

Colombian football league

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Abstract—The following paper addresses the analysis of the Colombian Football League system from a complex systems perspective, using concepts such as synergy, entropy, chaos theory, adaptability, recursion, butterfly effect and domino effect. The Colombian league behaves as a dynamic system in which the interactions between actors—teams, players, managers, fans and regulators—generate emerging patterns and behaviors that cannot be predicted simply by analyzing individual components.

I. INTRODUCTION

Football is a highly complex sport, where multiple factors interact to produce outcomes that are difficult to predict. The Colombian football league is no exception, being a highly interconnected system that involves a wide range of actors and factors, from teams and players to sponsors, media and regulators. In this paper, several concepts from systems theory will be applied to explain the emergent behaviors and dynamics that affect the development of the league.

II. SYSTEMS THEORY CONCEPTS

A. Chaos Theory

Chaos theory manifests itself in the Colombian league in the way that small events can have large repercussions on the development of the championship. A seemingly insignificant change, such as an unfair expulsion of a player or a goal in the last minute, can trigger a series of unexpected results that radically alter the order in the standings. This non-linearity characteristic of chaos shows that traditional predictions about the favorite teams or the probabilities of success can be made obsolete by a single incident. This concept is especially observed in short tournaments, where a streak of victories or defeats can determine the immediate future of a team.

B. Synergy

Synergy is one of the fundamental pillars of success in team sports. In the Colombian league, the results obtained by teams are not simply the sum of the individual skills of their players. Synergy occurs when positive interactions between team members and the coaching staff produce a performance that is higher than expected. Teams with modest rosters but high cohesion, such as La Equidad or Aguilas Doradas, have managed to surprise teams with larger budgets and more talented players, proving that teamwork and strategy can exceed expectations. This synergy, however, is fragile and highly sensitive to changes in the team structure, such as the rotation of key players or a change of coach.



Fig. 1. Enter Caption

C. Entropy

Entropy, in the context of the Colombian league, reflects the degree of uncertainty that builds up as the season progresses. Injuries, sanctions, weather changes, and other external factors can disrupt the structure of the championship, increasing the disorder and making predictions about the final results difficult. A clear example is how teams that start the season in a solid way, such as Junior or Millonarios, can suffer fluctuations in their performance due to accumulated fatigue, the unexpected sale of players, or controversial refereeing decisions that change the course of the competition. This phenomenon reflects the tendency towards chaos as the system becomes more complex and less predictable.

D. Adaptability

Adaptability is a key quality in the Colombian league, especially in a context where conditions can change rapidly due to economic, political or sporting factors. Teams that are better able to adapt to circumstances – such as injuries to key players, new regulations or the loss of sponsors – tend to be more successful in the long term. A recent example is the impact of the COVID-19 pandemic, which forced clubs to quickly adjust their rosters and financial strategies to survive the crisis. Those with more flexibility and adaptability managed to remain competitive in the league.

E. Recursion

Recursiveness in the Colombian league is seen in the repetitive cycles of success and failure that affect clubs. Teams tend to repeat patterns of behavior, such as the constant rotation of coaches in search of a winning formula or fluctuations in performance due to internal crises. This perpetual cycle is particularly visible in mid-level teams that oscillate between qualifying for international tournaments and relegation, reflecting a repetition of circumstances that seem to be on a loop.

F. Butterfly effect

The butterfly effect illustrates how small changes can create big effects in the Colombian league system. A key decision by a referee, an unexpected signing or a tactical change can have significant repercussions throughout the season. For example, a player being sent off in a crucial match can completely alter a team's strategy, affecting their performance not only in that match, but in subsequent matches, which can influence the league's overall standings.

G. Domino effect

The domino effect describes how a small event can trigger a cascade of consequences throughout the league. When a team enters a financial crisis, as happened with Cúcuta Deportivo, the repercussions are felt throughout the league. The sale of players, the loss of sponsors and the drop in performance affect other teams by disrupting the transfer market and changing the competitive balance. This effect shows the interconnectedness of the system and how the collapse of a single team can destabilise the national football ecosystem.

III. EMERGENT BEHAVIORS

A. Collective performance greater than the sum of the parts

A coach who understands how to manage interactions between players can generate a synergistic effect, where the team performs above what would be expected of individual players. This is an emergent behavior typical of systems where interactions between components (players and coaches) are key. Modest teams like La Equidad or Jaguares can surprise by defeating more powerful teams like Atlético Nacional or Millonarios, due to good teamwork or an exceptional tactical approach.

B. Cycle of success and positive feedback

This behaviour is emergent because financial and sporting success is not only linked to initial economic capacity, but is fuelled by sporting performance and the reactions of fans, creating a virtuous circle. Atlético Nacional, thanks to its successes both in the local league and in the Copa Libertadores, has been able to maintain a continuous cycle of high performance, increased investment, and growing support from sponsors and fans.

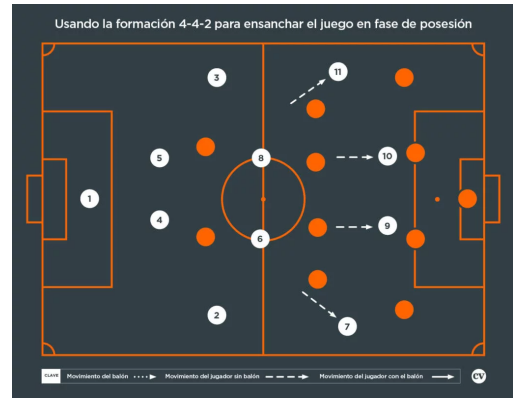


Fig. 2. Enter Caption

C. Effect of fans on team performance

This emergent behavior results from the interaction between players and fans. In stadiums with large capacity and highly engaged audiences, teams tend to exceed their expected capacities due to the emotional support they receive. In crucial matches, clubs like América de Cali, which has one of the largest fan bases in the country, usually improve their performance at home due to the unconditional support of their fans at the Pascual Guerrero stadium.

IV. IMPACT OF EXTERNAL FACTORS ON THE COLOMBIAN LEAGUE

A. Economic conditions

The fluctuations of the Colombian economy directly affect clubs. In periods of economic recession, teams tend to have fewer resources to sign players, which alters the dynamics of competition and can increase entropy in the system.

B. Government policies and sports regulations

Changes in football regulations (such as relegation rules, salary caps or the number of foreigners allowed) can create ripple effects throughout the league. This section may include an analysis of how decisions by Colombian football governing bodies have altered the course of several seasons.

C. Technological intervention

With the implementation of VAR (Video Assistant Referee), the impact on refereeing decision-making and how this affects team performance can be analysed under the framework of chaos theory. A goal disallowed by VAR can drastically change the trajectory of a match and, by extension, the season.

D. Sports rivalries and emerging tensions

Historical rivalries between certain clubs create high-tension emerging behaviour in some matches, regardless of the teams' position in the table. These matches generate additional pressure on both players and fans, which influences performance and can alter expected results.



Fig. 3. Enter Caption

E. Conclusion on emerging behaviors

In summary, the Colombian football league exhibits a series of emergent behaviors that result from the complex and dynamic interactions between its actors (teams, players, fans, media, sponsors, regulators). These emergent behaviors include phenomena such as synergistic team performance, positive feedback that reinforces success, inequalities between clubs, the influence of fans on performance, oscillations in performance due to external factors, and unforeseen team collapses. These patterns are difficult to predict and control, which makes the league a truly complex and fascinating system to study.

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