Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 9, No. 2, 2366-2374
2025
Publisher: Learning Gate
DOI: 10.55214/25768484.v9i2.5089

Alternative approaches to game scheduling of multiple round-robin tournament: Korea professional soccer league (K League 1) in focus

Dae-Gon Ko[1], Ha-Ram Kim[2*], Tae-Ho Kim[3]
[1]Bachelor of Science in Biological Science, Yongin University, South Korea; superhero9704@gmail.com (D.G.K.).
[2]Master of Science in Global Business, Georg-August-Universität Göttingen, Germany; gkfkaakstp@gmail.com (H.R.K.).
[3]Department of Business Administration, Incheon National University, South Korea; tacokim@gmail.com (T.H.K.).

Abstract: This study evaluates the quality of the current schedule of a professional soccer league, K League 1 (Korea Professional Soccer League), which is regarded as the top Asian professional soccer league and has unique characteristics compared to European leagues, such as odd numbers of games between some teams and final rounds based on previous performance. It assesses the total travel distance of teams to play all scheduled games, match fairness, and attendance fairness. Match fairness implies that each team should have the opportunity to play against other teams under similar performance conditions. Teams can be under different performance conditions during a long season due to several reasons, such as injuries and the level of team spirit. Attendance fairness relates to the maximum number of consecutive home or away series for each team. Alternatives that prioritize the minimization of the total travel distance while satisfying other factors are presented. The requirements of soccer league game scheduling differ in certain aspects from those of other sports leagues, like baseball leagues. Moreover, minimization results are compared with the 2023 K League 1 schedule and schedules generated by tournament scheduling methods, including the English Tournament Scheduling approach, where teams face previous opponents in reverse order. Despite extensive research, this study develops a new integer programming model and applies an existing heuristic to K League 1. Using quantitative methods, our research demonstrates match generation and adjustment issues, highlighting significant room for improvement in soccer scheduling.

Keywords: *Fairness, K league soccer game scheduling, Large-scale integer programming model, Multiple round-robin tournament, Travel distance.*

1. Introduction

Soccer (Football) is an interesting sport that is considerably popular all over the world unlike baseball and basketball which are played in some specific countries in North America, the Caribbean, Asia, and Europe. The K League, which currently has 12 teams in K League 1 and 13 teams in K League 2, is the first-ranked professional soccer league in Asia of 47 leagues. The league plays once or twice a week from the end of February till the end of October, and teams play a total of 38 round games during the regular season. The first 33 rounds are played on a home-and-away basis (3 games between each pair of teams), and 12 teams are decomposed into group A and group B based on the result of 33 round games and the final 5 round games will be performed within each group. After playing all 38 rounds, the 12th ranked team will be directly go down to K League 2 in next season and 10th and 11th-ranked teams should play the 2nd and the 3rd ranked teams of K League 2 to decide staying in K League 1 or going down to K league [1].

Kim [2] proposed an optimal approach to game scheduling for multiple round-robin tournaments, focusing on the Korea Professional Baseball League (KBO). This study references various findings from

History: Received: 25 December 2024; Revised: 5 February 2025; Accepted: 14 February 2025; Published: 28 February 2025
* Correspondence: gkfkaakstp@gmail.com

Kim's research to discuss different aspects of schedule optimization. In 2022, the K League had approximately 1.1 million attendees [3] the estimated total sales of all teams were approximately 710 million dollars [4] and the estimated total salary of players was approximately 91 million dollars [5]. In 2011, the economic ripple effect was approximately 590 million dollars [6].

The ability for fans to follow the league's standings and cheer on their favorite teams' games each week is one of the reasons the K League 1 is so popular and has such a significant economic impact in Korea. It is crucial to schedule games so that the players stay in peak physical condition and the audience can continue to pay attention to the league in order to sustain the K League 1's popularity and economic impact.

Studies in ice hockey, football, volleyball, and soccer have concentrated on the number of breaks that show how frequently all teams play two home or two away games in two consecutive series [7-9]. because travel distance does not change in any kind of scheduling schemes. In fact, direct travel from an away venue to the other away rarely happens in these sports. However, research on baseball and basketball game scheduling has centered on the objective function of each team's travel distance [10-13]. When compared to other sports leagues, baseball and basketball leagues feature a significantly higher number of series or games and teams should travel frequently from one away venue to the other away venue directly without coming back home venue.

Match fairness is another crucial component. This suggests that every team ought to be given the chance to play other teams in comparable performance scenarios. Throughout a lengthy season, teams may experience varying performance circumstances due to a variety of factors, including injuries and team spirit levels. Therefore, depending on when each team is scheduled to play other teams, match fairness may be broken. As a result, this element influences the teams' final standing at the end of the season. In fact, during a K League 1 season, a squad may win seven straight games then lose seven more. Each team must play exactly one game against every other team before playing against the same team again, and there should be a fair amount of time between matches to improve match fairness. In addition to these, the cap on the number of consecutive home or away series for each team should be taken into account in order to reflect attendance equity.

This research offers valuable information regarding the K League 1 game schedule. By enhancing current models, which may be large-scale optimization issues into certain small-scale sub-problems to reach solutions to an NP-hard problem, we create an integer programming model that captures the distinctive features of the K League [14] and a commercial solver is used to solve the model directly; in some situations, a problem-specific heuristic may be taken into consideration. To propose a better game schedule to the K League 1, the results are compared in terms of the total travel distance, match fairness, and attendance fairness. Moreover, we will propose to the K League 1 the use of the game scheduling scheme from this study for future seasons.

Table 1 summarizes the literature on round-robin tournament and the location of this research.

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 9, No. 2: 2366-2374, 2025
DOI: 10.55214/25768484.v9i2.5089

Table 1.
Summary of literature on round-robin tournament [15].

Approach Application	Direct IP	Two-phases based on IP	Simulated annealing/Tabu search	Other heuristics	Theory	Introductory /Survey
Baseball	Kim and Kim [15]	Russell and Leung [10] and Easton, et al. [11]	Anagnostopoulos, et al. [16]	Cain [17]; Hoshino and Kawarabayashi [13] and Kim and Kim [15]	De Werra [7]; Trick [18]; Briskorn and Drexl [19]; Nurmi, et al. [20] and Thielen and Westphal [14]	Anderson [21]; Easton, et al. [11]; Easton, et al. [22]; Rasmussen and Trick [23] and Kendall, et al. [24]
Football/ Soccer	Durán, et al. [25]; Fiallos, et al. [26] and Ribeiro [27] This research	Ribeiro and Urrutia [28]		Rasmussen and Trick [23] and Rasmussen [29] This research		
Ice Hockey			Kyngas and Nurmi [9]	Nurmi, et al. [20] and Nurmi, et al. [30]		
Basketball		Bao [12] and Durán, et al. [31]	Wright [32]			
Volleyball		Bonomo, et al. [33]				

In Section 2, we go over the specifics of multiple round-robin competitions, especially those held by the KBO League, and present an integer programming model that takes into account all of the previously mentioned variables. In Section 3, the integer programming model is used to try to solve the problem directly. If the model is unable to solve the problem directly, a problem-specific heuristic is taken into consideration. Section 4 presents and explains the empirical findings and some of the issues they raise. The K League 1's current schedule is derived from the English scheduling approach in Section 5, and the schedules produced by our model and heuristic are then contrasted to offer fresh managerial perspectives. The paper is finally summarized in Section 6.

2. Notation and Model Description

Reducing the overall travel distance for every team is the main challenge in this study. Based on Kim's basic model, we create a linear integer programming model for a multiple round-robin tournament problem [15].

To accomplish the foregoing, a specific number of teams, n $(i, j = 1, \ldots, n)$ and the number of games between each pair of teams k are available. We have to define rounds $(r = 1, \ldots, R)$, where R is equal to $k \times (n-1)$. In the K League 1, there are 12 teams ($n = 12$), with each team playing three matches against every other team ($k = 3$), across a total of 33 rounds ($R = 33$). The parameters H_1 and A_1 represent the maximum number of consecutive home and away series, respectively, that a team can have. The maximum number of home series within any 11-round period is denoted as $\bar{H}$, which is calculated as:

$$\bar{H} = \left[\frac{11}{2}\right] = 6$$

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 9, No. 2: 2366-2374, 2025
DOI: 10.55214/25768484.v9i2.5089

This constraint ensures a balanced distribution of home and away matches throughout the season. Regarding travel distances, the variable d_{ij} represents the distance in kilometers between the home venues of teams i and j. The total travel distance of all teams is used as the objective function, aiming to minimize overall travel. To model this scheduling problem, we define decision variables as follows. The binary variable $x_{r,i,j}$ is assigned a value of 1 if team i hosts a home match against team j in round r, and 0 otherwise.

The linear integer programming model of the K League 1 is as follows:

$$\underset{x_{r,i,j}}{Min}\sum_{r=1}^{R}\sum_{i=1}^{n}\sum_{j=1}^{n}\left(x_{r,i,j}+x_{r,j,i}\right)\cdot\left(d_{ij}+d_{ji}\right) \quad (1)$$

subject to,

$$x_{r,i,i}=0,\ r=1,...,R, i=1,...,n \quad (2)$$

$$\sum_{j=1}^{n}x_{r,i,j}+\sum_{j=1}^{n}x_{r,j,i}=1,\ r=1,...,R, i=1,...,n \quad (3)$$

$$\sum_{r=1}^{n-1}x_{r,i,j}+\sum_{r=n}^{2n-2}x_{r,j,i}=1,\ \ i=1,...,n,\ j=1,...,n \quad (4)$$

$$\sum_{r=n}^{2n-2}x_{r,i,j}+\sum_{r=2n-1}^{3n-3}x_{r,j,i}=1,\ i=1,...,n,\ j=1,...,n \quad (5)$$

……

$$\sum_{r=(k-1)n-(k-2)}^{kn-k}x_{r,i,j}+\sum_{r=kn-(k-1)}^{(k+1)n-(k+1)}x_{r,j,i}=1,\ \ i=1,...,n,\ j=1,...,n \quad (6)$$

$$\sum_{r=1}^{n-1}x_{r,i,j}\le\bar{H},\ i=1,...,n,\ j=1,...,n \quad (7)$$

$$\sum_{r=n}^{2n-2}x_{r,i,j}\le\bar{H},\ i=1,...,n,\ j=1,...,n \quad (8)$$

……

$$\sum_{r=(k-1)n-(k-2)}^{kn-k}x_{r,i,j}\le\bar{H},\ i=1,...,n,\ j=1,...,n \quad (9)$$

$$\sum_{r_1=r}^{r+2}\sum_{j=1}^{n}x_{r_1,i,j}\le\bar{H}_C,\ \ r=1,...,R-2, i=1,...,n \quad (10)$$

$$\sum_{r=1}^{n-1}x_{r,i,j}+\sum_{r=n}^{2n-2}x_{r,i,j}=1,\ i=1,...,n,\ j=1,...,n \quad (11)$$

$$\sum_{r=n}^{2n-2}x_{r,i,j}+\sum_{r=2n-1}^{3n-3}x_{r,i,j}=1,\ i=1,...,n,\ j=1,...,n \quad (12)$$

……

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 9, No. 2: 2366-2374, 2025
DOI: 10.55214/25768484.v9i2.5089

$$\sum_{r=(k-1)n-(k-2)}^{kn-k} x_{r,i,j} + \sum_{r=kn-(k-1)}^{(k+1)n-(k+1)} x_{r,i,j} = 1, \ \ i = 1,...,n, \ j = 1,...,n \quad (13)$$

$$\sum_{r_1=r}^{r+3} \left(x_{r_1,i,j} + x_{r_1,j,i} \right) \le 1, \quad r = 1,...,R-3, i = 1,...,n, \ j = 1,...,n \quad (14)$$

As seen by the objective function (1), the goal is to reduce the overall journey distance. The choice variables are specified as binary variables by constraint (2). In a round, every team faces exactly one other team, according to constraint (3). According to constraints (4), (5), and (6), every team competes against every other n-1 team in every n-1 round. Constraints (7), (8), and (9) restrict how many home games are allowed in each n-1 round. (10) restricts how many home games may be played in a row. Each pair of teams alternates between home and away games, as stated in constraints (11), (12), and (13) respectively. According to constraints (14) every pair of teams must play two games in a row with a minimum of four rounds between them.

3. Empirical Data

The K League 1 schedule for 2023 provides the data for our empirical investigation. For forty years, the league has been in existence. Depending on the outcome of the 33 rounds, each team plays both 33-round and 5-round games. The locations of the 12 Korean teams are displayed in Figure 1. Google Maps was used to calculate the distances (in kilometers) between each pair of home venues for every team. The data is summarized in Table 2. The greatest distance between two home venues is roughly 661 kilometers, as seen in the table. 3.5 kilometers is the minimum distance. The standard deviation of 151.02 km is high, and the mean distance of 266.61 km is roughly half of the greatest distance. It makes sense given each person's overall trip distance. It makes sense that each team's overall travel distance would vary, and the K League 1 would try to cut down on both this distance and the variation across teams.

Table 2.
Summary of distances between each pair of home venues (in kilometers).

Min	Max	Mean	Standard Deviation
3.5	661	266.61	151.02

Figure 1.
Venue of 12 teams in K League 1.

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 9, No. 2: 2366-2374, 2025
DOI: 10.55214/25768484.v9i2.5089

4. Results and Discussion

As noted in previous Sections, we develop two additional game schedules to the 2023 real schedule: one is generated from the integer programming model in section 2 and the other is generated from the English tournament scheduling approach, and compare them with each other in the aspects of total travel distance, match fairness, and the length of consecutive home and away games of teams.

Table 3 shows us the total travel distance of teams of the three schedules. As seen, the total travel distance and travel distance of each team are equal in all 3 schedules though they give teams different game schedules. This result is very natural because all teams visit the away venue and come back home before the next game without going to the next away venue directly unlike baseball league. In fact, soccer league does not play every day while baseball league does. Therefore, any schedule will not make a difference in travel distance. The difference in travel distance across teams comes from the location of home venues of teams as illustrated in Figure 1.

Table 3.
Total travel distance of K league 12 teams (km).

Team	2023 schedule	IP schedule	English schedule
1	18,378	18,378	18,378
2	17,748	17,748	17,748
3	15,966	15,966	15,966
4	13,236	13,236	13,236
5	15,126	15,126	15,126
6	13,581	13,581	13,581
7	13,623	13,623	13,623
8	20,586	20,586	20,586
9	15,744	15,744	15,744
10	15,078	15,078	15,078
11	33,156	33,156	33,156
12	18,936	18,936	18,936
Total	211,158	211,158	211,158
Mean	17,597	17,597	17,597
Standard deviation	5418.21	5418.21	5418.21

Table 4 and Figure 2 illustrate the result of match fairness across teams measured by the match interval of each pair of teams. Because the English schedule has a minimum of 1 and a maximum of 21 as match intervals, it is not good in the aspect of match fairness though the average is equal to other schedules. As seen in the top panel of Table 4 and Figure 2, because the summary of the average match interval of each pair of teams is homogeneous though the average match interval of each pair of teams is heterogeneous across 3 schedules, there is no difference in match fairness found. However, if we look at the second and third panels of Table 4 it is possible to find a slight difference in match fairness between 2023 real schedule and the optimal schedule from our model. The second panel illustrates the average match interval with the strongest 4 teams in the previous season and the optimal schedule seems to be slightly better in that the average match interval with strong team is longer than and standard deviation is shorter than the 2023 real schedule though it is not statistically significant.

The third panel shows us the nonparametric runs test result. The optimal schedule has slightly more runs than 2023 real schedule, which means that long match interval and short match interval repeated more frequently, and the optimal schedule has more observations below the mean than the latter, which means that the optimal schedule has more observations around mean than 2023 real schedule. In conclusion, the optimal schedule is said to be better than the 2023 real schedule in the aspect of match fairness. The p-values show that average match intervals are random in all three schedules because they are greater than 0.05.

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 9, No. 2: 2366-2374, 2025
DOI: 10.55214/25768484.v9i2.5089

Table 4.
Average match interval of each pair of teams.

Average match interval			
	Current schedule	**Optimal schedule**	**English schedule**
Mean	9.33	9.33	9.33
Standard deviation	1.06	1.06	1.06
Min	7.67	7.67	7.67
Max	11.00	11.00	11.00
Average match interval with top 4 teams in 2022 season			
Mean	9.32	9.37	9.32
Standard deviation	1.07	1.06	1.10
Min	7.67	7.67	7.67
Max	11.00	11.00	11.00
Runs test			
# (expected #) of runs	34 (33.72)	36 (33.72)	41 (33.72)
# of obs. above mean vs. below mean	36 vs. 30	30 vs. 36	30 vs. 36
p-value	0.946	0.570	0.069

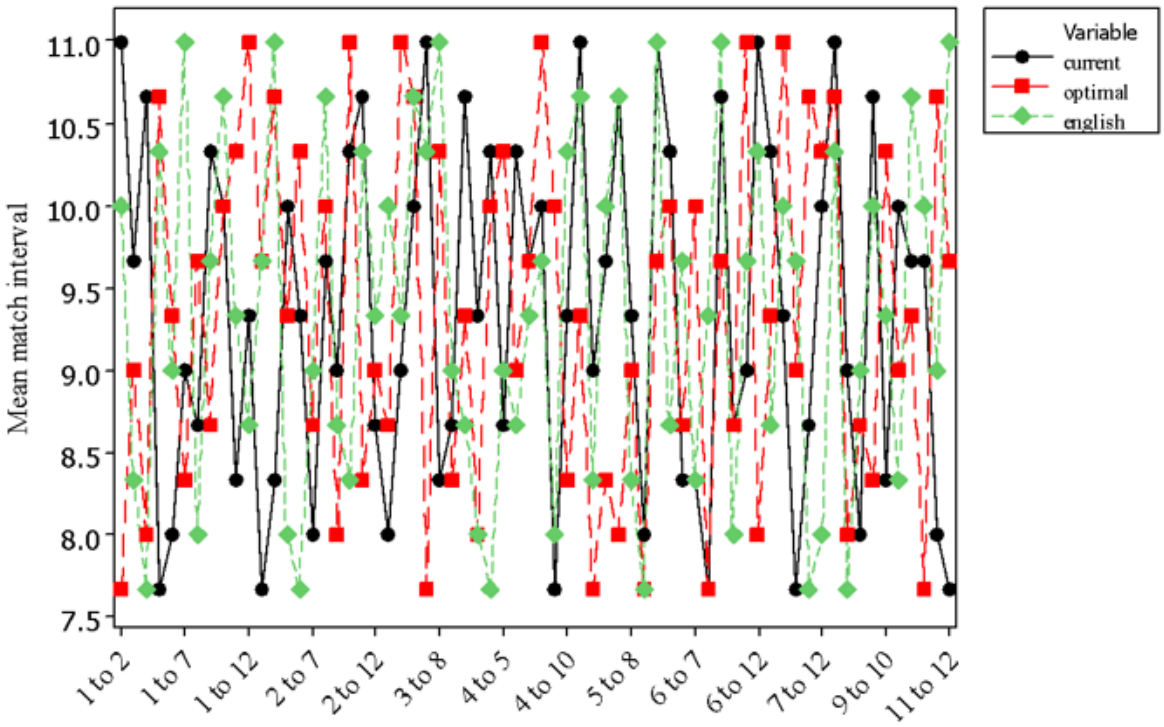

Figure 2.
Average match interval of each pair of teams across schedules.

In the number of consecutive home/away rounds, the optimal schedule guarantees that they are less than or equal to 2 while the English schedule has 1/1 and 2023 real schedule has 2/3 of 3 consecutive home/away rounds. In the rule of home-and-away-in-turns, while the optimal schedule and the English schedule keep the rule with no exception, the 2023 real schedule violates the rule 36 times in a season.

5. Conclusions

The overall trip distance, match fairness, and attendance fairness were the main topics of this study on soccer game scheduling. To optimize the overall journey distance while accounting for all other

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 9, No. 2: 2366-2374, 2025
DOI: 10.55214/25768484.v9i2.5089

variables, an integer programming model was also created. The model's output schedule quality was then contrasted with the English tournament schedule and the K League 1 calendar for 2023. It was verified that the K League 1 schedule produced by our model was significantly better in terms of overall travel distance, match fairness, and attendance fairness. Specifically, our suggested model was also validated to have the ability to provide higher-quality answers for problem settings in less than two hours of CPU time utilizing solvers such as CPLEX.

Transparency:

The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

Acknowledgment:

The authors sincerely acknowledge the financial support provided by the Yongin University Alumni Association Scholarship Foundation for this research. This support, granted through the 2023 Research Funding Program, enabled participation in the IFORS 2023 conference and contributed to the development of this study.

References

[1] K. League, "K League official website," Retrieved: http://www.kleague.com, 2021.

[2] T. Kim, "Optimal approach to game scheduling of multiple round-robin tournament: Korea professional baseball league in focus," *Computers & Industrial Engineering*, vol. 136, pp. 95-105, 2019. https://doi.org/10.1016/j.cie.2019.07.016

[3] Yonhap News Agency, "K League 1 professional football to use 'Big Bird' and 'DGB Daegu Bank Park' from the 2024 season," Retrieved: https://www.yna.co.kr/view/AKR20230916039000007, 2023.

[4] I. Chosun, "Evaluation meeting on 'two years of the promotion-relegation system' in professional football," Retrieved: https://www.chosun.com/site/data/html_dir/2013/08/01/2013080100923.html, 2013.

[5] Sports Kyunghyang, "K League concludes the 2023 season," Retrieved: https://sports.khan.co.kr/article/202301011015003, 2023

[6] I. Kyeonggi, "Changes in K League after the introduction of the promotion-relegation system," Retrieved: https://www.kyeonggi.com/article/201103030397010, 2011

[7] D. De Werra, "Some models of graphs for scheduling sports competitions," *Discrete Applied Mathematics*, vol. 21, no. 1, pp. 47-65, 1988. https://doi.org/10.1016/0166-218X(88)90033-9

[8] R. V. Rasmussen and M. A. Trick, "Round robin scheduling–a survey," *European Journal of Operational Research*, vol. 188, no. 3, pp. 617-636, 2008. https://doi.org/10.1016/j.ejor.2007.05.046

[9] J. Kyngas and K. Nurmi, "Scheduling the Finnish major ice hockey league," presented at the 2009 IEEE Symposium on Computational Intelligence in Scheduling, IEEE., 2009.

[10] R. A. Russell and J. M. Leung, "Devising a cost effective schedule for a baseball league," *Operations Research*, vol. 42, no. 4, pp. 614-625, 1994. https://doi.org/10.1287/opre.42.4.614

[11] K. Easton, G. Nemhauser, and M. Trick, *The traveling tournament problem: Description and benchmarks. In: Walsh T, editor. Principles and practice of constraint programming—CP 2001*. Berlin: Springer, 2001

[12] R. Bao, "Time relaxed round robin tournament and the NBA scheduling problem," Master's Thesis, Cleveland (OH): Cleveland State University, 2009.

[13] R. Hoshino and K. i. Kawarabayashi, "The multi-round balanced traveling tournament problem," in *Proceedings of the International Conference on Automated Planning and Scheduling*, 2011 doi: https://doi.org/10.1609/icaps.v21i1.13443.

[14] C. Thielen and S. Westphal, "Complexity of the traveling tournament problem," *Theoretical Computer Science*, vol. 412, no. 4-5, pp. 345-351, 2011. https://doi.org/10.1016/j.tcs.2010.10.001

[15] J. Kim and H. Kim, "The economic ripple effect of professional baseball industry," *KIET Ind Econ Rev*, vol. 178, pp. 71–99, 2013.

[16] A. Anagnostopoulos, L. Michel, P. V. Hentenryck, and Y. Vergados, "A simulated annealing approach to the traveling tournament problem," *Journal of Scheduling*, vol. 9, no. 2, pp. 177-193, 2006. https://doi.org/10.1007/s10951-006-7187-8

[17] W. Cain, *The computer-aided heuristic approach used to schedule the Major League Baseball clubs. In: Ladany SP, Machol RE, editors. Optimal strategies in sports.* Amsterdam: North-Holland, 1977.

[18] M. Trick, *Integer and constraint programming approaches for round-robin tournament scheduling. In: Burke E, De Causmaecker P, editors. Practice and theory of automated timetabling IV.* Berlin: Springer, 2003

[19] D. Briskorn and A. Drexl, "IP models for round robin tournaments," *Computers & Operations Research*, vol. 36, no. 3, pp. 837-852, 2009. https://doi.org/10.1016/j.cor.2007.11.002

[20] K. Nurmi, D. Goossens, T. Bartsch, F. Bonomo, D. Briskorn, and G. Duran, "A framework for scheduling professional sports leagues," in *AIP Conference Proceedings*, 2010, pp. 14–28, doi: https://doi.org/10.1063/1.3510542.

[21] I. Anderson, *Combinatorial designs and tournaments.* Oxford: Oxford University Press, 1997

[22] K. Easton, G. Nemhauser, and M. Trick, *Sports scheduling. In: Leung JT, editor. Handbook of scheduling: Algorithms, models, and performance analysis.* Boca Raton: CRC Press, 2004.

[23] R. V. Rasmussen and M. A. Trick, "A benders approach for the constrained minimum break problem," *European Journal of Operational Research*, vol. 177, no. 1, pp. 198-213, 2007. https://doi.org/10.1016/j.ejor.2005.10.063

[24] G. Kendall, S. Knust, C. C. Ribeiro, and S. Urrutia, "Scheduling in sports: An annotated bibliography," *Computers & Operations Research*, vol. 37, no. 1, pp. 1-19, 2010. https://doi.org/10.1016/j.cor.2009.05.013

[25] G. Durán *et al.*, "Scheduling the Chilean soccer league by integer programming," *Interfaces*, vol. 37, no. 6, pp. 539-552, 2007. https://doi.org/10.1287/inte.1070.0318

[26] J. Fiallos, J. Pérez, F. Sabillón, and M. Licona, "Scheduling soccer league of Honduras using integer programming," in *IIE Annual Conference and Expo 2010 Proceedings*, 2010.

[27] C. C. Ribeiro, "Sports scheduling: Problems and applications," *International Transactions in Operational Research*, vol. 19, no. 1-2, pp. 201-226, 2012. https://doi.org/10.1111/j.1475-3995.2011.00819.x

[28] C. C. Ribeiro and S. Urrutia, "Scheduling the Brazilian soccer tournament: Solution approach and practice," *Interfaces*, vol. 42, no. 3, pp. 260-272, 2012. https://doi.org/10.1287/inte.1110.0566

[29] R. V. Rasmussen, "Scheduling a triple round robin tournament for the best Danish soccer league," *European Journal of Operational Research*, vol. 185, no. 2, pp. 795-810, 2008. https://doi.org/10.1016/j.ejor.2006.12.050

[30] K. Nurmi, D. Goossens, and J. Kyngäs, "Scheduling a triple round robin tournament with minitournaments for the Finnish national youth ice hockey league," *Journal of the Operational Research Society*, vol. 65, no. 11, pp. 1770-1779, 2014. https://doi.org/10.1057/jors.2013.154

[31] G. Durán, S. Durán, J. Marenco, F. Mascialino, and P. A. Rey, "Scheduling Argentina's professional basketball leagues: A variation on the travelling tournament problem," *European Journal of Operational Research*, vol. 275, no. 3, pp. 1126-1138, 2019. https://doi.org/10.1016/j.ejor.2018.12.018

[32] M. B. Wright, "Scheduling fixtures for basketball New Zealand," *Computers & Operations Research*, vol. 33, no. 7, pp. 1875-1893, 2006. https://doi.org/10.1016/j.cor.2004.09.024

[33] F. Bonomo, A. Cardemil, G. Durán, J. Marenco, and D. Sabán, "An application of the traveling tournament problem: The Argentine volleyball league," *Interfaces*, vol. 42, no. 3, pp. 245-259, 2012. https://doi.org/10.1287/inte.1110.0587

Edelweiss Applied Science and Technology
ISSN: 2576-8484
Vol. 9, No. 2: 2366-2374, 2025
DOI: 10.55214/25768484.v9i2.5089