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Manipulation of Sports Competitions
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Group of Copenhagen



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Group of Copenhagen

Advisory Group to the Follow-up Committee on the Manipulation of Sports Competitions

Working Group on Performance Analysis Final report

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BACKGROUND

Modern tools for analysing sporting performance provide scientific expertise that could be used to detect and punish the manipulation of competitions. With this in mind, the members of the Group of Copenhagen have decided to set up a prospective working group on this subject, in order to examine the ins and outs of such an analysis.

CHAPTER 1 – OBJECTIVES AND ORGANISATION

The idea of a working group on “Sports performance analysis for Sports integrity” was accepted during the 7th meeting of the Group of Copenhagen in Oslo in February 2019. Different members decided to join this group, including representatives of including representatives from the Spanish, French, Dutch, Norwegian, Slovakian and Swedish national platforms.

The working group had three objectives:

- Identify companies and technologies on the analysis of sports performance;
- Make an assessment advantages-limits for the use of the analyses of sports performance;
- Think about the integration of the analysis of the sports performance to detect sports manipulations.

The analysis was carried out in three stages, firstly in 2019, with a review of the existing systems in each of the participating countries, then an analysis of the advantages and limitations of using this type of analysis and finally a test phase carried out by three companies specialising in the analysis of sports data or the detection of sports manipulation.

02-2019	03-2019	04/2019	05/2019	06/2019	07/2019	08/2019	09/2019	10/2019	11/2019
Action plan	State of play	Advantages	Limits	Report on the state of play	Test phase	Test phase	Test phase	Test phase	Test phase report

Planned for 2020, the final meeting of this project was postponed because of the confinement. In June 2022, the companies presented new results considering the latest technological advances. The working group drew up a final report in October 2022, for approval by the Copenhagen Group at its plenary meeting on 18 October. This approved report, which has been made completely anonymous, is being published today to promote the fight against the manipulation of sporting competitions.

CHAPTER 2 – WHAT ALREADY EXISTS IN OUR COUNTRIES

1. WHAT IS POSSIBLE WITH CURRENT TECHNOLOGIES

Several companies work on sports performance. The group has selected three companies presented in alphabetical order. Two are working on statistics methods (Footovision and StatsPerform), and one is working on the analytic approach (Good Game!).

Footovision

The French company Footovision specialises in football data collection. It can record up to 1000 performance indicators on a single match per player and team. Nearly 95% of this data is automatically collected thanks to artificial intelligence.

The difficulty, however, stems from analysing this indicator's data. Therefore, Footovision has developed a performance rating method based on PCA (principal component analysis), which consists of transforming linked variables (called "correlated" into statistics) into new variables. These new variables are called "principal components" or main performance axes. It allows the user to reduce the number of variables, such as the 1000 performance axis, into only ten and analyse each player's performance in each field of play quantitatively.

Good Game!

The French company **Good Game!** is dedicated to match-fixing detection and investigation, referring and VAR assistance. Its services are already used internationally by justice (civil courts), police and investigation services, sports betting operators and sports organisations. Several thousand matches are monitored live exclusively in football and tennis for the moment.

The MATCH-FIX® method developed by Good Game! is based on complex algorithms derived from artificial intelligence. The objective is to accurately distinguish unintentional errors that occur in all football matches or in other sports from intentional underperformances characterised by one or more voluntary actions of the players. The detection rate is over 99%.

Stats Perform

Based in London, Stats Perform is a market leader in sports tech, providing trusted sports data and the latest advancements in applying AI and machine learning. The company intends to deliver better predictions for teams, sportsbooks and a more engaging broadcast, media, and fan experience.

Their Opta division specialises in sports data and collects data across 3,900 competitions annually. Opta collects data to different levels of detail, with the lowest level having one analyst collecting over 1,200 data points on a typical match and the highest-level requiring collection by three analysts. The data collected includes the ball's location throughout a game, passing distances and pass direction, shot location, shot method (left foot, right foot, header) and shot direction.

The data feeds into analytical products used by sports teams and the media, including xG (expected goals), a measure of the quality of shooting opportunities for each team during a game. At the highest data collection level, Opta tracks players' movement on the pitch using AI technology and calculates distances covered, sprints and each player's speed throughout a match.

Opta collects data on matches independently of Stats Perform Integrity and in line with their standard processes to ensure the objectivity of the data collected. Stats Perform Integrity then investigate and analyse the data and match footage from an integrity perspective and have provided performance integrity analysis to over 20 sport's governing bodies worldwide to support investigations into 80+ suspicious matches.

Performance and betting analysis

Some of the companies interviewed work on sports performance and odds analysis in the sports betting market. The interviewees stated that at this point, there is no software capable of automatically collecting game data. A human operator is required for all game actions.

2. HOW COULD NATIONAL PLATFORMS USE IT TO FIGHT SPORTS MANIPULATION

The performance analysis could help law enforcement agencies and other professionals working in the field of integrity to better detect and prove competition manipulation. The results can be used as supporting evidence together with other analytical information or elements of proof to reach the applicable standard of proof. In any case, it may represent a valuable starting point for an investigation.

The tools developed by these companies could be a way to develop new clues for managing monitoring systems based solely on sports performance and to develop specific software for suspicious performance.

Lastly, it could also help identify risky games and help in the live surveillance of the competitions.

3. WHAT IS THE FUTURE OF SPORTS ANALYSIS FOR SPORTS MANIPULATION

Machine learning will help analysts improve the detection of sports manipulation, collecting data and even collecting some of the data itself. New algorithms will be developed to predict results more and more accurately. An important database is necessary for the statistical performance data (Stats Perform and Footovision). StatsPerform has both the database and the technology.

However, it is not the case for a method based on deficiencies identified and exclusively designed to detect suspicious performance (as Good Game!), which work without any database.

In addition to one of the largest sports performance databases, Stats Perform Integrity deploys sophisticated tools and visualizations in its performance analysis for match-fixing investigations. These visualizations are very useful in demonstrating the actions of a match in relation to integrity issues.

4. WHAT IS THE ECONOMIC MODEL

Stats Perform Integrity provides consultancy services to sports, and their capabilities leverage their access to the tools and data provided to elite sports teams and leagues worldwide.

Good Game! is a 100% independent service with no interest in the gambling or sports performance market. Their economic model is based on sharing information by various contributors via the [Bet True! platform](#).

CHAPTER 3 – ADVANTAGES OF WORKING ON SPORTS DATA PERFORMANCE FOR SPORTS INTEGRITY

Working on Sports data performance could be helpful both for the detection or in investigations concerning sports manipulation.

Purpose	Process	Perspectives
<p>DETECTION</p> <p>Automatic sports data performance analysis can help us to detect underperformance of a player or a team during a match.</p> <p>It is also an appropriate element to detect cases of manipulation that are not related to sports betting.</p>	<p>All ball data (number of passes, shots, distance from goal, visible angle, header, foot, pull-back, through ball, cross, danger zone pass, sequence time, progress of the ball, length, speed).</p>	<p>1- Currently, human intervention is essential in all existing video tracking systems, which makes it very expensive. But with the implementation of artificial intelligence, it will be possible in a short future.</p>
	<p>Geolocation of players GPS chips are used in several sports to collect data on the speed of the athlete, its acceleration, distance travelled.</p>	<p>2- The information given by GPS appears to be more easily used by artificial intelligence software and could facilitate detection at a reasonable cost but if they give information on the movements, they do not detail the movements. We think we can work on this subject.</p>
	<p>Compilation of data over several months is necessary to detect suspicious matches for classical performance data but not for specific deficiencies related to match-fixing.</p>	<p>3- Systematic and automatic data collection for classical performance data is inevitable to succeed the process, which is the biggest limit so far. We should work on it.</p>

INVESTIGATION Sports data performance's analysis can be very crucial in helping criminal investigations to determine which players participated to a match suspected to be fixed.	The combination of ball data and players moves can be very useful in the analysis of the behaviour of players.	4- We need a very scientific approach on players' behaviour, this could lead to be a complementary proof provision in court. We think we can work on this subject.
	Health data: Some new devices can record heartbeats, heart rate variability, and oxygen saturation which can help us to determine if a player made efforts or not.	5- Insofar, as these data are still too seldom collected, it seems difficult for now to consider using them in investigations. It may be too difficult to work on it.

CHAPTER 4 – LIMITS TO WORK ON SPORTS DATA PERFORMANCE FOR SPORTS INTEGRITY

Limits to the analysis of sports performance for the fight against the manipulation of sports competitions are multiple. They can be technical, legal, budgetary, or moral.

Technical limits	The storage of systematic and automatic data collection must be secured.
	The tracking methods are not yet adapted to all sports.
	A scientific approach can be fixed to represent a complementary proof provision in court.
	The risk of confusion between the manipulation of sports competition and sports strategy or natural underperformance, which is sometimes very delicate.
Legal limits	The European regulation on personal data must be respected, especially on sensitive data.
	Need to work with sport's governing bodies.
	Comply with public procurement and tendering procedures when using an external service provider ¹ .
Budgetary limits	Human cost in terms of tracking analysis.
	Human cost in terms of expertise.
	Human cost in terms of maintenance.
	Cost of adaptation to the sports movement.
	Cost to deliver the required data.
Moral limits	There is a risk of impact on the spontaneity of the game.
	This could create a climate of anxiety for athletes (all actions will be analysed/commented/viewed).
	There are discrepancies in the interpretation of the data.

¹ It should be noted that once a public/governmental organization enters into an agreement with a company for the provision of data, there are strict procurement/tendering procedures in place - it will probably be a European tender. This means that a public authority is not per se free to choose who to do business with.

CHAPTER 5 – TEST PHASE

As announced at the Copenhagen Group meeting held in Rennes in June 2019, the Slovak Football Federation shared videos of four matches played between 2016 and 2019. The companies involved were requested to analyse which matches were the ones on which the Slovak authorities had strong suspicions of manipulation. naturally without specifying which ones so as not to distort the study.

For some of these matches being investigated, the group decided to make them entirely anonymous for this report and will be quoted as follows: Match 2016, Match 2017, Match 2018, and Match 2019.

Three companies agreed to participate in the testing phase, which shows the interest in both the Group of Copenhagen and the subject, as it was neither a paid contract nor a tender.

Below are the participating companies in alphabetic order:

- Footovision (based in Paris, France);
- Good Game! (based in Lyon, France);
- Stats Perform Integrity (based in London, UK).

Footovision is mainly focused on the field of performance data analysis. Stats Perform Integrity and Good Game! are focused on integrity and anti-match-fixing, with a team experienced in performance integrity analysis to support external investigations.

The coordinators for the national platform's working group members would like to warmly thank these companies for participating in this test phase and for the time spent analysing the videos of these matches.

To complete the results, only the company Good Game! could analyse the 2016 match because the video arrived partially at the other companies.

The working group learned several lessons from the test phase.

LESSON 1: RESULTS CONFIRM THE SUSPICIONS (COMPANIES IN ALPHABETIC ORDER)

	Footovision	Good Game !	Stats Perform	Slovak Football Federation
Match 2016	No results (too low-quality footage)	Manipulated	No results (incomplete footage)	Match manipulated. The team was sanctioned.
Match 2017	Moderate suspicion	Manipulated	Moderate suspicion	Suspicious, possibly manipulated
Match 2018	No result (too low-quality footage)	Normal	No result (too low-quality footage)	No evidence of suspicion
Match 2019	No suspicion	Normal	No suspicion	No suspicion

Good Game!

The company concludes its analysis on a three-simple and accurate level scale for a match: normal, suspicious or manipulated.

This scale is based on a complex algorithm from key points analysis. The status is determined from the number of players with at least one deficiency, the maximum number of deficiencies for a player in that phase of game play, the type of keypoint and the type of deficiency and enables the following classification.

This scale is based on a complex algorithm derived from the analysis of key points. The status of a key point is determined by several elements:

- The status is determined from the number of players with at least one deficiency;
- The maximum number of deficiencies for a player in that phase of game play;
- The type of keypoint;
- The type of deficiency.

The combination of these elements determines the following classification:

1- Normal Keypoint	corresponds to a normal phase of game play without deficiency or to a specific phase of game play involving a limited number of players with at least one deficiency and a limited number of deficiencies for each of these players and types of minor deficiency
2- Potentially abnormal Keypoint	corresponds to a specific phase of game play involving a substantial number of players with at least one deficiency and/or a substantial number of deficiencies for at least one of these players and/or at least one type of major deficiency
3- Abnormal Keypoint	corresponds to a specific phase of game play involving a high number of players with at least one deficiency and/or a high number of deficiencies for at least one of these players and/or at least one type of major deficiency

Stats Perform

The company works from a scale that has 5 levels (Match Integrity Grading):

1. **No suspicion:** no indicators for integrity concerns
2. **Low suspicion:** considering all available information, integrity concerns around a match are low
3. **Moderate suspicion:** considering all available information, integrity concerns around a match are moderate
4. **Strong suspicion:** multiple factors indicate strong integrity suspicions around a match
5. **Very strong suspicion:** an assessment of the available information indicates the integrity of the match is likely to be compromised.

LESSON 2: THE METHODS USED ARE VERY DIFFERENT

Good Game!

The company worked on each match according to the following method. The MATCH-FIX method and software system, on which Good Game! holds any rights, use a multifactorial analysis of players' and referees' technical and tactical performances based on video analysis to identify manipulation in sports competition.

Match analysis is performed thanks to the MATCH-FIX software system through identifying and sequencing key phases of game plays called "key points". The players' performances within these critical points are then analysed to detect potential anomalies in the gameplay ("deficiencies") based on performance data which is quantifiable a posteriori (distance, time, speed, acceleration angles, reaction time, etc.)

The MATCH-FIX method then relies on the models of physical laws, biomechanics, and physiology to precisely distinguish the involuntary errors ("normal deficiency"), which occur in all football matches, from an intentional underperformance characterised by one or several deliberate actions of the players ("abnormal deficiency"). It enables the classification of those key points based on a three-step scale between "normal", "potentially abnormal", and "abnormal".

The MATCH-FIX method integrates an algorithmic processing of all those key points to conclude that the match was or was not manipulated. In case of manipulation, the system details for each player and the body of referees whether he/it is "involved", "potentially involved" or "not involved" or "not classified" (in the absence of analysis elements) in case of manipulation.

As part of this experiment, the working group agreed that Good Game! would only provide Level 1 reports on these four matches (3 pages/report), which are only used to determine the status of the matches between "Normal", "Suspicious", and "Handled". The Performance WG members read and used the level 2 reports provided by Good Game! (100-150 pages/report) which detail the involvement or not of each player on both teams or the referees. Level 3, with all metrics (150-300 pages), is for some civil courts.

Stats Perform

The company follows the process below:

Opta data collection	Data is collected independently of any investigation by Opta, with Opta's clear event definitions ensuring objectivity and data accuracy. Match data is presented to Stats Perform Integrity including team stats, distribution, duels, defence etc.
Setting context	The integrity concerns regarding a match are defined so that relevant on-field events and statistics can be identified and analysed. Are there suspicions one team been bribed to help their opponents avoid relegation, is there betting market support for Goals, could match officials be involved?
Opta data analysis	Match data is compared to Opta's historic database of over 130,000 matches to highlight irregularities in player and team performance. Anomalies in player or team-level data are flagged and analysed within the context of the integrity concerns on the match.

Opta visualisations	Opta's data visualisation software used by elite professional teams is used to display and analyse match data, highlighting players of concern and irregular team performances. Data visualisations available include pass maps, match supremacy, race charts and more.
Integrity Performance Ratings	All relevant match events are assigned an Integrity Performance Rating (IPR) on a scale between 1 ('No suspicion') and 5 ('Very strong suspicion'). Ratings are peer-assessed and compared with archive clips to ensure consistency.
Key event analysis	Key events including goals, red cards and events assigned IPRs of two or higher are selected for detailed qualitative analysis.
Annotated Video	Annotated video clips show the reader quickly and easily the areas of concern. Video editing can enable labelling of players, slowing down and zooming in on suspicious player actions and highlighting tactical and formation issues through video analysis.
Individual Player Analysis	Players of concern identified in the analysis are selected for forensic performance review including data and video analysis, as well comparative analysis across multiple matches. The likelihood of each player's involvement in match manipulation is set out.
Periods of Play Highlighted for Further Analysis	Specific periods of the match are identified for further analysis – can in-play betting patterns be justified through events on the pitch?
Conclusion	Every aspect of SPI's analysis is unified, and betting market analysis and any intelligence received are also referenced. Final conclusions on the integrity of the match and any participants of suspicions are presented, and an overall integrity grading is assigned to the match.

LESSON 3: A VIDEO OF GOOD QUALITY IS ESSENTIAL TO FACILITATE THE ANALYSIS OF THE SPORTS PERFORMANCE OF PLAYERS DURING A SPORTING EVENT

This observation was made by the three companies that agreed to participate in this test.

According to Footovision, which was unable to analyse the 2018 match...

"It is not difficult to improve the quality of the images on matches where risks of manipulation have been identified. The installation of a single camera at the height of 15/20 m, placed on the median line, gives a good tactical plan video. Otherwise, Footovision is in capacity to transcribe all the images of any TV video, ideally with a resolution of 1080p".

According to Good Game!...

"Our method and technologies allow us to analyse competitions even with a single low-quality video (wide shot). We have never had to deal with not being able to analyse a match because of the video quality. However, the higher the quality of the video and the more video sources (several camera angles), the better the quality of the analysis."

The observations of Stats Perform Integrity are particularly clear...

“High-quality match footage aids data collection, and analysis is made more difficult with low-quality footage. High-quality match footage comprises a good resolution video filmed from an elevated level to see all areas of the pitch. Replays recorded into match footage can be helpful but are not strictly necessary. In some cases, replays of significant events can overwrite other significant events and cause incidents to be missed. Multiple cameras covering an event are always beneficial.”

“The quality of the recording of match 2018 was below the minimum quality from which Opta could reliably collect player-specific information. Player numbers were frequently indistinguishable, creating a barrier to assessing individual player actions, and it was impossible to say with certainty that players were identified correctly. It is particularly the case where players are tightly grouped, for example, at corners or free kicks.”

“If players cannot be identified at the beginning of the match, the quality of match analysis is severely impaired, as is the potential for using the analysis in a formal investigation. The quality of the footage may be used to challenge the validity of the findings. The quality of footage required for analysis can differ depending on factors such as kit colour and weather, and as such no single minimum standard can be recommended.”

LESSON 4: THE RESULTS ARE VERY ENCOURAGING

The results can confirm the underperformance of several teams on suspicious matches and could lead the investigators to some players.

According to Footovision (Match 2017)

Example 1

“In many situations, Anonymous player one does not seem to be interested in the opponent's attacks (walk, far from opponents). We especially looked at his moves and positions during all Team A goals. The sixth goal is for us the most interesting (video).”

Example 2

“We especially looked at the 15/20 unsuccessful high passes, which are not made under pressure. For all of them, we count how many teammates and opponents are in the target area. We also count the number of aerial ball duals. Those results are compared with some second league average team games (season 2018/2019).”

	Anonymous player	Team B
Aerial ball duals (%)	24%	74%
No teammate in target area (%)	24%	17%
Mean of teammates in target area	0.93	0.94
Mean of opponents in target area	1.3	0.89

According to Good Game!

"We are the only company to produce and use data specifically dedicated to match-fixing detection. Our data have no interest, contrary to classical data, with performance in sport and, as such, are not accessible to a large public and could not be detailed and published in this report. Again, a Level 2 report provides all the information related to a potential match-fixing (which player(s) is/are involved? How are they involved? Which deficiencies? When?). With a detection rate over 99%".

According to Stats Perform

The conclusion made by Stats Perform Integrity regarding the match in 2017 is obvious:

"Opta data, performance analysis and betting market analysis all lead to serious concerns over the integrity of Team A, who under-perform in an almost unprecedented manner using the best available data for comparison.

The key takeaway from the Opta analysis is the pass completion rate of 50%. Only on two occasions from 9,485 matches used for comparison did a team's pass completion rate drop below 50%, and one was affected by two red cards (Le Havre vs Toulouse in January 2009).

In isolation, there is a possibility that Team A's historically low passing rate was influenced by form/fatigue. An analysis of a more comprehensive selection of matches would allow more robust conclusions. However, when considering the abnormal data points identified, coupled with suspicious betting patterns that predicted rather than reflected on-field events, it isn't easy to draw any other conclusion than there are strong concerns over the integrity of Team A's performance in the match in question.

For Team A to be priced the same when a goal down as they were five minutes previously with the scores 0-0 is such an irregular market move, signifying such extreme confidence in a comeback for Team B that, when supported by the performance analysis, points to a high likelihood that elements of the match were pre-determined".

Stats Perform Integrity ranks the players with a positive rating, making it possible to clear relevant players (i.e., the goalkeeper is not suspected).

Stats Perform Integrity included betting market analysis and intelligence alongside performance analysis. They partly motivated this decision by findings from the Court of Arbitration for Sport (CAS) regarding their arbitration in this match.

"The conclusion that "normal" circumstances cannot explain the statistical information does not necessarily imply the conclusion that the results must be explained by match-fixing. To conclude that a match is fixed, the analytical information must be supported by other, different, and external elements pointing in the same direction. It is necessary to distinguish between so-called quantitative data and qualitative analysis, which is also required."

In conclusion, the working group welcomes this choice, again demonstrating that exchanging information from different sources is mandatory to fight against sports manipulation. Moreover, national platforms have an essential and central role to play in collecting and exchanging information.

POSSIBLE NEXT STEPS

With this report, the working group completes this first comparative study. At the end of the plenary meeting in October 2022, the Copenhagen Group must decide on a possible follow-up.

Cooperation with prosecutors

On November 2022, the Council of Europe will launch the Magistrates Network responsible for Sports (MARS). The prosecutors are interested in performance analysis to help them in their investigations.

The working group proposes to publish this report and share it with the prosecutors of the network because. As noted by one of the companies: *“following the analysis by the three companies, a key next step to explore would be exploring the admissibility of performance analysis in the legal and disciplinary proceeding”*.

Cooperation with UEFA

Already working in this rather innovative sphere, UEFA joined the Performance Working Group in June 2022 and attended the presentation of the three companies involved in the pilot project as well as contributed to the following discussion. UEFA is interested in the potential of methodologies that could help proving and/or detecting match manipulation by analysing on-pitch performance. In this regard, UEFA suggested to closely monitor the development in this field and invest resources where appropriate.

APPENDIX – LIST OF COMPANIES SPECIALISED IN DATA SPORTS

In grey are the ones which participated to the Test phase.

Accenture	Irish	https://www.accenture.com/	Multisports
Catapultsports	Australian	https://www.catapultsports.com/about	trackers
Footovision	French	https://www.footovision.com/	Football
Good Game!	French	https://goodgame.sport	Multisports
Hawk-Eye	English	https://www.hawkeyeinnovations.com/	Multisports
Hypercube	Dutch	https://www.hcube.io/fr/plateforme/	Multisports
La Liga	Spanish	https://www.laliga.es/	Football
Mac Lloyd	French	http://mac-lloyd.com/	Trackers
Mojjo	French	https://www.mojjo.fr/	Tennis
Stats Perform	English	https://www.statsperform.com/integrity/	Multisports