	PEOPLE	MACHINE-INSTRUMENT*	MATERIALS*	SERVICE	TRAVEL
IMU FUND	X	X	X	X	X
SPONSOR COMPANY FUND	X	X	X	X	X
TOTAL	X	X	X	X	X

22. APPENDIX

Informative Figure 1.

Team Code	Team Name
1	Galatasaray
2	Fenerbahce
3	Trabzonspor
4	Istanbul Basaksehir
5	Kasımpasa
6	Besiktas
7	Sivasspor
8	Alanyaspor
9	Rizespor
10	Antalyaspor
11	Gaziantep
12	Adana Demirspor
13	Samsunspor
14	Kayserispor
15	Hatayspor
16	Konyaspor
17	Ankaragucu
18	Fatih Karagumruk
19	Pendikspor
20	Istanbulspor

2. Literature Review

Table 1.

Topic Titles	Topic	Articles
Tournament Scheduling and Optimization Models	These studies discuss optimization techniques and mathematical models to address challenges in	Optimization in sports league scheduling: experiences from the Belgian Pro League soccer. (Dries Goossens , 2017) , Optimal matchday schedule for Turkish professional soccer league using nonlinear binary integer programming (Yasin Göçgün and Niyazi Onur Bakır, 2022) , Determining the Matchdays for the Turkish Super League using Non-Linear Binary Integer Programming (Yasin Göçgün, Niyazi Onur Bakır , Baba Ali Saleh , 2022) , An

	football leagues and other tournament formats.	Introduction to the National Football League Scheduling Problem using Integer Programming (Amrith Deepak, Benjamin Teo, Yihao Yang) , Scheduling the Professional Ecuadorian Football League by Integer Programming (D. Recaldea,∗, R. Torresa, P. Vacaa , 2013)
Minimizing Rest Inequalities, Breaks and Ensuring Fairness	Methods are proposed to equalize rest periods between teams and ensure a fair competitive environment.	Minimization of rest mismatches in round robin tournaments (Tankut Atan, Burak Çavdaroğlu, 2018), Determining Matchdays in Sports League Schedules to Minimize Rest Differences (Burak Çavdaroğlu, Tankut Atan, 2020) Scheduling the Turkish Super Football League (Hasan Bayrak , 2019) , Sports Scheduling: Problems And Applications (CELSO C. RIBEIRO, 2011) , An Integer Programming Formulation for Scheduling of the Icelandic Football League (Eva Linda Gunnarsdóttir, 2019) ,Scheduling the Australian Football League (Jari Kynga¨s1, Kimmo Nurmi1, Nico Kynga¨s1, George Lilley2, Thea Salter3 and Dries Goossens4*, 2016)
Reducing Imbalances Between Home/Away Matches	Algorithms are suggested to reduce imbalances caused by consecutive home or away games.	Scheduling the Italian Football League: an ILP-based approach (F. Della Croce∗, D. Oliveri, 2006)
Reducing Travel Distances and Managing Logistical Burdens	Techniques to reduce travel distances and ease logistical burdens for teams are discussed.	Scheduling the Main Professional Football League of Argentina (Guillermo Dur´an, Facundo Guti´errez, Mario Guajardo, Javier Marenco, Denis Saur´e, Gonzalo Zamorano, 2021), Scheduling the Turkish Super Football League, (Hasan Bayrak , 2019) Scheduling the English Football League with a Multi-objective Evolutionary Algorithm (Lyndon While1, and Graham Kendall2 , 2014) , /Sports Scheduling: Problems And Applications (CELSO C. RIBEIRO, 2011) , Scheduling the Australian Football League (Jari Kynga¨s1, Kimmo Nurmi1, Nico Kynga¨s1, George Lilley2, Thea Salter3 and Dries Goossens4*, 2016)
Reducing Carry-Over Effects and Improving Team	Models are developed to minimize carry-over effects from previous	Sports Scheduling: Problems And Applications (CELSO C. RIBEIRO, 2011)

Performance	matches, which can impact team performance in future games.	
Round Robin or Double Round Robin	Optimizes tournaments where each competitor takes turns facing the other teams, or both teams face off.	Scheduling the Italian Football League: an ILP-based approach (F. Della Croce*, D. Oliveri, 2006), Scheduling the English Football League with a Multi-objective Evolutionary Algorithm (Lyndon While1, and Graham Kendall2 , 2014) Scheduling the professional soccer leagues of Austria and Germany (Thomas Bartscha, Andreas Drexlc, Stefan Krögerd,2007) Scheduling the South American Qualifiers to the 2018 FIFA World Cup by integer programming (Guillermo Durán, Mario Guajardo, Denis Sauré , 2017) , Integer programming models for round robin tournaments (Jasper van Doornmalen, Christopher Hojny, Roel Lambers, Frits C.R. Spieksma, 2023)
Others	Optimizes by taking other situations into account	Scheduling Sports League Systems with Interleague Restrictions (Jörn Schönberger , 2015) Scheduling the Chilean Soccer League by Integer Programming (Guillermo Durán, Mario Guajardo, Jaime Miranda, Denis Sauré, Sebastián Souyris, Andres Weintraub, Rodrigo Wolf, 2007) The U.S. National Football League Scheduling Problem(Bistra N. Dilkina and William S. Havens)

4. Scope Of The Project and Experiments/Methods

4.3 Experiments/Methods:

1. Data Collection and Analysis

Table 2.

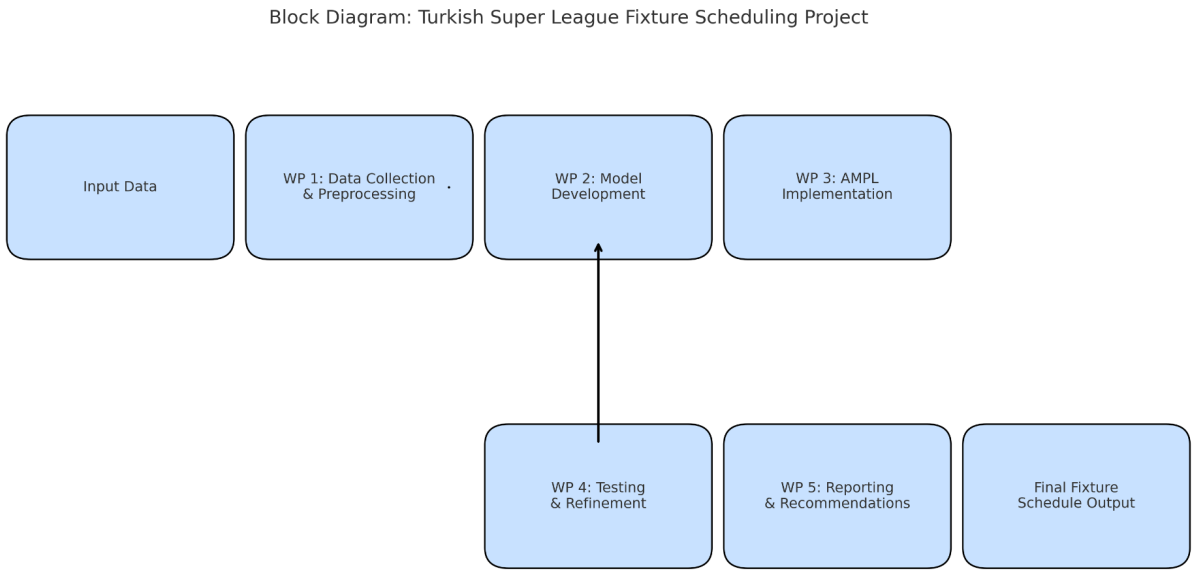
	Friday	**Saturday**			**Sunday**			**Monday**
	Evening	Noon	Afternoon	Evening	Noon	Afternoon	Evening	Evening
Week 1	1	0	0	4	0	0	3	2
Week 2	2	0	0	3	0	0	3	2
Week 3	1	0	0	4	0	0	4	1
Week 4	2	0	0	4	0	0	3	1
Week 5	0	0	2	2	0	2	2	2
Week 6	1	0	2	2	0	2	2	1

Week 7	1	1	2	1	1	1	2	1
Week 8	2	1	1	2	1	1	1	1
Week 9	0	1	2	1	1	1	2	2
Week 10	2	0	1	2	0	1	3	1
Week 11	1	1	1	1	1	2	1	2
Week 12	2	1	2	1	1	2	1	0
Week 13	0	1	2	1	1	2	1	2
Week 14	2	1	1	2	1	1	1	1
Week 15	1	1	1	1	1	2	1	2
Week 16	MATCHES PLAYED ON THE DAYS TUESDAY, WEDNESDAY, THURSDAY							
Week 17								
Week 18								
Week 19	3	1	1	2	1	1	1	0
Week 20	0	2	1	2	1	2	1	1
Week 21	0	1	2	2	1	2	1	1
Week 22	MATCHES PLAYED ON THE DAYS TUESDAY, WEDNESDAY, THURSDAY							
Week 23	0	0	1	1	1	2	1	4
Week 24	3	1	1	2	1	1	1	0
Week 25	1	0	1	1	1	2	1	3
Week 26	1	1	1	1	1	2	1	2
Week 27	1	1	1	2	1	2	1	1
Week 28	1	1	1	2	2	1	1	1
Week 29	1	1	1	2	1	2	1	1
Week 30	2	1	1	2	1	2	1	0
Week 31	MATCHES PLAYED ON THE DAYS TUESDAY, WEDNESDAY, THURSDAY							
Week 32	1	1	1	2	1	2	1	1
Week 33	1	1	1	2	1	0	3	1
Week 34	1	0	2	2	0	2	2	1
Week 35	2	0	1	2	0	1	2	2
Week 36	0	0	0	0	0	0	10	0
Week 37	2	0	0	7	0	0	1	0
Week 38	1	0	1	1	0	0	7	0

Table 3.

PATTERN	FREQUENCY
10040032	1
20030032	1
10040041	1
20040031	1
00220222	1
11211121	1
01211122	1
20120131	1
21211210	1
01211212	1
02121211	1
01221211	1
00111214	1
10111213	1
11122111	1
21121210	1
11121031	1
20120122	1
000000100	1
20070010	1
10110070	1
10220221	2
21121111	2
11111212	3
31121110	2
11121211	3

4.4 Overall Project Block Diagram:
Table 4:



5. Project Targets and Success Criteria:

WP1: Data Collection and Analysis :

Table 5.

Matches		11-14 August			
Home	**Away**	**same_TFF**	**exact dates**	**hours**	**part of the day**
3	10	Friday	8/11/2023	21.00	evening
14	1	Saturday	8/12/2023	21.45	evening
19	15	Saturday	8/12/2023	21.45	evening
5	17	Saturday	8/12/2023	19.15	evening
16	20	Saturday	8/12/2023	19.15	evening
2	11	Sunday	8/13/2023	21.45	evening
7	13	Sunday	8/13/2023	19.15	evening
12	9	Sunday	8/13/2023	21.45	evening
18	6	Monday	8/14/2023	21.00	evening
8	4	Monday	8/14/2023	21.00	evening

Table 6.

European Matches			
Team Name	**Team Code**	**Exact Date**	**Day**
Galatasaray	1	8 August	Tuesday

Fenerbahce	2	10 August	Thursday
Besiktas	6	10 August	Thursday
Adana Demirspor	12	10 August	Thursday

8. Demo Plan:

Run File of 10th Week:

```
model Grad_Project_week_10.mod;
option solver CPLEX;

let I:=20; # There are 20 teams in the Turkish Super League
let R:=2;  # Number of round
let D:=8;  # Number of time slots
let K:=3;  # Tuesday, Wednesday, Thursday

let C_one:=0.5;
let C_two:=1;

let weight[1]:=0.1; let weight[2]:=0.4; let weight[3]:=0.4; let weight[4]:=0.1;

read {i in 1..I, r in 1..R} match_2[i,r] < Grad_Project_Schedule_week_10.txt;

for{i in 1..I, r in 1..R}{let match[i,r,match_2[i,r]] :=1;}

let match_other[1,1,1]:=1;
let match_other[2,1,3]:=1;
let match_other[6,1,3]:=1;

let match_other[5,2,1]:=1;
let match_other[15,2,1]:=1;
let match_other[8,2,1]:=1;
let match_other[20,2,2]:=1;
let match_other[10,2,2]:=1;
let match_other[7,2,3]:=1;
let match_other[11,2,3]:=1;
let match_other[16,2,3]:=1;
let match_other[14,2,3]:=1;

let data_1[1]:=0;let data_1[2]:=0;let data_1[3]:=3;let data_1[4]:=0;let data_1[5]:=1;let data_1[6]:=1;let data_1[7]:=0;
let data_1[8]:=1;let data_1[9]:=1;let data_1[10]:=2;let data_1[11]:=3;let data_1[12]:=1;let data_1[13]:=1;let data_1[14]:=1;
let data_1[15]:=0;let data_1[16]:=2;let data_1[17]:=0;let data_1[18]:=2;let data_1[19]:=0; let data_1[20]:=2;
```

```
let data_2[1]:=8;let data_2[2]:=0;let data_2[3]:=3;let data_2[4]:=3;let data_2[5]:=3;let data_2[6]:=1;let data_2[7]:=4;
let data_2[8]:=2;let data_2[9]:=5;let data_2[10]:=6;let data_2[11]:=4;let data_2[12]:=1;let data_2[13]:=2;let data_2[14]:=5;
let data_2[15]:=3;let data_2[16]:=4;let data_2[17]:=3;let data_2[18]:=1;let data_2[19]:=8; let data_2[20]:=2;

let data_3[1]:=0;let data_3[2]:=7;let data_3[3]:=1;let data_3[4]:=3;let data_3[5]:=5;let data_3[6]:=6;let data_3[7]:=4;
let data_3[8]:=4;let data_3[9]:=3;let data_3[10]:=1;let data_3[11]:=2;let data_3[12]:=4;let data_3[13]:=4;let data_3[14]:=2;
let data_3[15]:=3;let data_3[16]:=2;let data_3[17]:=4;let data_3[18]:=3;let data_3[19]:=1; let data_3[20]:=3;

let data_4[1]:=1;let data_4[2]:=2;let data_4[3]:=2;let data_4[4]:=3;let data_4[5]:=0;let data_4[6]:=1;let data_4[7]:=1;
let data_4[8]:=2;let data_4[9]:=0;let data_4[10]:=0;let data_4[11]:=0;let data_4[12]:=3;let data_4[13]:=2;let data_4[14]:=1;
let data_4[15]:=3;let data_4[16]:=1;let data_4[17]:=2;let data_4[18]:=3;let data_4[19]:=0; let data_4[20]:=2;

let s[1]:=10*3/32;
let s[2]:=10*13/32;
let s[3]:=10*13/32;
let s[4]:=10*3/32;
#13 out of 32 matches will be on Saturday etc.

solve;

display match_day;
display total_deviation;

let objective_func_part1:=

        C_one*(weight[1]* ( sum{i in TEAMS} (sum{j in 1..I:i!=j} match_day[i,j,1]+data_1[i]-s[1])^2) +
                weight[2]* ( sum{i in TEAMS} (sum{j in 1..I:i!=j} (match_day[i,j,2] + match_day[i,j,3] + match_day[i,j,4]) + data_2[i]-s[2])^2 )+
                weight[3]* ( sum{i in TEAMS} (sum{j in 1..I:i!=j} (match_day[i,j,5] + match_day[i,j,6] + match_day[i,j,7]) + data_3[i]-s[3])^2)+
                weight[4]* ( sum{i in TEAMS} (sum{j in 1..I:i!=j} match_day[i,j,8]+ data_4[i]-s[4])^2)
        ) ;

let objective_func_part2:=

        C_two*(  ( (sum{i in TEAMS} sum{j in 1..I:i!=j} match_day[i,j,1])/2 -2)^2 +
```

```
( (sum{i in TEAMS} sum{j in 1..I:i!=j} match_day[i,j,2])/2 -1)^2 +
( (sum{i in TEAMS} sum{j in 1..I:i!=j} match_day[i,j,3])/2 -1)^2+
( (sum{i in TEAMS} sum{j in 1..I:i!=j} match_day[i,j,4])/2 -1)^2 +


( (sum{i in TEAMS} sum{j in 1..I:i!=j} match_day[i,j,5])/2 -1)^2 +
( (sum{i in TEAMS} sum{j in 1..I:i!=j} match_day[i,j,6])/2 -2)^2 +
( (sum{i in TEAMS} sum{j in 1..I:i!=j} match_day[i,j,7])/2 -1)^2 +

( (sum{i in TEAMS} sum{j in 1..I:i!=j} match_day[i,j,8])/2 -1)^2);
```

```
display  objective_func_part1;
display  objective_func_part2;

param total_data_sum{i in TEAMS} := data_1[i] + data_2[i] + data_3[i] + data_4[i];

display total_data_sum;
```

MOD Files of 10th Week:

```
param I;   # number of teams in the Turkish Super League.
param R;   # number of rounds dealt with week 1.
param D;   # time slots (fri, sat1, sat2, sat3, sun1, sun2, sun3, mon)
param K;   # other match days (Tuesday, Wednesday, Thursday)

set TEAMS := 1..I;
set ROUND := 1..R;

set DAYS := 1..D; # {Fri, Sat1, Sat2, Sat3, Sun1, Sun2, Sun3, Mon}
set OTHER_DAYS:= 1..K; # {Tuesday, Wednesday, Thursday}

set TOP_TEAMS := {1,2,3,4,6}; # (Galatasaray, Fenerbahce, Trabzonspor, Basaksehir, Besiktas) (These teams generally plays for top 5.)

set ISTANBUL_HOME_TEAMS := {5,6}; # (These teams will play in the Istanbul as a home teams in week 10.
set TOP_HOME_TEAMS := {6};

param outp_rest{i in 1..I, r in 1..R} default 0;

param match{i in 1..I, r in 1..R, j in 1..I:i!=j} default 0;
param match_previous{i in 1..I, r in 1..R, j in 1..I, d in 1..D :i!=j} default 0;

param match_2{i in 1..I, r in 1..R};

param match_other{i in 1..I, r in 1..(R+1), k in 1..K} default 0;
param match_oth{i in 1..I, r in 1..R} default 0;
```

```
param s{k in 1..7} default 0;
param weight{k in 1..7} default 0;
param C_one;
param C_two;

param data_1{TEAMS} default 0;
param data_2{TEAMS} default 0;
param data_3{TEAMS} default 0;
param data_4{TEAMS} default 0;

param objective_func_part1 default 0;
param objective_func_part2 default 0;

var match_day{i in 1..I,j in 1..I, d in 1..D: i!=j} binary;
minimize total_deviation:

# match_day parametresi bu haftaki maç sayısını, data_1 parametresi geçen haftalardaki maç sayısını,
parametre s ise şu ana kadar oynanması gereken ideal
# maç sayısını verir (cuma için).

C_one*(                 weight[1]* ( sum{i in TEAMS} (sum{j in 1..I:i!=j} match_day[i,j,1] +
data_1[i]-s[1])^2) +
                        weight[2]* ( sum{i in TEAMS} (sum{j in 1..I:i!=j} (match_day[i,j,2] +
match_day[i,j,3] + match_day[i,j,4]) + data_2[i]-s[2])^2 )+
                        weight[3]* ( sum{i in TEAMS} (sum{j in 1..I:i!=j} (match_day[i,j,5] +
match_day[i,j,6] + match_day[i,j,7]) + data_3[i]-s[3])^2)+
                        weight[4]* ( sum{i in TEAMS} (sum{j in 1..I:i!=j} match_day[i,j,8] + data_4[i] -
s[4])^2)) +

C_two*(         ( (sum{i in TEAMS} sum{j in 1..I:i!=j} match_day[i,j,1])/2 -2)^2 +

                        ( (sum{i in TEAMS} sum{j in 1..I:i!=j} match_day[i,j,2])/2 -1)^2 +
                        ( (sum{i in TEAMS} sum{j in 1..I:i!=j} match_day[i,j,3])/2 -1)^2 +
                        ( (sum{i in TEAMS} sum{j in 1..I:i!=j} match_day[i,j,4])/2 -1)^2 +


                        ( (sum{i in TEAMS} sum{j in 1..I:i!=j} match_day[i,j,5])/2 -1)^2 +
                        ( (sum{i in TEAMS} sum{j in 1..I:i!=j} match_day[i,j,6])/2 -2)^2 +
                        ( (sum{i in TEAMS} sum{j in 1..I:i!=j} match_day[i,j,7])/2 -1)^2 +

                        ( (sum{i in TEAMS} sum{j in 1..I:i!=j} match_day[i,j,8])/2 -1)^2 );

# Friday: Targeted number of matches = 2
# Saturday Noon: Targeted number of matches = 1
# Saturday Afternoon: Targeted number of matches = 1
# Saturday Evening: Targeted number of matches = 1
# Sunday Noon: Targeted number of matches = 1
# Sunday Afternoon: Targeted number of matches = 2
```

```
# Sunday Evening: Targeted number of matches = 1
# Monday: Targeted number of matches = 1

subject to Constraint1{i in 1..I,j in 1..I: i!=j}:
sum{d in 1..D} match_day[i,j,d] = match[i,2,j];
ubject to Constraint2{i in 1..I, j in 1..I, d in 1..D: i!=j}:
 match_day[i,j,d] = match_day[j,i,d];
subject to Constraint3{i in 1..I, j in 1..I: i!=j}:
  match_day[i,j,1]*match[i,2,j] + match_day[i,j,2]*match[i,2,j] + match_day[i,j,3]*match[i,2,j] +
match_day[i,j,4]*match[i,2,j] +
        match_day[i,j,5]*match[i,2,j] + match_day[i,j,6]*match[i,2,j] +
match_other[i,1,3]*match[i,2,j] <=1;
subject to Constraint4{i in 1..I, j in 1..I: i!=j}:
  match_day[i,j,1]*match[i,2,j] + match_day[i,j,2]*match[i,2,j] + match_day[i,j,3]*match[i,2,j] +
match_other[i,1,2]*match[i,2,j] <=1;
subject to Constraint6{i in 1..I,j in 1..I: i!=j}:
  match_day[i,j,5]*match[i,2,j] + match_day[i,j,6]*match[i,2,j] + match_day[i,j,7]*match[i,2,j] +
match_day[i,j,8]*match[i,2,j] + match_other[i,2,1]*match[i,2,j] <=1;
subject to Constraint8{i in 1..I, j in 1..I: i!=j}:
 match_day[i,j,8]*match[i,2,j] + match_other[i,2,2]*match[i,2,j] <=1;
subject to Constraint9{i in TOP_TEAMS, k in {2,5}, j in 1..I: i!=j}:  # The purpose of this restriction
is to prevent matches from being played on sat1 and sun1.
 match_day[i,j,k]*match[i,2,j] =0;
subject to Constraint10_a{k in {1,8}}:
 sum{i in ISTANBUL_HOME_TEAMS, j in 1..I: i!=j}  match_day[i,j,k]*match[i,2,j] <= 2;
subject to Constraint10_b:
 sum{i in ISTANBUL_HOME_TEAMS, k in {2,3,4}, j in 1..I: i!=j}  match_day[i,j,k]*match[i,2,j] <=
3;
subject to Constraint10_c:
 sum{i in ISTANBUL_HOME_TEAMS, k in {5,6,7}, j in 1..I: i!=j}  match_day[i,j,k]*match[i,2,j] <=
3;
subject to Constraint11{k in {3,4,6,7}}:
 sum{i in ISTANBUL_HOME_TEAMS, j in 1..I: i!=j}  match_day[i,j,k]*match[i,2,j] <= 1;
subject to Constraint12{k in {3,4,6,7}}:
 sum{i in TOP_HOME_TEAMS, j in 1..I: i!=j}  match_day[i,j,k]*match[i,2,j] <= 1;

subject to Constraint13:
   match_day[5,20,1] = 1;
subject to Constraint14:
   match_day[15,14,1] = 1;
subject to Constraint15:
   match_day[9,1,4] = 1;
subject to Constraint16:
   match_day[8,7,3] = 1;
subject to Constraint17:
   match_day[12,16,4] = 1;
subject to Constraint18:
   match_day[18,3,6] = 1;
```

```
subject to Constraint19:
   match_day[10,4,7] = 1;
subject to Constraint20:
   match_day[17,13,7] = 1;
subject to Constraint21:
   match_day[19,2,7] = 1;
subject to Constraint22:
   match_day[6,11,8] = 1;
```

Output of 10th Week:

```
sw: ampl
ampl: include Grad_Project_week_10.run;
 CPLEX 22.1.1: optimal solution; objective 18.728125
69 simplex iterations

match_day [*,*,1]
:   1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20 :=
1   .  0  0  0  0  0  0  0  1  0  0  0  0  0  0  0  0  0  0  0
2   0  .  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
3   0  0  .  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
4   0  0  0  .  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
5   0  0  0  0  .  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
6   0  0  0  0  0  .  0  0  0  0  0  0  0  0  0  0  0  0  0  0
7   0  0  0  0  0  0  .  0  0  0  0  0  0  0  0  0  0  0  0  0
8   0  0  0  0  0  0  0  .  0  0  0  0  0  0  0  0  0  0  0  0
9   1  0  0  0  0  0  0  0  .  0  0  0  0  0  0  0  0  0  0  0
10  0  0  0  0  0  0  0  0  0  .  0  0  0  0  0  0  0  0  0  0
11  0  0  0  0  0  0  0  0  0  0  .  0  0  0  0  0  0  0  0  0
12  0  0  0  0  0  0  0  0  0  0  0  .  0  0  0  0  0  0  0  0
13  0  0  0  0  0  0  0  0  0  0  0  0  .  0  0  0  1  0  0  0
14  0  0  0  0  0  0  0  0  0  0  0  0  0  .  0  0  0  0  0  0
15  0  0  0  0  0  0  0  0  0  0  0  0  0  0  .  0  0  0  0  0
16  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  .  0  0  0  0
17  0  0  0  0  0  0  0  0  0  0  0  0  0  1  0  0  .  0  0  0
18  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  .  0  0
19  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  .  0
20  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  .

 [*,*,2]
:   1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20 :=
1   .  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
2   0  .  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
3   0  0  .  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
4   0  0  0  .  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
5   0  0  0  0  .  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
6   0  0  0  0  0  .  0  0  0  0  0  0  0  0  0  0  0  0  0  0
7   0  0  0  0  0  0  .  1  0  0  0  0  0  0  0  0  0  0  0  0
```

8	0	0	0	0	0	0	1	.	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	.	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	.	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	.	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	.	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	.	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0	.	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	.	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	.	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	.	0	0	0
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	.	0	0
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	.	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	.

[*,*,3]

:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	:=
1	.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2	0	.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
3	0	0	.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
4	0	0	0	.	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	
5	0	0	0	0	.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
6	0	0	0	0	0	.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
7	0	0	0	0	0	0	.	0	0	0	0	0	0	0	0	0	0	0	0	0	
8	0	0	0	0	0	0	0	.	0	0	0	0	0	0	0	0	0	0	0	0	
9	0	0	0	0	0	0	0	0	.	0	0	0	0	0	0	0	0	0	0	0	
10	0	0	0	1	0	0	0	0	0	.	0	0	0	0	0	0	0	0	0	0	
11	0	0	0	0	0	0	0	0	0	0	.	0	0	0	0	0	0	0	0	0	
12	0	0	0	0	0	0	0	0	0	0	0	.	0	0	0	0	0	0	0	0	
13	0	0	0	0	0	0	0	0	0	0	0	0	.	0	0	0	0	0	0	0	
14	0	0	0	0	0	0	0	0	0	0	0	0	0	.	0	0	0	0	0	0	
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	.	0	0	0	0	0	
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	.	0	0	0	0	
17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	.	0	0	0	
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	.	0	0	
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	.	0	
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	.	

[*,*,4]

:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	:=
1	.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2	0	.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
3	0	0	.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
4	0	0	0	.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
5	0	0	0	0	.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
6	0	0	0	0	0	.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
7	0	0	0	0	0	0	.	0	0	0	0	0	0	0	0	0	0	0	0	0	
8	0	0	0	0	0	0	0	.	0	0	0	0	0	0	0	0	0	0	0	0	
9	0	0	0	0	0	0	0	0	.	0	0	0	0	0	0	0	0	0	0	0	

10	0	0	0	0	0	0	0	0	0	.	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	.	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	.	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	.	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0	.	1	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	1	.	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	.	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	.	0	0	0
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	.	0	0
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	.	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	.

[*,*,5]

:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	:=
1	.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2	0	.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
3	0	0	.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
4	0	0	0	.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
5	0	0	0	0	.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	
6	0	0	0	0	0	.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
7	0	0	0	0	0	0	.	0	0	0	0	0	0	0	0	0	0	0	0	0	
8	0	0	0	0	0	0	0	.	0	0	0	0	0	0	0	0	0	0	0	0	
9	0	0	0	0	0	0	0	0	.	0	0	0	0	0	0	0	0	0	0	0	
10	0	0	0	0	0	0	0	0	0	.	0	0	0	0	0	0	0	0	0	0	
11	0	0	0	0	0	0	0	0	0	0	.	0	0	0	0	0	0	0	0	0	
12	0	0	0	0	0	0	0	0	0	0	0	.	0	0	0	0	0	0	0	0	
13	0	0	0	0	0	0	0	0	0	0	0	0	.	0	0	0	0	0	0	0	
14	0	0	0	0	0	0	0	0	0	0	0	0	0	.	0	0	0	0	0	0	
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	.	0	0	0	0	0	
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	.	0	0	0	0	
17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	.	0	0	0	
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	.	0	0	
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	.	0	
20	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	.	

[*,*,6]

:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	:=
1	.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2	0	.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
3	0	0	.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	
4	0	0	0	.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
5	0	0	0	0	.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
6	0	0	0	0	0	.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
7	0	0	0	0	0	0	.	0	0	0	0	0	0	0	0	0	0	0	0	0	
8	0	0	0	0	0	0	0	.	0	0	0	0	0	0	0	0	0	0	0	0	
9	0	0	0	0	0	0	0	0	.	0	0	0	0	0	0	0	0	0	0	0	
10	0	0	0	0	0	0	0	0	0	.	0	0	0	0	0	0	0	0	0	0	
11	0	0	0	0	0	0	0	0	0	0	.	0	0	0	0	0	0	0	0	0	

12	0	0	0	0	0	0	0	0	0	0	0	.	0	0	0	1	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	.	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0	.	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	.	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	.	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	.	0	0	0
18	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	.	0	0
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	.	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	.

[*,*,7]

:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	:=
1	.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2	0	.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
3	0	0	.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
4	0	0	0	.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
5	0	0	0	0	.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
6	0	0	0	0	0	.	0	0	0	0	1	0	0	0	0	0	0	0	0	0	
7	0	0	0	0	0	0	.	0	0	0	0	0	0	0	0	0	0	0	0	0	
8	0	0	0	0	0	0	0	.	0	0	0	0	0	0	0	0	0	0	0	0	
9	0	0	0	0	0	0	0	0	.	0	0	0	0	0	0	0	0	0	0	0	
10	0	0	0	0	0	0	0	0	0	.	0	0	0	0	0	0	0	0	0	0	
11	0	0	0	0	0	1	0	0	0	0	.	0	0	0	0	0	0	0	0	0	
12	0	0	0	0	0	0	0	0	0	0	0	.	0	0	0	0	0	0	0	0	
13	0	0	0	0	0	0	0	0	0	0	0	0	.	0	0	0	0	0	0	0	
14	0	0	0	0	0	0	0	0	0	0	0	0	0	.	0	0	0	0	0	0	
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	.	0	0	0	0	0	
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	.	0	0	0	0	
17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	.	0	0	0	
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	.	0	0	
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	.	0	
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	.	

[*,*,8]

:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	:=
1	.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2	0	.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	
3	0	0	.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
4	0	0	0	.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
5	0	0	0	0	.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
6	0	0	0	0	0	.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
7	0	0	0	0	0	0	.	0	0	0	0	0	0	0	0	0	0	0	0	0	
8	0	0	0	0	0	0	0	.	0	0	0	0	0	0	0	0	0	0	0	0	
9	0	0	0	0	0	0	0	0	.	0	0	0	0	0	0	0	0	0	0	0	
10	0	0	0	0	0	0	0	0	0	.	0	0	0	0	0	0	0	0	0	0	
11	0	0	0	0	0	0	0	0	0	0	.	0	0	0	0	0	0	0	0	0	
12	0	0	0	0	0	0	0	0	0	0	0	.	0	0	0	0	0	0	0	0	
13	0	0	0	0	0	0	0	0	0	0	0	0	.	0	0	0	0	0	0	0	

14	0	0	0	0	0	0	0	0	0	0	0	0	0	.	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	.	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	.	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	.	0	0	0
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	.	0	0
19	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	.	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	.

total_deviation = 18.7281

objective_func_part1 = 18.7281
objective_func_part2 = 0

Percentage Improvement

Table 7.

PERCENTAGE IMPROVEMENT				
c1	AMPL	1	0.725	72%
c2		1		
c1	TFF	1		
c2		1		
c1	AMPL	1	0.777	78%
c2		0,5		
c1	TFF	1		
c2		0,5		
c1	AMPL	0,5	0.743	74%
c2		1		
c1	TFF	0,5		
c2		1		

10. Preliminary Results

Table 8.

Search Results:

Details	Home Team		Away Team	Date	Time	Stadium	Organization Group(Week)
1093	KASIMPAŞA A.Ş.	3-1	İSTANBULSPOR A.Ş.	27.10.2023	20:00	RECEP TAYYİP ERDOĞAN STADYUMU - İSTANBUL	Trendyol Super League (10)
1091	ATAKAŞ HATAYSPOR	1-2	MONDİHOME KAYSERİSPOR	27.10.2023	20:00	MERSİN STADYUMU - MERSİN	Trendyol Super League (10)
1100	ÇAYKUR RİZESPOR A.Ş.	0-1	GALATASARAY A.Ş.	28.10.2023	19:00	ÇAYKUR DİDİ - RİZE	Trendyol Super League (10)
1094	CORENDON ALANYASPOR	1-2	EMS YAPI SİVASSPOR	28.10.2023	16:00	ALANYA OBA STADYUMU - ANTALYA - ALANYA	Trendyol Super League (10)
1095	YUKATEL ADANA DEMİRSPOR A.Ş.	3-0	TÜMOSAN KONYASPOR	28.10.2023	19:00	YENİ ADANA STADYUMU - ADANA	Trendyol Super League (10)
1096	VAVACARS FATİH KARAGÜMRÜK	0-0	TRABZONSPOR A.Ş.	29.10.2023	16:00	ATATÜRK OLİMPİYAT - İSTANBUL	Trendyol Super League (10)
1097	BITEXEN ANTALYASPOR	1-0	RAMS BAŞAKŞEHİR FUTBOL KULÜBÜ	29.10.2023	19:00	CORENDON AIRLINES PARK ANTALYA STADI - ANTALYA	Trendyol Super League (10)
1099	MKE ANKARAGÜCÜ	2-0	YILPORT SAMSUNSPOR	29.10.2023	19:00	ERYAMAN STADYUMU - ANKARA - ETİMESGUT	Trendyol Super League (10)
1092	SİLTAŞ YAPI PENDİKSPOR FUTBOL A.Ş.	0-5	FENERBAHÇE A.Ş.	29.10.2023	19:00	PENDİK STADI - İSTANBUL - PENDİK	Trendyol Super League (10)
1098	BEŞİKTAŞ A.Ş.	2-0	GAZİANTEP FUTBOL KULÜBÜ A.Ş.	30.10.2023	20:00	BEŞİKTAŞ PARK - İSTANBUL - BEŞİKTAŞ	Trendyol Super League (10)

Table 9.

Matches		27-30 October			
Home	**Away**	**same_TFF**	**exact dates**	**hours**	**part of the day**
5	20	Friday	10/27/2023	20.00	evening
15	14	Friday	10/27/2023	20.00	evening
9	1	Saturday	10/28/2023	19.00	evening
8	7	Saturday	10/28/2023	16.00	afternoon
12	16	Saturday	10/28/2023	19.00	evening
18	3	Sunday	10/29/2023	16.00	afternoon
10	4	Sunday	10/29/2023	19.00	evening
17	13	Sunday	10/29/2023	19.00	evening
19	2	Sunday	10/29/2023	19.00	evening
6	11	Monday	10/30/2023	20.00	evening