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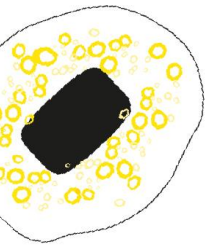

A strategic toolkit for IoT integration in professional football: Talent identification as a case study – a design science approach

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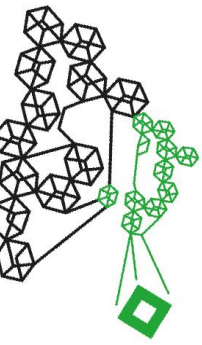

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Stefan Overbeeke,
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Abstract

The integration of IoT technologies is playing an increasingly significant role in the professional football industry, where the strategic use of data can provide a competitive advantage. This research focuses on developing a strategic decision-making model to support football clubs in making informed choices regarding IoT implementations. Although talent identification is used as a case study to illustrate the model, this research demonstrates that the applications extend far beyond this, encompassing player monitoring, performance analysis, and technological innovation at the club level.

The study combines a literature review, interviews, and case studies involving three Dutch football clubs with varying levels of IoT integration. The findings reveal that successful implementation depends not only on technological capabilities but also on strategic vision, organizational capacities, and partnerships with technology providers. Key insights emphasize the critical role of a holistic approach to technology integration, where clubs consider not only the technological benefits but also organizational challenges such as balancing traditional scouting skills with technological reliance, building internal expertise in data usage, and ensuring effective collaboration with technology partners.

The developed model offers a robust framework for clubs to evaluate and prioritize their IoT strategies based on benefits, risks, and opportunities. Moreover, the study highlights the need for an industry-wide standard for IoT applications in sports, which could contribute to the professionalization of the field.

This research contributes to both academic knowledge and practice by presenting a practical and flexible model that helps clubs strategically deploy IoT technologies, not only in talent identification but also across various organizational processes. The findings underscore the importance of an integrated approach to technology and strategic management. Additionally, the strategic tool provides practical guidance for clubs to implement technologies that not only enhance talent identification but also improve overall performance and competitive advantage.

Keywords: Internet of Things (IoT), Strategic Management, Professional Football Clubs, Talent Identification, IoT-BALL Analysis

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1 Introduction

This chapter serves as the introduction to the research. Section 1.1 provides a description of the motivation behind this study, including background information and the limitations of current practices. Section 1.2 defines the research objectives and scope. Subsequently, Section 1.3 introduces the research question. Finally, Section 1.4 outlines the academic and practical relevance of the study.

1.1 Situation and complication

"Data experts are becoming football's best signings," according to a BBC news article (Harper, 2021). The use of data is gaining increasing attention in football, with examples such as: "Champions PSV also lead in data analysis" and "Willem II sees video analyst depart for a Dutch top club" (Van der Beek, 2024; Sportredactie, 2024). Internationally, clubs like Arsenal in the Premier League are also investing in data expertise, as seen in Arsenal's recruitment of a video analyst from Malmö FF (Training Ground Guru, 2021).

These advancements are driven in part by the rise of the Internet of Things (IoT). In 2023, there were 15.7 billion IoT devices worldwide (Transforma Insights, 2024). According to McKinsey, an IoT device is an object equipped with sensors and actuators that communicate with an external network (Chui et al., 2021). IoT offers organizations opportunities to innovate and improve operational efficiency. Chui et al. (2021) identify IoT as one of the key trends in the digital transformation of businesses and economies. IoT devices range from everyday objects like household appliances to more complex systems such as industrial machinery and medical equipment. Generally, these devices are used in domains such as human bodies, homes, retail environments, offices, standardized production environments, custom production environments, vehicles, cities, and outdoor spaces (Manyika et al., 2015).

Data and video analysts in football, as highlighted in news articles, often utilize data collected through IoT devices. Camera systems play a significant role, alongside smart sensors in balls and wearable technologies like monitoring vests. Wearable technology, as described by Godfrey et al. (2018), includes devices such as monitoring vests, smartwatches, and shoes that collect data on physical performance, heart rate, and movement patterns. These technologies illustrate the growing adoption of IoT in sports.

A Deloitte study emphasizes that increasing digitization forces the sports industry to adapt (Deloitte Development LLC, 2018). IoT bridges the physical and digital worlds. According to Deloitte Development LLC (2018), this transformation is changing how teams operate, train, and engage with fans. A notable example is the disallowed goal by Belgium during the UEFA Euro 2024, where an inertial measurement unit (IMU) in the ball provided crucial evidence of a handball. This technology, visualized on television through a ball "heartbeat" graph showing its movement, was used for the first time in a major tournament and demonstrates IoT's impact on the game.

IoT technologies are increasingly embraced in football to collect detailed data during training sessions and matches. These data help optimize player performance, prevent injuries, and enhance tactical strategies. However, IoT also raises strategic questions for clubs: which technologies should they implement, who will manage these integrations, and how reliant should they become on IoT for decision-making? These questions highlight that IoT is not just about technology but also strategy.

Integrating IoT requires a broader vision where technologies are effectively implemented by a team of experts. Clubs vary in their approaches depending on financial resources and strategic goals. Understanding where, when, and how to use technology is crucial for a club's long-term strategy.

Although the strategic questions surrounding IoT are broadly applicable across various domains in professional football, this research focuses specifically on talent identification as a case study. Scouting and identifying new talent using innovative technologies highlights the value and challenges

of IoT implementation in football. By focusing on a single domain, namely talent identification, we gain in-depth insight into the strategic considerations and questions relevant to IoT adoption. This targeted approach allows for a detailed exploration of how IoT can be optimally used.

The strategic issues surrounding the use of IoT in talent identification form the foundation of this study. Talent identification is crucial for every professional football club. Football is the world's most popular sport, with approximately 3.5 billion fans and 250 million players across more than 200 countries. Identifying new talents like Lionel Messi or Kylian Mbappé remains a challenge for professional football organizations (PFOs), where technological support plays an increasingly significant role.

The success of professional football organizations, despite football's global popularity, largely depends on the quality of their players. Star players often represent significant financial value, making it challenging for clubs with limited resources to remain competitive. To distinguish themselves from financially stronger competitors, clubs like Brentford FC and FC Midtjylland adopt innovative, data-driven strategies. These clubs integrate data analysis into all aspects of club management, such as strategically substituting fatigued players and identifying talent using tools like the "Table of Justice." This demonstrates the power of an analytical approach (Soccerment Research, 2020).

For clubs with limited resources, it is particularly crucial to identify talented players early, before their market value increases. This underscores the importance of strategic and technological support in talent identification processes. IoT technologies offer significant potential in this regard, yet little in-depth research has been conducted on how these technologies can be effectively integrated into the strategic decision-making of professional football organizations.

This gap in the existing literature provides an opportunity for so-called "blue water research." While numerous studies have explored IoT applications in other sectors, there is a lack of comprehensive analysis on how professional football organizations should strategically approach IoT adoption, with talent identification serving as a key case study. Addressing this knowledge gap can not only broaden the scientific foundation but also drive innovation and competitive advantage in the football industry.

By combining IoT capabilities with the growing demand for data-driven decision-making, it becomes compelling to explore how clubs can make strategic choices about adopting IoT technologies, particularly in the context of talent identification.

1.2 Research objective and scope

Data experts and IoT technologies are playing an increasingly significant role in football. The integration of IoT enables clubs to collect and analyze detailed and valuable data, such as monitoring player performance through wearables or gaining in-depth insights using optical sensors. However, these technological advancements raise important strategic questions: how can football organizations effectively deploy IoT to support both specific processes, such as talent identification, and broader organizational goals?

This research aims to support professional football organizations in making strategic decisions regarding the use of IoT technologies. By developing a strategic toolkit based on the IoT-BALL analysis, clubs are provided with a structured framework to analyze the benefits, associated risks, leveraging potential, and limitations of IoT integration. This toolkit not only assists clubs in talent identification but also facilitates strategic decision-making across other domains within their organization.

The tool serves as a means to an end, not an end in itself. The primary objective of the research is to offer clubs practical and strategic guidance, enabling them to understand how IoT devices such as sensors, wearables, and smart cameras can enhance various processes. While talent identification is

used as a case study, the toolkit is designed for broader application across the organization. This allows clubs to integrate IoT technologies not only in scouting processes but also in other strategic domains.

The research specifically focuses on the Netherlands. Studies by Bullough & Coleman (2019) and Poli et al. (2021) demonstrate that the Netherlands, with its advanced youth academies such as Ajax's, is at the forefront of developing talented football players. By concentrating on Dutch clubs, logistical and practical challenges, such as long travel distances and cultural differences, are minimized. This approach enhances the efficiency and quality of data collection and analysis.

This research provides a strategic and practical approach to the integration of IoT in professional football organizations. It offers clubs the opportunity to leverage IoT not only to improve specific processes, such as talent identification, but also to develop broader strategic competencies, thereby strengthening their competitive position in the long term.

1.3 Research question

This research focuses on developing a strategic tool to support football clubs in making decisions about the use of IoT for various processes, such as talent identification. The research question is:

How can a strategic tool be designed to support professional football clubs in strategic decision-making about the use of IoT, with talent identification as a key case study?

1.4 Academic and practical relevance

This research into the strategic integration of IoT technologies in professional football provides both academic and practical value.

Academic relevance

This study contributes scientifically to the limited body of literature on the application of IoT in sports science, with a specific focus on talent identification in football. It addresses a critical gap by exploring how IoT technologies can be strategically integrated into the decision-making processes of sports organizations, using talent identification as a case study. While IoT applications such as wearables and sensors are more commonly studied in other sectors, knowledge about their effective implementation in sports remains scarce. This project can be considered "blue water research," exploring new and uncharted areas within sports science and data analytics. By analyzing the benefits, associated risks, leveraging potential, and limitations of IoT use in the context of professional football clubs, this research extends the scientific understanding of IoT in sports.

Additionally, the study contributes to the development of new theoretical frameworks and methods for data collection and analysis in sports science. It provides insights into how technological innovations can transform the operational processes and long-term strategies of sports organizations. By selecting talent identification as a case study, the research offers in-depth insights that can be applied to broader organizational challenges.

This research opens new perspectives and offers valuable directions for future studies, including the impact of technological innovation on talent identification processes and broader topics such as athlete development and health.

Practical relevance

From a practical perspective, this study addresses the growing need for professional football clubs to make data-driven decisions in an increasingly competitive industry. The strategic tool developed through this research provides clubs with a structured framework to evaluate and implement IoT technologies effectively. The results can be directly applied to enhance talent identification strategies, offering competitive advantages to both large and small organizations. Moreover, the insights gained from this specific case may also be applicable to other domains within football organizations once fully understood.

IoT technologies such as monitoring vests, smart cameras, and ball-tracking systems enable clubs to gain detailed insights into both player performance and tactical analyses. Using these technologies can help clubs make better data-driven and strategic decisions, resulting in more efficient resource allocation, improved scouting processes, and a stronger competitive edge. Additionally, the research offers practical guidelines to help clubs strike a balance between technological innovation and organizational flexibility.

In summary, this study provides academic value by generating new knowledge and methods in sports science and practical value by delivering concrete tools and insights to help football clubs leverage technological innovations. It lays the foundation for both scientific advancement and practical improvements in talent identification processes within professional football.

2 Methodology

This chapter outlines the methodology for the research into the strategic application of IoT technologies in football, using talent identification as a practice-oriented case study, including the development of the IoT-BALL analysis-based strategic toolkit. First, the chosen research methodology is explained, detailing why this approach is suitable for the study. Next, the various steps are discussed, including the unit of observation and analysis, the data collection process, and the method of data analysis.

2.1 Research design

As discussed in the introduction, the aim of this research is not to design a specific tool but to provide strategic guidance to football clubs in integrating IoT technologies into their broader processes. Talent identification serves as a practice-oriented case study to explore the challenges and opportunities of IoT implementation. This research develops a strategic toolkit based on the IoT-BALL analysis, which assists clubs in making well-informed strategic decisions about the use of IoT technologies. The toolkit acts as a means to translate insights from the analysis into practical, data-driven strategies rather than being the primary objective of the research itself.

The developed tool will function as the research artifact. An artifact is a created object or concept that emerges from research and offers valuable insights or solutions (Hevner, 2007). A suitable research methodology for developing an artifact is the Design Science Research Methodology (DSRM) by Peffers et al. (2007). This methodology comprises a structured process consisting of six steps. While the process is typically sequential, it allows for iterations by revisiting earlier phases, making it suitable as an iterative research method.

By iteratively progressing through the six steps, an artifact is created and evaluated at least once by a stakeholder during the process. This iterative approach enables continuous refinement and adaptation of the artifact to user needs, increasing its chances of success and acceptance in practice (Peffers et al., 2007).

Figure 1 provides a visual representation of the methodology as applied in this research, based on the DSRM by Peffers et al. (2007). Between the six steps, elements are included that represent essential types of knowledge and processes for creating and evaluating effective solutions (Peffers et al., 2007, pp. 7-9). These elements act as inputs and outputs within the different stages of the DSR process, illustrating how they are interconnected and contribute to valuable and relevant research outcomes. This also highlights the iterative nature of DSR, where insights and knowledge from earlier phases are leveraged to further enhance and refine the process.

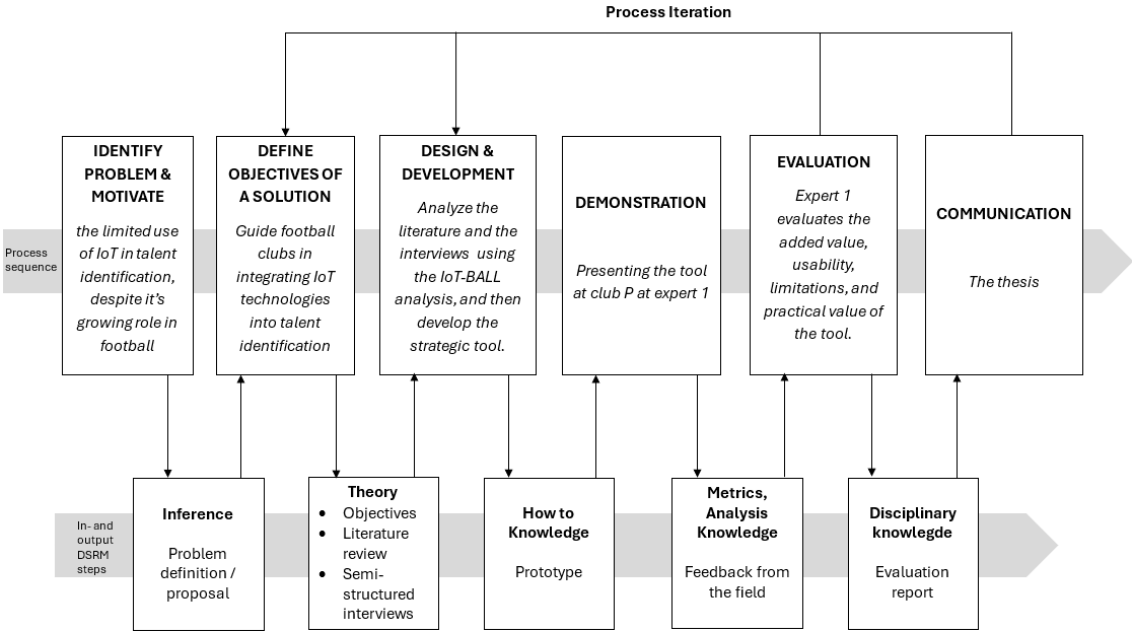


Figure 1: Research Methodology Process Model for this study (Peffers et al., 2007, p. 44)

2.2 The research design of the strategic toolkit

The methodology consists of six steps that lead to the development of an artifact, in this case, the strategic toolkit. Below is a description of these six steps:

1. Problem identification and motivation

The first step according to the DSR process is identifying the problem and the motivation for the research (Peffers et al., 2007). Football clubs are experiencing a growing need for data-driven decision-making, with technologies such as IoT becoming increasingly important. Traditional methods often cannot provide the desired level of accuracy and objectivity. IoT technologies enable the collection of detailed and real-time data, which can help clubs optimize both strategic decisions and operational processes.

Despite the growing relevance of IoT in football, there is limited in-depth research on the strategic use of these technologies, especially in areas such as scouting and other organizational processes. This presents an opportunity for new research, which can be considered 'blue water research'. By combining IoT with data-driven decision-making, the effectiveness of strategic choices within clubs can be enhanced, potentially providing them with a competitive advantage. The central research question and the full motivation for this research are described in Chapter 1.

2. Define the objectives for a solution

Based on the problem identification discussed earlier in Chapter 1, the objectives for the solution are defined. The aim of this research is to support football clubs in their strategic decision-making regarding the use of IoT technologies, not only in talent identification but also in other relevant processes within their organization. This support is provided through a strategic tool that assists clubs in integrating IoT technologies into their operations.

The tool serves as a means to optimize strategic choices by offering a structured framework that helps clubs assess the effectiveness of IoT technologies across various domains. The tool provides concrete guidelines and scenario analysis, which not only contributes to a better understanding of their current situation but also aids in formulating strategic objectives and making data-driven decisions.

3. Design and development

In this phase, the artifact is created: the strategic toolkit. The input for this step comes from step two, namely the objectives for the solution. However, additional information is needed to develop a prototype of the strategic toolkit. Therefore, a qualitative approach to data collection was chosen. As Seawright and Gerring (2008) state, qualitative data collection is often used in studies that require in-depth analysis, which aligns well with the objectives of this research.

The data for this phase was collected using two methods: a literature review to identify key concepts and potential building blocks for the tool, and semi-structured interviews with experts. The choice of interviews is particularly relevant because the research focuses on 'blue water research,' where innovative insights are sought based on practical experiences and expertise. Both methods are further explained in the following sections. Finally, it is explained how the collected data was analyzed and how this contributed to the development of the strategic toolkit.

3.1. Literature review

The next chapter will consist of a collection of secondary data, also known as a literature review. The literature review will serve as a data collection method to gain insights into the key concepts and potential building blocks for the tool. Kitchenham (2004) describes a systematic literature review as secondary research used to identify, evaluate, and interpret all available studies relevant to a topic of interest. The literature review will consist of three phases: planning, execution, and result analysis. The planning phase aims to minimize bias and maximize consistency, for which a research strategy and process are described. Through a preliminary study, several relevant search terms have already been identified. These were then used in the execution phase to find relevant articles in various academic databases. The found articles were then assessed based on inclusion and exclusion criteria. Finally, the remaining articles were thematically categorized. This helps to identify and communicate the key themes and patterns in the literature, which is essential for understanding the current knowledge on the subject and formulating conclusions based on the collected literature. Chapter 3 will provide a detailed explanation of the literature review process.

3.2. Expert interviews

In addition to the information gathered from the literature review, data was also collected through semi-structured interviews with experts in the fields of IoT, football, policy, and talent identification. Adeoye-Olatunde and Olenik (2021) describe a semi-structured interview as a flexible and structured data collection approach that allows the researcher to obtain in-depth information while maintaining focus. The key feature of a semi-structured interview is the use of an interview guide with open-ended questions addressing the main themes and research objectives. The researcher has the freedom to ask additional questions and follow up based on the responses of the interviewee, providing room for new insights and the exploration of unexpected topics that arise during the conversation.

The primary goal of this qualitative empirical data is to gain insight into how different experts perceive the potential added value of IoT technologies for talent identification and development in football, using this domain as an example for broader application across various strategic areas. This includes analyzing the interviews and integrating the results into the strategic toolkit, which helps clubs make informed decisions regarding the use of IoT in various domains.

For the selection of experts, convenience sampling was employed, a non-random sampling method where participants are selected based on their availability, accessibility, or willingness to participate in the study (Etikan et al., 2016). This method was chosen due to practical considerations, such as time and cost savings, and limited the sample to experts working in professional football organizations in the Netherlands. This geographical framework prevents the sample from being overly fragmented and allows for relevant insights within a realistic research scope.

Within the selected organizations, snowball sampling was then applied, where an initial contact person often referred to other relevant experts within the same organization. While snowball sampling carries

the risk of selection bias (such as a limited diversity of perspectives within the same network), this bias was partially mitigated by the initial phase of convenience sampling, which ensured a broad selection of organizations. By interviewing experts from various professional football organizations with diverse backgrounds and responsibilities, an effort was made to obtain as diverse a picture as possible of the opinions, experiences, and challenges surrounding IoT applications in football and talent identification.

While both sampling methods have practical limitations, they complement each other in this research. By first selecting a geographically diverse group of organizations and then referring to additional experts within these organizations, the risk of one-sided or limited perspectives is minimized. At the same time, it is acknowledged that generalizability is limited due to the non-random nature of both sampling methods.

Once the correct contact details of experts with the necessary knowledge were obtained, the semi-structured interviews were conducted. These interviews often began with specific questions, but offered the interviewee the freedom to share their thoughts and experiences as the conversation progressed (Adeoye-Olatunde & Olenik, 2021). This flexibility makes the method particularly suitable for exploratory research, such as this study within 'blue water research'. The goal is to gain new insights and valuable perspectives on the role of IoT technologies in strategic decision-making, with talent identification serving as an example of broader organizational applications. This aligns with the exploratory nature of the research, which is focused on identifying opportunities and challenges in a relatively unknown research area.

The interviews can be considered in-depth interviews, providing detailed insights into the application of IoT technologies in strategic decision-making. A standard questionnaire was developed and used as a guide for the interviews, but spontaneous questions specific to each interview also emerged during the conversations. The interview guide can be found in Appendix D.

3.3. Data analysis

A crucial aspect of qualitative research is the interpretation of the collected data; it is essential to carry this out as accurately as possible. To ensure that important information is not lost, the interviews are recorded. The recorded interviews with the experts are transcribed afterward. This will be done using transcription software, namely Happy Scribe. Since the interviews are conducted in Dutch, the interviews will also be transcribed in Dutch. This is because translating qualitative data is almost always subject to some degree of subjectivity (Temple & Young, 2004). For this reason, only the quotes that are relevant to the research will be translated into English. To minimize the risk of bias in the translation, the translation software deepl.com will be used.

Next, all the collected data will be analyzed using a thematic analysis (Nowell et al., 2017). The transcriptions will be reviewed, relevant sections will be coded, and grouped within the four categories of the IoT-BALL analysis: internal factors (benefits and associated risks) and external factors (lucrative opportunities and limitations). This thematic categorization helps to systematically organize and analyze the data, so that both the benefits and challenges of IoT technologies in strategic decision-making, with talent identification as a case study, are clearly mapped out.

3.4. Development of the strategic toolkit

The development of the strategic toolkit builds upon the results of the IoT-BALL analysis, which forms the foundation for the design and structure of the tool. The IoT-BALL analysis identified four key categories: benefits, associated risks, leveraging potential, and limitations, each containing three themes. In total, twelve themes emerged, which were used as the basis for formulating strategic questions within the tool. The questions are designed to help organizations reflect on their current strategies and the potential impact of IoT on their strategic decision-making processes, with talent

identification as an example. Each question has three or four response options, enabling clubs to evaluate their situation and make strategic decisions regarding IoT use.

The strategic toolkit is intended as a self-assessment tool that allows professional football organizations to analyze their use of IoT technologies and make strategic choices. The questions are structured to challenge the user to reflect on both their current status and future ambitions. The goal is to raise awareness of the different aspects of IoT implementation, enabling clubs to make informed decisions. While the results of the IoT-BALL analysis served as a guide in the development of the tool, its implementation is refined through user-specific feedback and practical experiences to improve usability and functionality.

4. Demonstration

Since the Design Science Research Methodology (DSRM) was chosen, it is essential to have at least one iteration in the development process of the tool. This allows the strategic toolkit to be tested in practice, feedback to be gathered, and improvements to be made where necessary. In line with this iterative approach, a demonstration of the strategic toolkit was organized via an online Teams meeting. During this session, the first version of the tool was presented to Expert 1 from club A, a Data Scientist with extensive experience in data, technology integration within the club, and talent identification.

To structure and deepen the feedback, four structured interview questions were asked during the demonstration. These questions were specifically designed to provide the expert with insights into the added value, usability, limitations, and practical value of the tool in the context of the club. By asking these targeted questions, valuable feedback was collected that not only evaluated the overall functionality of the tool but also the specific components and strategic questions that may need optimization.

5. Evaluation

The evaluation focuses on assessing the added value, usability, limitations, and practical value of the developed tool. After the demonstration of the tool to Expert 1 from club A, the collected feedback was analyzed based on the four structured interview questions asked during the session. These questions were specifically designed to gain insights into the added value, usability, limitations, and practical value of the tool within the context of the club. Expert 1's responses provided valuable input for further refining the tool.

The insights gained from this evaluation formed the basis for the first iteration of the tool. The feedback was incorporated to further refine the tool so that it not only better aligns with the practical needs of the clubs but is also more broadly applicable for strategic decision-making regarding IoT applications, with talent identification as a case study.

6. Communication

The final phase involves communicating the research results. This includes preparing a comprehensive research report, presenting the results to the academic community, and sharing the tool with football clubs. This research will be published on the University of Twente's website.

3 Theoretical background and literature review

In this chapter, the key theoretical concepts and findings from the literature are discussed regarding the application of the Internet of Things (IoT) in football, with a specific focus on talent identification as a case study. This case study is used to gain broader insights into strategic issues related to the integration of IoT in professional football organizations. The theory will primarily focus on the application of IoT in talent identification, which will ultimately help shape strategic considerations for broader IoT integration.

The literature review is structured according to the methodology of Stanković (2020), which integrates the insights of Kitchenham (2004) and Rouhani et al. (2015) to conduct a systematic literature review (SLR). The SLR is divided into three phases: planning, execution, and reporting, with this methodology further supplemented by the snowball method of Wohlin (2014) to gain broader and deeper insights into emerging research areas, such as the integration of IoT in professional football.

While the systematic approach ensures consistency and transparency, the snowball method has played a key role in identifying additional literature that might otherwise have been overlooked, particularly in interdisciplinary domains. These combined methods provide a more holistic overview of the literature and allow for deeper insights into how IoT is applied in talent identification and other strategic aspects of football organizations. This will be further elaborated in the section on the execution stage, where the use of the snowball method and its added value for this research will be explained in more detail.

3.1 Systematic literature review process description

Figure 2 below visualizes the approach for conducting the systematic literature review.

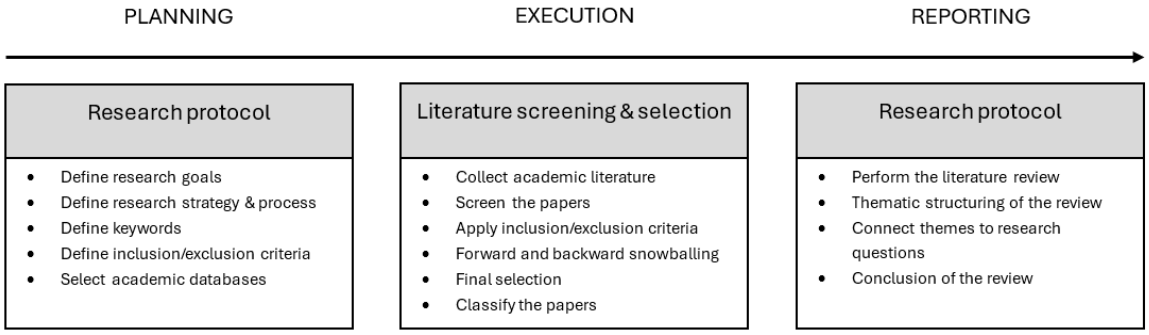


Figure 2: Visualization systematic literature review approach for this study

3.1.1 Planning stage

To avoid selection bias and publication bias, a systematic research strategy and process have been established to maximize consistency in selecting literature. Selection bias is prevented through the use of clearly defined inclusion and exclusion criteria, ensuring that literature is selected transparently and objectively, without favoring certain studies that may not be representative of the entire research domain. This ensures that the selected literature provides a balanced representation of different perspectives and approaches (Hernán et al., 2004).

Furthermore, publication bias is avoided by ensuring that only relevant articles published between 2015 and 2024 are included. This prevents the inclusion of only studies with positive or significant results, while excluding studies with negative or non-significant findings. Additionally, academic databases are carefully chosen based on their reliability and relevance to the topic, ensuring that a wide range of studies is included. This results in a representative and balanced selection of literature (Song et al., 2013).

The first step in the systematic research strategy and process is to establish research objectives for the literature review. The most important objective was to summarize the existing knowledge base, identify gaps in the current literature, and appropriately position new research activities. It is essential not only to investigate talent identification but also to gain strategic insights that could be relevant to other areas of the football organization.

In the next phase of the research strategy, academic databases were selected, namely Scopus, ACM Digital Library, IEEE Xplore, and AIS e-Library. These databases were chosen based on recommendations from fellow students, scholars, previous experiences with using them, and the volume of relevant and related literature. Based on exploratory research, including during the writing of the introduction, various keyword combinations related to IoT and talent identification were formed.

The search keys used for the academic databases were:

- *'iot AND football OR soccer AND identification'*
  OR *'iot AND football OR soccer AND development'*
  OR *'iot AND football OR soccer AND scouting'*
- *'iot AND "football player" OR "soccer player" AND identification'*
  OR *'iot AND "football player" OR "soccer player" AND development'*
  OR *'iot AND "football player" OR "soccer player" AND scouting'*

By using the term 'football', this could also yield results related to 'American football'. However, the semantics of the search terms made it clear that this research is specifically focused on the application of the Internet of Things in (European) football. When search results were related to 'American football', they were immediately filtered to ensure the relevance of the literature.

Additionally, inclusion and exclusion criteria (Table 1) were established to filter the relevance of the search results. One of these criteria was to include only journal articles, conference papers, books, theses, and whitepapers published between 2015 and 2024 to ensure the currency and avoid outdated data in the thesis.

The full systematic literature review protocol can be found in Appendix A.

Table 1: Inclusion/exclusion criteria for the systematic literature review

Include	Exclude
Papers about Internet of Things and sport	Papers that only conceptualize data-driven decision making
Papers about Internet of Things and talent identification	Papers that only conceptualize machine learning
Papers about football/soccer and sensor data	Papers that only conceptualize Internet of Things
Only include sources published in the period 2015-2024	Papers outside of the topic and not in English or Netherlands

3.1.2 Execution stage

After the planning is completed, the execution of the systematic literature review follows. During the execution stage, the selected keywords and criteria are applied to identify, select, and analyze relevant papers. The literature screening process is carried out through several steps. In the first step, the list of papers was filtered based on titles. A further selection was made by reading the abstracts of the remaining papers. Finally, the full texts of the remaining papers were reviewed.

During the full-text review, the relevance of the study was confirmed. The papers primarily focus on technologies such as IoT combined with data analysis in football, but there is limited attention to the role of talent identification and scouting as an additional component. When this third component is present, it is often missing another element, such as IoT or football. This indicates a scientific gap in combining these three components.

To address this gap, additional papers specifically focusing on football and aspects of identification, development, and scouting were searched for. Other databases were also consulted for this purpose. Then, the backward/forward snowball method by Wohlin (2014) was applied. This method was chosen for its strength in identifying additional relevant literature that may be overlooked in a standard search. By analyzing both the references of selected articles and the studies citing these articles, the comprehensiveness of the literature collection was enhanced. For a detailed description of the execution of this method, see Appendix B.

This approach aligns with critical discussions in the literature, as described by Boell and Cecez-Kecmanovic (2015), who argue that a purely systematic literature review may not always be sufficient to obtain a complete picture, especially in multidisciplinary fields. While SLR methods provide transparency and reproducibility, it is recognized that additional methods, such as the snowball method, can be essential to obtain a broader and more nuanced overview. The snowball methods led to the discovery of 13 additional papers that delve deeper into identification, development, and scouting within football.

Therefore, it was decided to divide the literature section into two parts. The first part focuses on the Internet of Things in combination with football, while the second part addresses talent identification and scouting within football. This division clarifies how the information is organized within academic databases and highlights the gaps in the literature concerning these three components.

The visualization of the entire systematic review process can be found in Figure 3, which resulted in 26 sources.

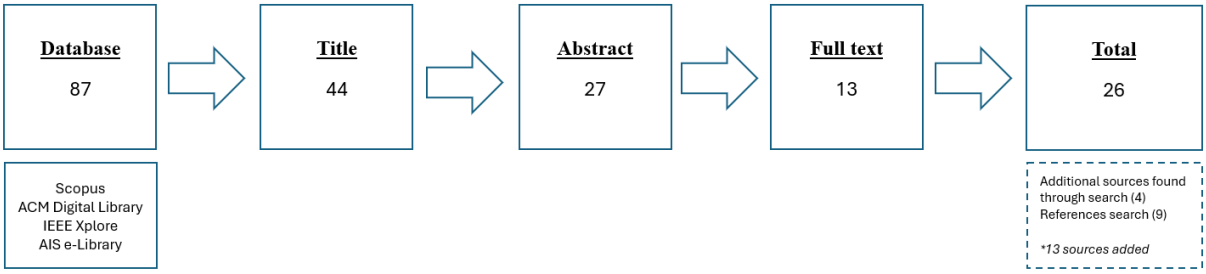


Figure 3: Systematic literature review process and results

The hybrid approach of a systematic literature review, supplemented by the snowball method, was intentionally chosen to meet the specific needs of this research. This choice not only targets completeness but also validity and reproducibility. As previous criticisms of SLR methods indicate, a strict application of systematic methodologies can pose limitations in interdisciplinary contexts. The snowball method was, therefore, used as a supplement, with the aim of obtaining in-depth and interconnected insights.

Although the ratio between systematically found and snowball-found sources is equal, this does not indicate a flaw in the SLR methodology. On the contrary, it demonstrates that additional methods are necessary to effectively address a scientific gap. This approach was designed to be transparent, as all steps have been carefully documented, including criteria, search terms, and selected databases. While the snowball method is not fully reproducible due to its dependence on subjective choices and changing citation patterns, the process in this study was systematically executed by assessing the found sources based on predetermined criteria. Although detailed documentation of individual steps is not available, the consistent application of these criteria provides a level of transparency and reliability that is appropriate within the context of this research.

This literature review not only highlights the technological possibilities of IoT in football but also offers crucial insights into the strategic implications of these technologies. By examining the benefits, risks, limitations, and potential applications of IoT, clubs can make better-informed decisions about how to effectively implement these technologies. This research contributes to bridging the gap between theoretical findings and the practical needs of football organizations, with talent identification serving as a practical case study to gather broader insights.

3.1.3 Reporting stage: classification and thematic structuring

The selected papers primarily consist of conference papers, with a few journal articles. Upon reviewing the selected papers (Appendix C), it is immediately apparent that they are all recent publications, which is logical given the rapid growth of IoT devices in recent years and their increasing application in sports. It is also not surprising that this research area has not yet been fully established.

As described in the execution stage, the sections can be divided into two groups. One group focuses on IoT (with attention to data analysis and AI) in combination with football, while the other group focuses on football in combination with talent identification and scouting.

The first group of analyzed papers primarily focuses on technological solutions to improve sports performance, particularly in football. Various studies introduce systems that provide real-time feedback during training, promote injury prevention, and monitor players' health through sensor technology and machine learning. Additionally, new evaluation methods are proposed, such as measuring creativity in passes and multidimensional assessment of player performance. Advanced video and tracking technologies for tactical analysis are also discussed.

The second group of analyzed papers focuses on talent identification and scouting in football. These studies discuss both the theoretical and practical challenges and solutions of talent identification, emphasizing the importance of broader and fairer evaluation systems. Finally, these papers also address the growing role of technology within talent identification.

To organize the literature review, thematic categorization was used. Several categories were formulated based on reading and analyzing the papers, with specific attention paid to recurring themes and topics. This led to the development of seven thematic categories, as shown in Table 2.

These themes not only relate to technological developments but also to the broader strategic aspects that are important for clubs when implementing IoT solutions. In the final analysis, attention is paid to the benefits, associated risks, leveraging potential, and limitations of IoT technologies in the context of talent identification. These four indicators will be further discussed, offering a holistic approach for the strategic deployment of IoT within clubs. The thematic categorization thus forms the foundation for a strategic model that can assist clubs in their decision-making.

Table 2: Thematic categorization of the systematic literature review

THEMATIC CATEGORY	DESCRIPTION
Introduction to IoT and the sports world	Examination of IoT's impact on performance monitoring and data analysis in football organizations.
IoT technologies in football	Examination of various IoT technologies applied in football for player performance measurement and team analysis. This category also addresses the challenges of privacy and data security, highlighting the need for secure data management and compliance with regulations like GDPR.
Applications of IoT in football	Exploration of specific applications of IoT technologies in football, including movement tracking, performance evaluation, injury prevention, and talent identification.
Talent identification process	Examination of the talent identification process in football, emphasizing the importance of holistic data collection across physical, technical, tactical, psychological, and medical domains, and comparing traditional scouting practices with modern, dynamic approaches to understanding player development.
Comparison between theoretical challenges and practical scouting methods in talent identification	Compares theoretical challenges (e.g., early specialization, RAE, lack of reflection) with practical scouting methods, highlighting solutions like broader evaluations, balanced development, and standardized training.
(Inter)national perspectives on talent identification and development	Investigation of diverse international approaches to talent identification and development in youth football, with special attention to the Dutch context and holistic evaluation criteria.
Technological integration and innovations	Examination of how technology integration transforms talent identification, highlighting the use of IoT, wearables, and video technologies for objective evaluations and a holistic approach.

3.2 Internet of Things (IoT)

The integration of the Internet of Things (IoT) within the sports world, particularly in football, offers new opportunities for data-driven analysis and performance improvements. IoT technology leverages advanced sensors, real-time data analysis, and machine learning to provide in-depth insights into various aspects of the game. From tracking player movements and injury prevention to talent identification and strategic optimization, IoT is revolutionizing how clubs and coaches manage their players and teams. The following subsections explore the diverse ways in which IoT is used in football, including advanced motion tracking, improving scoring chances, creativity measurement, and injury monitoring. Additionally, the crucial role of IoT in data-driven talent identification is discussed in detail. This allows football teams not only to measure performance more accurately but also to make better decisions regarding player development and team strategies.

3.2.1 Introduction to IoT and the sports world

The Internet of Things (IoT) is described by Ikram et al. (2015) as an innovative approach that brings together various technologies to enhance our daily lives. The impact of IoT has grown significantly in recent years, including in sectors such as the sports industry. Specifically, in football, IoT is used for monitoring performance, tactics, and player health, resulting in valuable insights that were previously unavailable. These technologies help bridge the gap between the physical and digital worlds by collecting and analyzing real-time data, leading to improved performance and strategic decision-making (Konzag & Schütz, 2024). As noted by Konzag and Schütz (2024), the integration of these technologies enables sports organizations to adapt to changing market conditions and gain competitive advantages through data analysis.

Macuri et al. (2024) emphasize the benefits of IoT technologies in their research. The use of wearables, such as smart vests, in the training of amateur footballers is a clear example of how sports organizations leverage technology to enhance performance. These vests record crucial physical data, such as speed, heart rate, distance covered, and sprint frequency. By comparing this data with that of

professional athletes, such as elite Champions League footballers, teams can identify weaknesses and target improvements. The study compares data such as average speed, maximum speed, distance covered, sprints, average heart rate, and playing time of amateur players with those of elite footballers to determine if an amateur has the physical condition to play a football match. This is particularly useful for planning training and tailoring training schedules for individual players.

For professional sports organizations, this technology offers significant competitive advantages. By continuously collecting and analyzing real-time data, teams can respond more quickly to changes in players' physical conditions and prevent injuries. This not only increases training efficiency but also ensures that players are better prepared for matches, benefiting their performance. In an increasingly competitive market where sports performance is closely tied to financial gains, this form of data analysis enables clubs to achieve strategic advantages.

3.2.2 IoT technologies in football

IoT technologies are being deployed in various ways within football, primarily for measuring, analyzing, and improving player performance. Monitoring and tracking devices, such as smart vests with location and motion sensors, track speed, distance covered, and the intensity of individual players' movements. This data can also be used to analyze team movements, such as investigating how players collectively contribute to creating scoring opportunities. Gyarmati and Hefeeda (2016) emphasize that success in football depends not only on individual actions but also on the coordinated movements of players. Analyzing these movements helps assess the effectiveness of attacking patterns and strategies, for example, when multiple players move towards the penalty area to pressure the defense.

In addition to tracking tools, analysis devices such as the connected ball and smart cameras are essential. The connected ball, equipped with an inertial measurement unit (IMU), collects data on speed, rotation, impact force, and ball trajectory, which helps improve technical skills such as passing and shooting (Institution of Mechanical Engineers, 2024). This ball gathers high-frequency data, which also contributes to accurate referee decisions and semi-automated offside technology. Smart cameras, such as those from Veo, analyze tactical and technical data, including goals, shots, passing sequences, heatmaps, free kicks, ball possession, and team formations.

Interactive training tools, such as smart walls (e.g., the 'Rox Rebounder') and cone systems, use Bluetooth technology to dynamically adjust training based on player performance. These tools enhance skills such as ball control, reaction time, and agility by simulating realistic scenarios. Table 3 below provides an overview of various IoT devices and their applications within football.

Table 3: Type of IoT devices and performance metrics

Category	Type of IoT device	Performance metrics	Source
Monitoring and tracking devices / wearable technology	Smart / performance vest	Monitoring of speed, distance traveled, heart rate, acceleration, and movement intensity; equipped with location and motion sensors, accelerometers, gyroscopes, and heart rate monitors for outdoor analysis.	(Ikram et al., 2015)
	Smartwatch	Heart rate monitoring, step counting, calorie consumption, sleep tracking, ECG, VO2 max, cycle insights, recovery data, and stress monitoring.	Apple
	Smart ring	Sleep patterns, heart rate 24/7, skin temperature, SpO2, cardiovascular age, VO2 Max, stress measurements, daily activity, cycle insights, and recovery ability.	Oura Ring
	Smart Shin Pads	Distance covered, distance covered per minute, total steps, high-speed running distance, sprint distance, calories burned, total sprints, total high-speed runs, max speed, max acceleration, sharp turns, total jumps, max jump height, max kicking power, and the use of your left and right foot as a percentage of your total kicks.	Futbol Shin Pads
	Smart Footworn Player Development System	Technical metrics: number of ball contacts, foot zone contact, directional changes, and ball possession time. Physical metrics: distance covered, sprint speed, accelerations and decelerations, and activity per minute.	Playermaker
Analyzing and measuring objects	Connected Ball	Movement data such as speed, rotation, impact force, and ball trajectory; suitable for technical skills like passing and shooting.	(Institution of Mechanical Engineers, 2024)
	Smart Camera	Analysis of tactical and technical data such as goals, shots, passing sequences, heatmaps, free kicks, ball possession, and team formations.	Veo
Interactive training tools	Smart interactive soccerwalls	Training ball control, cognitive skills, and scanning ability by simulating realistic game scenarios; improving the speed and accuracy of passing.	Multi-ball
	Rox Rebounder	Enhancing ball control, cognitive responses, and visual scanning in dynamic training environments.	A-Champs
	Interactive cone system	Measuring and training speed, agility, acceleration, and reaction time during dribbling and movement exercises.	Smart Goals

Privacy and data security

The use of IoT technologies, such as the devices mentioned in the previous paragraph, generates a significant amount of data regarding player performance, physical condition, and behaviors both on and off the field. This data can provide valuable insights for football clubs in identifying talent and optimizing training programs. However, the collection and processing of this data raise significant concerns regarding privacy and data security.

Research by Tawalbeh et al. (2020) highlights that in an era where data breaches and cyberattacks are becoming more frequent, it is crucial for clubs to implement robust security measures to protect players' personal information. This includes using encryption techniques, secure data transmission protocols, and strict access controls to ensure that only authorized individuals have access to sensitive data. Furthermore, clubs must comply with applicable laws and regulations, such as the General Data Protection Regulation (GDPR) in Europe, which provides strict guidelines for processing personal data.

This is confirmed by the research of Chanal and Kakkasageri (2020), which emphasizes that the vast amount of data collected by IoT devices requires effective encryption and security strategies to prevent unauthorized access. They also note that IoT devices are often vulnerable to attacks due to their limited computing power and memory, which makes implementing complex security protocols more difficult. Additionally, they point to network security risks, as the networks connecting IoT devices are often targeted by attacks.

Privacy concerns represent another key issue. The authors argue that users are often inadequately informed about what data is being collected and how it is being used. They stress the need for transparency, user control, and data minimization as essential privacy-protecting measures.

While IoT offers significant benefits for talent identification and player development, the risks related to privacy and security underscore the need for a dynamic and adaptive security framework. This aligns with the recommendations from the survey in the research by Chanal and Kakkasageri (2020), which calls for dynamic models for information flow and collaboration between researchers, industry, and policymakers to develop effective solutions. Football clubs must therefore adopt a proactive approach to minimize these risks while maximizing the benefits of IoT technologies.

3.2.3 Applications of IoT in football

A major challenge remains the accurate interpretation of the collected IoT data. Football clubs, for example, may face an overwhelming amount of numbers, but without the expertise to understand them and convert them into actionable insights, the value of the data remains limited. To make informed decisions, football teams not only need data but also the tools and analyses to interpret it effectively. Imperial College Business School London illustrates this concept clearly in Figure 4.

Figure 4: Representation data-analytics-decision (Imperial College Business School (2021)

Moreover, modern analytics now enable the generation of increasingly advanced statistics, something that was previously limited to traditional statistics such as goals, assists, corners, and free kicks. Thanks to technological advancements and the data collected via IoT, analyses can now be applied in many more ways, leading to deeper insights into the performance of players and teams.

A crucial aspect of realizing the benefits of IoT use, therefore, is how the collected data is analyzed and applied. Earlier sections have already discussed some applications, but this paragraph will delve deeper into the specific areas of application for this data. Various studies have contributed to exploring these areas, and these will be further explained in the following sub-paragraphs. Depending on the research, certain studies may be mentioned multiple times as they can be relevant to different application areas.

IoT for advanced motion tracking in football

IoT leverages advanced movement tracking technologies to analyze the movements of both teams and individual players in detail. Gyarmati and Hefeeda (2016) explore how this data can contribute to insights into player performance and team strategies. They analyzed player movements in the Spanish top division during the 2012/13 season and discovered that the uniqueness of movements is crucial for identifying players with specific roles. For example, Adriano Correia was identified as the most unique player, highlighting the value of versatile players.

Additionally, they investigated the consistency of movements throughout the season. Players like Xavi Hernandez displayed remarkable consistency, which is important for coaches seeking reliable players. The study also shows how similar movement patterns between players, such as those of Lionel Messi, Cristiano Ronaldo, and Xavi Hernandez, can assist in identifying potential replacements for existing stars.

Xie et al. (2023) confirm the value of movement tracking with an affordable, lightweight system that uses wearable sensors for both motion recognition and intensity analysis. This system, supported by machine learning, provides detailed feedback on movements and intensity, which can contribute to improved performance and more efficient analysis of player movements.

The research by Gyarmati and Hefeeda (2016) and Xie et al. (2023) highlights how advanced movement tracking provides insights into both individual players and team strategies, which can assist football clubs in talent identification, team selection, and strategic planning. These technologies underscore the value of IoT in the modern football world.

IoT for insights into scoring opportunities and strategies

IoT offers opportunities for recognizing patterns that lead to successful goal attempts. Analyzing team movements and success ratios helps teams identify and optimize attacking patterns. Gyarmati and Hefeeda (2016) demonstrate how analyzing movements before shots provides insights into patterns that increase the likelihood of scoring. For example, movements from the right toward the penalty area, with diagonal runs, are found to be more successful. This can help coaches develop effective attacking drills and understand which movements are most effective for scoring opportunities.

Stein et al. (2016) expand on this analysis by introducing a system that allows real-time movement tracking and data analysis during matches. This system helps analysts quickly identify passing options, free spaces, and player interactions. Through advanced movement tracking, teams gain insight into the best passing options and open spaces, enabling them to adjust attacking patterns and make better decisions, which is crucial for optimizing scoring opportunities.

The term 'Expected Goals' (xG), which reflects the likelihood that a shot results in a goal, is increasingly used to analyze scoring chances (Soccerment Research, 2020). The probability of a goal depends on variables such as distance, shot angle, body part used, and the game situation (e.g., penalty, corner kick, open play, or counterattack). The xG value is calculated using a frequentist approach,

categorizing shots based on these variables. For instance, a penalty has an xG of 0.76, while a difficult shot has only an xG of 0.02.

A good example from another sport, basketball, shows how scoring chances are analyzed. In the NBA, there has been a shift in shot locations, as seen in Figure 5, which shows the difference in shot locations between 2001-02 and 2016-17 (Soccerment Research, 2020). This has led to more three-point shots due to their higher efficiency and fewer two-pointers from outside the "paint." This suggests that football coaches may reconsider their tactical approach by integrating Expected Goals and specifically examining shot locations, which could lead to a change in where shots are taken in football.

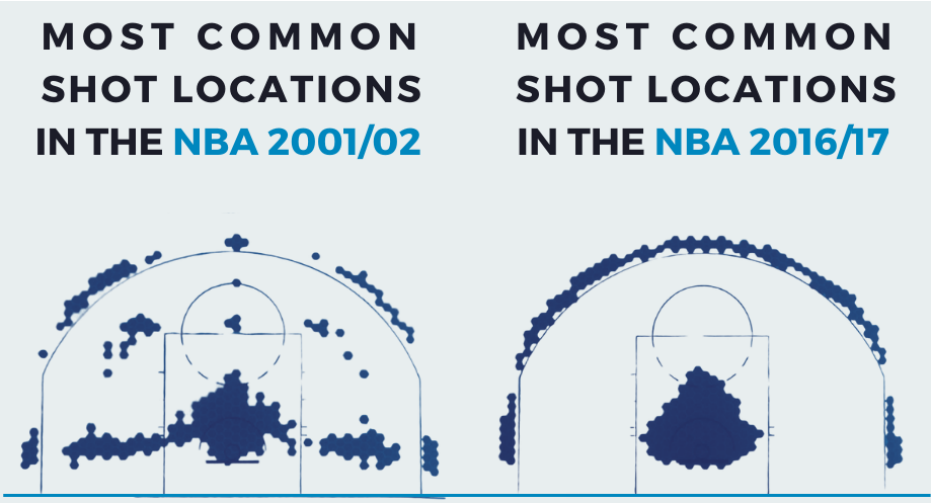


Figure 5: NBA: most common shot locations in 2001/02 vs. 2016/17 (Soccerment Research, 2020)

The research by Decroos et al. (2019) introduces a framework to assess the value of individual actions on the field. This framework takes into account the context of each action and evaluates the impact of actions on the match outcome. In addition to shots, other actions such as passes, dribbles, and defensive interventions are also assessed. This provides a holistic approach to player performance, considering not only the final results but also contributions to scoring opportunities.

Merhej et al. (2021) extend this approach by applying deep learning to quantify the value of defensive actions. The study analyzes how defensive actions influence scoring chances and helps coaches optimize both offensive and defensive strategies. Quantifying the total offensive and defensive contributions of players provides coaches and analysts with detailed insights into which actions and strategies are most effective.

By integrating the insights of Decroos et al. (2019) and Merhej et al. (2021) with analyses of Expected Goals and team movements, teams can further optimize their playing patterns. Analyzing the actions preceding shots offers a deeper understanding of scoring opportunities and helps develop more effective attacking patterns.

IoT for performance evaluation and creativity measurement

The rise of the Internet of Things (IoT) has dramatically changed the way footballer performance and skills are measured and analyzed. In addition to traditional statistics such as goals and assists, IoT enables the quantification of more complex skills, such as creativity. One example is the study un-xPass: Measuring Soccer Player's Creativity, in which the Creative Decision Rating (CDR) is introduced. This machine learning algorithm analyzes the creativity and decision-making of footballers by measuring the originality of their passes (Robberechts et al., 2023). This provides clubs with an innovative way to concretely evaluate creativity, a often abstract concept, allowing them to assess players based on their ability to find innovative solutions in game situations.

The integration of IoT technologies enables the collection of real-time data on players, resulting in a dynamic evaluation of performance. Previously, a player's performance was often assessed with simple statistics such as goals and assists. With the introduction of models like the pass choice model, the creativity of players such as Kevin De Bruyne and Martin Ødegaard can now be quantitatively measured. IoT and machine learning allow us to not only evaluate the success of a pass but also the difficulty and innovation behind the decision, providing a more holistic insight into the value of a player. Passes that are difficult to predict or carry risks often lead to greater opportunities for the team.

Another example of an analytical method is the PlayeRank framework, which uses IoT data for multidimensional player evaluations (Pappalardo et al., 2019). This framework goes beyond pass analysis and takes into account various actions such as shots, tackles, and off-ball movements. By placing these actions in context, clubs can compare and rank player performances. This advanced data analysis improves the scouting process and helps coaches make better-informed choices for team selection and strategy.

By using IoT and machine learning to measure creativity and performance, clubs can better tap into the unique qualities of their players and optimize their potential. Advanced analytics provide deeper insights into the game and can lead to better decision-making in scouting, team selection, and strategy development. The measurements of creativity, such as with De Bruyne and Ødegaard, offer a new perspective on football performance, where not only success counts but also the process and innovations that lead to it.

IoT in injury prevention and health monitoring

IoT plays a crucial role in injury prevention and health monitoring in sports. Sensors that track players' functional capabilities in real-time enable clubs to intervene proactively to prevent injuries. Risk factors such as overtraining or incorrect movements can be detected early, and health issues such as concussions or respiratory problems can be identified, promoting player safety during training and matches. Where medical checks once typically only occurred at the start of the season, these can now be conducted regularly throughout the season with sensors (Wilkerson et al., 2018).

Wilkerson et al. (2018) examined how IoT technologies can contribute to injury prevention by using smartphone accelerometers to measure the stability and movements of college football players. The data from stability tests were analyzed to identify patterns indicating an increased risk of injury, allowing for targeted interventions to be developed for the athletes.

This research confirmed that IoT devices are effective in monitoring player health and predicting injuries, contributing to both the safety and performance of athletes. Identifying risks in a timely manner enables coaches and medical staff to intervene proactively and prevent injuries, resulting in a healthier and more resilient player group.

Xie et al. (2023) added that a cost-effective system of wearable sensors, combined with AI models, can analyze movements and the intensity of movements of footballers. This system enables coaches to adjust training sessions in real-time to prevent overtraining, thereby reducing the risk of injury.

Additionally, Ikram et al. (2015) described an IoT system for football monitoring that uses sensors, RFID, and telecommunication technologies such as ZigBee to collect real-time data on players' physical condition. The system monitors vital signs such as heart rate, breathing, and blood glucose levels, alerting medical staff and coaches to abnormal values, enabling preventive measures.

These studies highlight that IoT technologies can significantly enhance the safety and performance of footballers. Through continuous monitoring, clubs can make better decisions and optimize player health, which not only prevents injuries but also supports talent development and scouting processes.

IoT data-driven talent identification

For this research, it is important to understand how data collected through IoT devices can contribute to talent identification. Two papers delve deeper into this topic than the other literature. Pappalardo et al. (2019) developed PlayeRank, a data-driven framework for evaluating football players. This framework utilizes millions of data points from four seasons of 18 major leagues, including passes, tackles, and shots. It provides a multidimensional and role-specific assessment of player performance and has been shown to be more effective than traditional methods, as confirmed by scouts. PlayeRank also detects player role changes, which is valuable for assessing their versatility. The system can be expanded with video tracking and other data sources, allowing for a more complete picture of player performance. This approach is also applicable to other team sports, such as basketball and hockey.

Lim (2023) provides additional insight into data-driven talent identification by examining how age-related variations in the importance of player characteristics influence the prediction of future performance. Although not specifically focused on IoT data, the findings are relevant to the use of IoT data. The study analyzed a FIFA dataset of player characteristics and performances, divided into three age groups. The research showed that prediction accuracy for younger players was lower than for older players, due to the limited experience of young players. For older players, financial factors were key predictors of future performance. These findings can help refine talent identification processes by better understanding age-related differences in performance characteristics.

Hossain et al. (2017) contribute to the topic by showing how IoT and wearable technologies, such as smartwatches and sensors, collect detailed data on player performance. These technologies can be used in youth academies to collect real-time data on speed, acceleration, heart rate, and other aspects of the game. By analyzing this data, coaches and scouts can identify talents who may not stand out in traditional observations, such as a player excelling in speed and acceleration but not yet scoring many goals.

These studies highlight how IoT technologies can enhance talent identification by collecting and analyzing detailed data, enabling clubs to more precisely and effectively recognize talent.

3.2.4 Sub conclusion about Internet of Things (literature part 1)

The literature review shows that IoT technologies are playing an increasingly significant role in football, with applications ranging from performance evaluation and injury prevention to health monitoring and creativity measurement. The widespread use of IoT allows clubs to collect real-time data, leading to more data-driven decision-making. For performance evaluations, such as Expected Goals (xG), IoT provides the ability to measure performance more objectively, independent of final results. This is crucial for assessing both players and coaches, as poor results are often not due to bad performance, but factors such as luck. By using objective metrics like xG and other IoT-driven data, clubs can gain a fairer and more accurate picture of performance, leading to better decision-making.

IoT technologies contribute to performance improvement by gathering data on both individual players and team dynamics. Devices like smart vests and connected balls offer valuable insights for talent identification and development. However, processing this data raises privacy and security risks, requiring strict security measures and transparency. This highlights the need for a holistic approach that considers not only the technical aspects of IoT but also the ethical and privacy-related issues.

Despite the clear potential of IoT in football, the literature reveals that only a few studies specifically focus on the application of IoT in talent identification, such as those by Pappalardo et al. (2019) and Lim (2023). Most publications address broader applications of IoT, like performance analysis or health monitoring, without delving into how IoT can contribute to the actual identification and development of talent. One exception is the PlayeRank framework, which uses IoT data to evaluate players. However, Lim's (2023) research does not provide a deep focus on IoT in talent identification, limiting

the depth of the topic. As a result, a comparison with traditional talent recognition methods is not fully addressed.

Based on the findings in the literature, we can conclude that there is still significant room for the integration of IoT in talent identification, which could lead to a shift from subjective judgments to more measurable and reliable methods. It is expected (and encouraged) that football clubs will increasingly rely on objective, data-driven insights, such as Expected Goals analysis, to identify and develop talent. This offers the opportunity to enhance scouting processes by making more data-driven decisions. The information from this literature review provides a solid foundation for further exploring the role of IoT in talent identification. The next section will continue this exploration by examining talent identification within football practice.

By connecting these findings with the theoretical framework, the need for a holistic and strategic deployment of IoT technologies in talent identification becomes clear. The literature confirms that there is a demand for an integrated model that not only includes the technological aspects of IoT but also the broader implications for decision-making and scouting processes. This aligns with the previously discussed need for a holistic model for the strategic use of technology in the football club, which is further developed in this study.

3.3 Talent identification in football

The following sub-sections provide an in-depth analysis of talent identification in football. The focus is on the processes and methodologies used to select and develop promising young players. An overview of the current state of research, as outlined by Baker et al. (2017), Bergkamp et al. (2019), and Jokuschies et al. (2017), highlights the limitations of traditional evaluation methods, the challenges surrounding early specialization, and the relative age effect (RAE). Additionally, innovative approaches such as broader evaluation systems and the growing role of technology are discussed. This section offers insights into both the theoretical and practical aspects of talent identification and scouting, laying the foundation for understanding the strengths and weaknesses of current systems.

3.3.1 Talent identification process

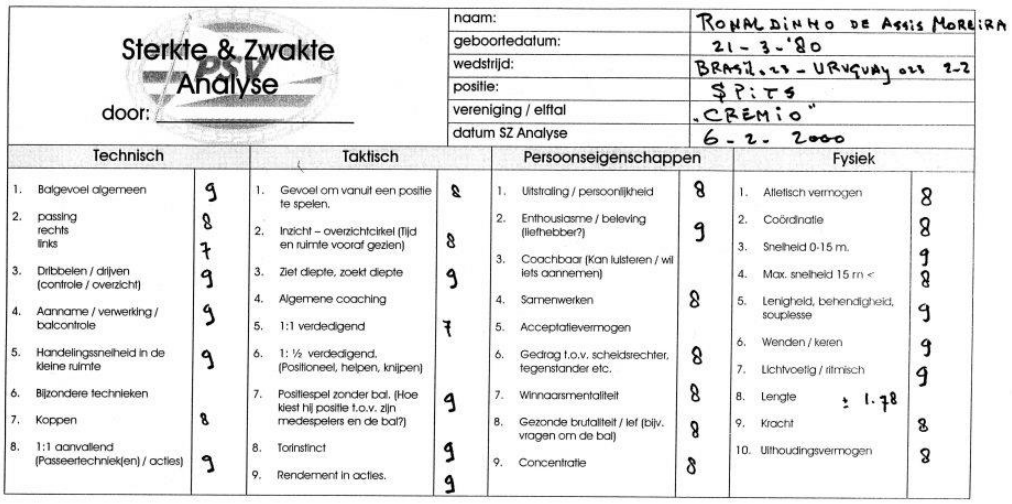
It is therefore crucial to understand how talent can be effectively identified. For football clubs, it is not only important to know which IoT technologies to acquire, but more importantly, what information to collect in order to gain meaningful insights into a player and their development. This helps in identifying and developing the right talents. The focus should be on collecting data that provides insight into the performance and potential of players. Research by Forsman et al. (2016) has shown that various factors contribute to the success of young players later in life, such as technical skills, physical capabilities, and motivation. To effectively identify talent, the following aspects can be analyzed:

1 **Physical Performance:** Data such as speed, endurance, strength, and recovery capacity can provide insights into a player's physical capabilities. Studies show that speed, endurance, and agility are important indicators of a player's future success, with a strong correlation between agility and achieving elite level at 19 years old.
2 **Technical Skills:** Capturing and analyzing data on ball control, passing, shooting, and other technical aspects helps assess a player's technical competencies. Specific skills such as passing and crossing are significantly associated with success later in life, with the ability to pass and cross well at age 15 strongly correlating with elite performance at 19 years old.
3 **Tactical Insight:** Using video footage and motion sensors, a player's tactical awareness can be analyzed, such as positioning choices and responses to different game situations. Tactical awareness, such as reacting to changing game situations, plays an important role in distinguishing elite players.
4 **Mental and Psychological Aspects:** Collecting information on mental resilience, motivation, and stress tolerance is essential for identifying talent with high potential. Studies show that motivation

is a key predictor of success, with highly motivated players having a much greater chance of reaching elite status.

5 **Medical Data:** Understanding a player's medical history and injury susceptibility can help clubs get a more complete picture of their durability and availability. It is important to understand how injury susceptibility can affect a player's long-term development so that clubs can make informed decisions.

The collection of this data enables clubs to assess talent in a holistic manner, by not only measuring technical or physical skills but also psychological and tactical characteristics that are essential for predicting future performance and development. This data collection process is not new; an example of this can be found in scouting forms that have been used for a long time. The well-known Dutch scout Piet de Visser developed a form in which he evaluates talents on four key categories: technical, tactical, personality, and physical. Figure 6 shows an example of this form, where various criteria are rated with numbers, illustrating how traditional scouting practices still revolve around gathering comprehensive and diverse data about a player.



Sterkte & Zwakte Analyse

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Technisch		Taktisch		Persoonseigenschappen		Fysiek	
1. Balgevoel algemeen	9	1. Gevoel om vanuit een positie te spelen.	8	1. Uitstraling / persoonlijkheid	8	1. Atletisch vermogen	8
2. passing rechts	8	2. Inzicht – overzichtcirkel (Tijd en ruimte vooraf gezien)	8	2. Enthousiasme / beleving (liefhebber?)	9	2. Coördinatie	8
links	7			3. Coachbaar (Kan luisteren / wil iets aannemen)		3. Snelheid 0-15 m.	9
3. Dribbelen / drijven (controle / overzicht)	9	3. Ziet diepte, zoekt diepte	9	4. Samenwerken	8	4. Max. snelheid 15 m <	8
4. Aanname / verwerking / balcontrole	9	4. Algemene coaching		5. Acceptatievermogen		5. Lenigheid, behendigheid, souplesse	9
5. Handelingssnelheid in de kleine ruimte	9	5. 1:1 verdedigend	7	6. Gedrag t.o.v. scheidsrechter, tegenstander etc.	8	6. Wenden / keren	9
6. Bijzondere technieken		6. 1: ½ verdedigend. (Positioneel, helpen, knijpen)		7. Winnaarsmentaliteit	8	7. Lichtvoetig / ritmisch	9
7. Koppen	8	7. Positiespel zonder bal. (Hoe kiest hij positie t.o.v. zijn medespelers en de bal?)	9	8. Gezonde brutaliteit / lef (bijv. vragen om de bal)	8	8. Lengte ± 1.78	
8. 1:1 aanvallend (Passeertechniek(en) / acties)	9	8. Torinstinct	9	9. Concentratie	8	9. Kracht	8
		9. Rendement in acties.	9			10. Uithoudingsvermogen	8

Figure 6: Scouting form Piet de Visser. Data sourced from Voetbal Loopbaan, accessed December 3, 2024, from https://www.voetballoopbaan.nl/nieuws/het-geheim-waarmee-topscout-piet-de-visser-83-spelers-scout.

One drawback of these forms is that they only capture a snapshot: the data comes from a single specific match. This is confirmed by research from Verbeek et al. (2023), who state that the collected data is often based on a static-interindividual perspective. This means that the performance of different players is compared at a certain moment in time, often to identify talent based on a player's potential relative to others. However, for a deeper understanding of talent development, it is important to also consider dynamic intra-individual processes. Talent development changes over time for each player. This aspect is often missing in current literature on talent identification, which is primarily focused on static comparisons. Therefore, it is crucial to not only collect data at a given moment but also track the changes in this data over time, in order to better understand and develop talent.

3.3.2 Comparison between theoretical challenges and practical scouting methods in talent identification

This paragraph compares the theoretical and methodological challenges in talent identification with the practical application of scouting methods and criteria. The differences are discussed in each paragraph and summarized in Table 4.

Theoretical and methodological challenges in talent identification

In youth football, methodological approaches focus on the effectiveness and reliability of evaluation methods. Several issues affect the identification and development of talent. Baker et al. (2017) highlight the disadvantages of early specialization, such as overload and burnout, which can harm the

long-term development of athletes. Another issue is the relative age effect (RAE), where older players in the season often have a physical and cognitive advantage, leading to skewed selection. This effect means that younger, potentially talented players are often overlooked (Baker et al., 2017).

Jokuschies et al. (2017) emphasize the need for systematic reflection by coaches, as inconsistency and subjectivity in assessments influence the quality of talent identification. Coaches often rely on their experience rather than structured evaluation methods, which can lead to biased assessments (Jokuschies et al., 2017).

To address these issues, various studies propose solutions. Bergkamp et al. (2019) advocate for broader and fairer evaluation methods to ensure more diversity in talent identification. This helps to discover hidden talents and prevents traditional thinking patterns from missing opportunities. Furthermore, the research by Baker et al. (2017) suggests that a balance should be struck between early talent identification and the long-term development of the athlete to mitigate the RAE.

In addition, implementing a structured approach to reflection is essential to enhance the reliability of talent assessments. Coaches should actively review their perceptions, leading to more objective and transparent evaluations (Jokuschies et al., 2017). Creating a supportive environment for young athletes that promotes both talent identification and their overall development is crucial. This means that the social and cultural context of the athletes must also be considered in the evaluation processes.

Practical application of scouting methods and criteria
In practice, the application of scouting methods focuses on identifying talented players. However, several factors influence the effectiveness of these methods.

A key challenge is the subjectivity in assessments. Reeves et al. (2018) highlight the role of perceptual-cognitive skills, such as decision-making, which are difficult to quantify. This leads scouts to often rely on intuition and experience, increasing variability in evaluations. Additionally, contextual factors, such as a player’s performance in different environments, play a significant role (Bergkamp et al., 2021).

To address these issues, Bergkamp et al. (2021) suggest combining objective measurements with subjective assessments. This multidimensional perspective provides a more complete picture of a player's talents and enables a more accurate judgment. Roberts et al. (2019) further emphasize the importance of standardizing and training scouts to minimize biases and promote objectivity. This contributes to a broader range of talent recognition.

Moreover, continuous evaluation and feedback are essential for optimizing scouting. Reeves et al. (2018) highlight the importance of regular feedback and monitoring of player development. This ensures a dynamic approach to talent identification and promotes the long-term growth of the athlete.

Just as in the theoretical approach, it is important in practice to consider the context of the athletes. Scouting should not only be based on technical skills but also on the social and cultural environment of the players. By incorporating these contextual factors, scouts gain a more complete and fairer picture of a player's potential (Roberts et al., 2019).

For an overview of the differences and similarities between these approaches, see Table 4 below.

Table 4: Comparison of theoretical challenges and practical scouting methods in talent identification

	Methodological Approaches and Challenges	**Scouting Practices and Criteria**
Focus	Theoretical and Methodological Challenges in Talent Identification.	Practical Application of Scouting Methods and Criteria.
Key issues	- **Early Specialization:** Can lead to overtraining and burnout, affecting long-term development and engagement in the sport. - **Relative Age Effect (RAE):** Players born early in the season often have an advantage over younger peers, which can lead to biased selection. - **Insufficiently Structured Reflection:** Coaches often lack a systematic approach to reflection, which can result in inconsistent and biased assessments.	- **Subjectivity in Assessments:** Scouts often rely on intuition and experience when evaluating perceptual-cognitive skills, leading to variability in evaluations. - **Contextual Factors:** Player performance varies depending on their environment and circumstances, which affects scouting outcomes.
Suggestions/ solutions	- **Developing Broad Evaluation Methods:** Creating broader and fairer evaluation methods to identify and support diverse talents. - **Finding Balance:** Balancing early talent identification with providing a supportive and flexible environment. - **Systematic Reflection:** Implementing a structured approach to reflection to enhance objectivity and reliability.	- **Use of Objective and Subjective Criteria:** Combining objective measurements with subjective assessments for a more comprehensive view of players. - **Standardization and Training of Scouts:** Training scouts and applying standardized criteria to ensure objectivity and reduce biases. - **Continuous Evaluation and Feedback:** Providing regular feedback and monitoring player development to promote a dynamic and adaptive approach.
Importance of context	- **Balance Between Identification and Development:** The importance of an environment that supports both talent identification and the overall development of young athletes.	- **Considering Contextual Factors:** It is crucial to take contextual factors into account, such as performance in different circumstances and behavior during training.

3.3.3 (Inter)national perspectives on talent identification and development

International approaches to talent identification and development in youth football vary significantly, with countries developing unique methods tailored to their cultural and sporting contexts. Kelly et al. (2023) provide an overview of talent pathways in countries such as Canada, England, Germany, Gibraltar, India, Ireland, Scotland, the Netherlands, and the United States, demonstrating that there is no uniform approach. They emphasize the importance of a holistic approach to talent development, which incorporates not only technical and physical skills but also cognitive and psychological factors such as thinking ability, game insight, mental resilience, and motivation. This ensures that players become mentally and emotionally stronger both on and off the field, aiding in their overall development.

An example of innovative talent identification are clubs like Brentford FC and FC Midtjylland, which implement data-driven strategies. By utilizing statistical analyses and performance indicators, these clubs can identify talents that may be overlooked by traditional methods (Deloitte Development LLC, 2018). This has led to success on the field and a more efficient, objective way of scouting.

Ford et al. (2020) describe how youth academies worldwide have structured their talent identification processes. One example of this is the Premier League's Elite Player Performance Plan (EPPP), which involves a systematic evaluation of youth players and has contributed to discovering promising talents through a consistent approach to scouting.

Focus on the Netherlands
As the field research will take place in the Netherlands, it is relevant to discuss the Dutch approach to talent identification. Kelly et al. (2023) describe that children from the age of 4 can join one of the 2,834 amateur football clubs (The Dutch Football Association, 2022b), which is considered the foundation for the success of Dutch football. Talent development is managed by professional clubs in the Eredivisie, the second division, and the KNVB. Youth players are selected for specialized programs from around the age of 7, but only 6% of them eventually sign a professional contract with the academy (Jonker et al., 2019).

Since most players are selected between the ages of 11 and 15 (Jonker et al., 2019), academies have chosen to select players starting from U12. Some academies have a U21 team or collaborate with senior teams in lower divisions to facilitate the transition to senior football.

Annually, the KNVB evaluates academies on their compliance with the Quality & Performance Program (K&P) (The Dutch Football Association, 2022a), which helps academies improve their training programs. This program focuses on the development of academies, forming a vision, and monitoring performance. In addition, the KNVB provides a base amount to academies, which is dependent on their performance and collaboration with amateur clubs.

In addition to the academy system, the KNVB has the Youth Plan (DYP), which further develops talented players who have not yet been selected for academies. This plan offers extra training and performance-oriented activities to accelerate their development.

International best practices show that continuous evaluation of scouting methods is essential for the success of talent identification programs (Saunders et al., 2022). By combining traditional and innovative approaches, clubs can identify and develop a broader range of talents, contributing to the growth and diversity of youth football.

3.3.4 Technological integration and innovations
The integration of technology into talent identification can significantly change the scouting process. According to Jokuschies et al. (2017), systematizing the subjective talent criteria of expert coaches is essential for improving talent assessments in top-level youth football. Technologies such as IoT, wearables, sensors, and video technology provide an objective complement to these subjective evaluations. They deliver real-time data on player performance, physical condition, and technical skills, offering a more complete and accurate picture of talent. By combining this technological data with traditional scouting methods, hidden talents can be identified, increasing the effectiveness of talent identification. This underscores the need to integrate technological innovations into existing scouting processes for a balanced and thorough player evaluation.

Reeves et al. (2018) investigated talent identification in English category one academies and emphasized the importance of a holistic approach. This means assessing not only physical and technical skills but also psychological and social factors. Ford et al. (2020) conducted a global survey on talent identification and development processes in youth academies and highlighted the need for a multidisciplinary approach, especially for older players. These studies show that technology, such as smart vests and sensors, can contribute to a detailed understanding of player performance and physical conditions. By integrating these tools, scouts can discover talents that would otherwise go unnoticed and provide a deeper evaluation of both technical and cognitive skills.

Additionally, several studies point to the benefits of video technologies for analyzing matches and training sessions. These technologies allow clubs to make detailed analyses of player movements and decisions, helping to identify patterns and improve tactical and technical skills. The use of wearables and sensors also contributes to monitoring players' physical load and recovery, which is crucial for injury prevention and optimizing performance.

In summary, the integration of technology in talent identification not only contributes to a more objective and detailed evaluation of players but also supports a holistic approach to talent development. By combining technological innovations with traditional scouting methods, clubs and scouts gain a more complete and accurate view of young players' potential, leading to better decisions and more successful talent development.

3.3.5 Sub conclusion talent identification in football (literature part 2)

Talent identification in football requires the collection of holistic data that encompasses not only physical, technical, and tactical aspects but also the mental and social dimensions of a player. Traditional methods, such as scouting forms, provide valuable insights, but it turns out that dynamic data, collected over time, is essential for a more comprehensive understanding of talent development. It is important to track the evolution of players in their context, taking into account both progress and challenges in their development.

The literature shows that both theoretical and practical approaches to talent identification present significant challenges and opportunities. Studies by Baker et al. (2017), Bergkamp et al. (2019), and Jokuschies et al. (2017) highlight the limitations of traditional evaluation methods, such as early specialization and the relative age effect (RAE), which hinder diversity in talent development. This underscores the need for innovative evaluation systems that are more inclusive and long-term focused, considering the various developmental stages of young players.

Comparing different methodological approaches to talent identification reveals that subjectivity and contextual influences often reduce the effectiveness of the processes. It is essential to introduce standardized, multidimensional assessment systems that incorporate not only technical skills but also social and environmental factors. Systematic reflection by coaches plays a crucial role in this, as it helps minimize bias and increase objectivity.

International approaches to talent identification show that success depends on the context in which talents develop. There is no uniform approach; each region adapts its methods based on local circumstances and culture. The Dutch approach, with its youth academies and the Quality & Performance Program (K&P), offers an example of a structured and results-oriented approach, where both talent identification and development are effectively promoted.

Additionally, the integration of technology, such as IoT and video technologies, is becoming increasingly important. These tools contribute to a more holistic view of players by combining objective data on performance with detailed insights into their development. The use of modern technologies provides the opportunity to enrich traditional evaluation methods and offers new perspectives for identifying and developing talent. The combination of both traditional and technological approaches will lead to more inclusive and effective scouting processes.

In summary, the literature shows that the future of talent identification in football lies in an integrated approach that embraces both technological innovations and a holistic view of player development. This approach will not only improve talent identification itself but also strengthen strategic decision-making around the development of young players, which is essential for the success of both individual players and the team as a whole.

3.4 Chapter conclusion

This research focuses on the integration of IoT technologies in strategic decision-making within football. The literature review, which examines talent identification as a case study, highlights that IoT technologies offer significant opportunities to improve various processes within football clubs, including talent identification. While traditional approaches still often rely on subjective assessments and outdated evaluation methods, an increasing number of initiatives are being developed where IoT technology is integrated into both performance analysis and talent identification.

The use of IoT technologies provides important benefits for performance enhancement by collecting data on both individual players and team dynamics. Devices such as smart vests and connected balls offer valuable insights for talent identification and development. At the same time, processing this data raises privacy and security risks, necessitating strict security measures and transparency. These risks highlight the need for a holistic approach that not only addresses the technical aspects of IoT but also considers ethical and privacy-related concerns.

Furthermore, the literature indicates that talent identification in football is a complex process, where not only technical and physical factors play a role, but also mental and social aspects are essential. While traditional evaluation methods such as scouting forms provide valuable insights, the literature review shows that dynamic data over time is crucial for a more complete understanding of talent development. This points to the need for an integrated, data-driven approach that goes beyond players' physical performances. There is still a significant gap in the application of IoT technology specifically for talent identification, suggesting that there is room for improvement in current scouting processes. This presents an opportunity for further research on how IoT can contribute to obtaining more objective and reliable insights into players' potential, including cognitive skills and developmental opportunities.

The findings show that traditional evaluation methods, such as early specialization and the relative age effect (RAE), continue to have a major influence on talent identification. This underscores the urgency of innovative and inclusive evaluation systems that take both technical and social dimensions of players into account. The integration of technologies such as IoT can significantly improve objectivity and fairness in scouting processes. This is not only important for identifying talent but also for the strategic development of players and the overall success of the team.

In summary, this literature review provides a solid foundation for further research into the strategic use of IoT technologies within the context of talent identification. The literature confirms the need for a holistic model that approaches the integration of IoT technology not only from a technological perspective but also from a strategic and ethical standpoint. This research aims to develop such a model, where IoT technology is effectively combined with traditional methods. The future of talent identification in football lies in the development of an integrated approach that combines technological innovations and traditional evaluation systems for more data-driven, inclusive, and efficient processes. This chapter offers important theoretical insights that contribute to the development of a strategic model that supports clubs in making informed decisions about the integration of technology.

4 Results

To investigate whether the practice, like the literature, perceives the need for a holistic model for the strategic deployment of IoT technology, with a focus on talent identification, interviews were conducted with three Dutch professional football organizations. These interviews took place between October 9 and 21, 2024, at the training locations of the professional football organizations and were supplemented with tours. The combination of interviews and tours provides valuable insights into the organizations' perspectives and forms the basis for three case studies.

In total, nine experts were interviewed to collect empirical data. Table 5 provides a clear overview of some characteristics of the experts and the interviews. To ensure anonymity, the names of the experts and organizations have been replaced with numbers or letters. Some interviews took place with two experts simultaneously: an IoT and/or data expert and a talent identification specialist. As a result, it may appear that expert 2 is listed under interview 1 in the table, for example. The three case studies are visually distinguished by colors in the table.

The three case studies form the basis for a benchmark analysis in which the three Dutch football clubs are compared in their application of IoT and digital technologies in talent identification. This comparison, based on insights from the interviews, maps out the similarities and differences between the clubs.

The interviews provide a detailed picture of how clubs integrate IoT and data analysis into their processes, with specific attention to both IoT and talent identification. The results are presented around four key topics: the identification process, the integration and effectiveness of IoT, policy-making and collaborations, and challenges and areas for improvement. These themes are derived from the literature review and flexibly adjusted to the interview results, contributing to the depth of the research. The results outline both the strengths and weaknesses of the clubs and provide insights into optimization opportunities, which are discussed per club and then summarized in an overview table for all clubs.

Tabel 5: Overview of experts from three professional football organizations

Participant	Organization	Interview	Job	Expertise
Expert 1	Club A	1	Data scientist	Data science and analytics
Expert 2	Club A	1	Youth scouting coordinator U8-U12	Talent identification (U8-U12)
Expert 3	Club B	2	Video and data analysis coordinator	Creating and coding video footage
Expert 4	Club B	5	Regional plan coordinator (partner clubs)	Regional planning and partner club management
Expert 5	Club B	5	Head of youth scouting	Youth scouting and development
Expert 6	Club C	3	Professional football player & youth academy trainer	Football training and youth development
Expert 7	Club C	3	Data analist & Sport scientist	Data analysis and movement science
Expert 8	Club C	4	Assistant head of youth development & youth scouting coordinator U13-U17 & Coordinator AV/BV (partner clubs)	Youth development and scouting (U13-U17)
Expert 9	Club C	4	Intern in Sport Sciences	Movement science

4.1 Case studies

Below, the key perspectives of the different Dutch professional football organizations will be described. The full interview questionnaires and the detailed elaboration of the quotes, including large benchmark tables per topic, can be found in Appendix D and E, respectively.

4.1.1 Club A

Identification process

The identification process at Club A is structured, with voluntary scouts, the four-eyes principle, standardized forms, and talent pathways carefully built to assess both performance and potential. The club tries to balance performance-driven choices with the development of talents for the long term. Expert 2 notes that the approach of scouts varies, but there is a clear need to identify the core qualities of players: *"But what you see very much is: each scout really does it quite well report in his own way. And that in itself is fine, because we have to take into account when you have ninety scouts..."* This highlights how Club A strives to maintain consistency in a process that is sensitive to personal preferences and biases, such as the birth month effect.

Integration and effectiveness of IoT in talent identification and organization

While IoT technologies play a limited role, their use is clearly applied in the older youth teams at Club A. For instance, the Aura ring is used from the U17 level to collect data on sleep behavior, heart rate, stress levels, and other biometric data. Expert 1 explains: *"It's a ring that players should wear at least at night, and maybe also during the day, and it measures... just like a smartwatch, but more precisely..."* Additionally, video analysis plays an important role, especially in the older teams, where it is used to measure physical and tactical performance. As Expert 1 further states: *"Based on the camera footage, you can translate that into physical components. For example, total distance covered, distance covered at high intensity, accelerations, and decelerations."* Despite its limited application in the scouting process itself, technology is effectively used to evaluate older players, contributing to an objective and detailed assessment.

Vision, policy, and collaborations for IoT usage

Club A's vision emphasizes continuous innovation and improving measurement capabilities through IoT technologies. Expert 1 says: *"Every component that we could measure better, we try to improve by creating a more advanced Internet of Things solution."* Internally, great attention is paid to translating measurement data into practical insights for coaches. As Expert 1 explains, it is crucial to translate raw data into concrete, understandable information for practice: *"The most important thing is: How do you ensure that the things we measure properly support that opinion?"* The club also collaborates with external parties such as ASML and the KNVB to develop new IoT solutions and further refine existing methods, indicating a strong network of collaboration and knowledge sharing.

Challenges and improvement areas with IoT

Club A faces several challenges in the integration of IoT. Expert 1 emphasizes the need to combine data with traditional scouting work: *"Of course, a scout needs to complement certain aspects and perhaps challenge them as well, but it should become much more of a combination for making a judgment..."* It is acknowledged that the application of technology should complement the scout's intuition, not replace it. Additionally, limited access to international tracking data plays an important role in the ability to compare players from other leagues. Expert 1 notes: *"If we had that for all players in Europe, we could make much better comparisons..."* This points to a lack of data needed for better comparisons. IoT is also primarily used for the first team, while the youth academy benefits little from these technologies: *"But that is not possible for the youth, only for the first team..."* These findings indicate room for improvement in access to technologies and the expansion of IoT usage to the youth academy.

4.1.2 Club B

Identification process

Club B places a strong emphasis on the social-emotional development of young players, focusing on broad development before they move on to the academy. This is evident in the decision to form an academy team starting only from U12. As the club states: *"We believe it is important for the social-emotional development of young children to let them play at their own amateur club during their early years."* The club invests in regional training sessions and the U11 program, providing young talents the opportunity to develop their skills more broadly. Expert 5 clarifies: *"It is a pre-selection for our first academy team under 12. We are very intensively involved, training on both Mondays and Fridays, to see if we are making the best choice."* This shows that Club B contributes not only to selection but also to the development of amateur clubs and the overall football level. The focus is not solely on performance but also on building a solid foundation for the players' future.

Integration and effectiveness of IoT in talent identification and organization

Club B uses some IoT technologies, such as IP cameras and video analysis software, but these are still limited in their integration. Expert 3 explains: *"We built our own system. We don't really have a name for it, but we created a setup ourselves using IP cameras."* The use of this technology is still manual, limiting the efficiency of the analyses. Data analysis is mostly carried out manually, with various software programs that are not well integrated. Expert 3 further explains: *"We have a laptop, and on that laptop, we use various shortcuts. These shortcuts are all set up for different actions."* This lack of integration between systems leads to inefficient use of technology. Physical measurements such as speed and explosiveness are carried out, but they are not yet a structural part of the scouting process. Expert 5 notes: *"Incidental, not structural. It's not yet part of our program."* This highlights that the full integration of IoT in talent identification is still in its early stages.

Vision, policy, and collaborations for IoT usage

Club B lacks a clear strategy for the use of data analysis and technology, as evidenced by the lack of coordination and absence of a uniform policy. Expert 4 notes: *"I assume there is a vision from expert 4's department, but not within our department."* Expert 3 confirms that there is no central policy for the use of data: *"There is nothing for that."* While there are good individual initiatives, such as the use of video analysis by coaches, there is no uniform approach to systematically utilizing technology. The use of more advanced technology, such as IoT devices, is still dependent on the coaches' individual choices: *"It is up to the coach to decide whether to use their own code, coding program, download their own footage..."* The lack of a central vision complicates the ability to consistently leverage the benefits of technology. Collaborations with other clubs in the region offer opportunities for knowledge sharing, but here too, there is a lack of central coordination. Expert 4 says: *"Every now and then, once every six months, we have a meeting with all the clubs to see: What are you doing, and what are we doing?"*

Challenges and improvement areas with IoT

IoT offers many opportunities, but its application varies greatly within the club, especially between the first team and the youth academy. According to Expert 3, youth coaches use very little technology: *"They use very few gadgets, they really just use a laptop and that's it."* There is also a lack of knowledge about the capabilities of more advanced tools. The size of the youth academy makes it difficult to implement technology for all players: *"In youth football, we have such a large pool of players to work with."* Budget differences play a role, with ample resources available for the first team, while the youth academy often has to make do without. Expert 3 emphasizes: *"In first teams, everything is possible and everything is filmed, recorded, measured, and weighed, you name it."* Additionally, there is variability in data analysis, which affects reliability: *"You have a margin of 20% for errors."* This indicates the need for more standardization and consistency in data collection and analysis. These challenges highlight the need for more knowledge sharing, better collaboration between departments, and a uniform approach to the use of IoT within the club.

4.1.3 Club C

Identification process

Club C follows a structured training system with three phases: the talent plan (U9-U12), the basic plan (U13-U16), and the professional plan (U17-U21), with most intake occurring from the younger age groups, particularly from U9. As expert 8 points out, the largest intake is at the younger age groups: *"We have the largest intake starting from the under-9 age group. So, the biggest influx is from under-9, under-10, and under-11."* The identification process focuses on the observation of motor skills, technique, and mentality, without extensive forms. Scouts use the "four eyes" principle and focus primarily on motor skills and mentality of young players. Expert 8 explains: *"Yes, just observing. Especially with the younger kids, they look closely at good movers. Whether their motor skills are on point."* In addition, Club C organizes regional training sessions where talents can showcase their abilities. This helps to understand the birth month effect, as expert 8 notes: *"If among the younger players at the regional training there are a few boys born in November or December, they stand out to us even more."* The policy is aimed at early intake and a development-oriented approach, with players remaining in the program until U14, without pressure for annual dropout.

Integration and effectiveness of IoT in talent identification and organization

Club C is open to using IoT technologies, but their implementation is hindered by financial constraints and a lack of specialized knowledge. As expert 9 points out, initiatives are often halted due to insufficient resources: *"Last year, I believe they did have data for the under-17s, but they cut back on it. I think that's also because they didn't have the manpower to analyze it all."* While location and movement data from smart vests are used for recovery monitoring in the U19 team, there is no integration with other analysis methods, such as video analysis. Expert 9 says: *"I'm really into testing, and I want to see if we can establish some sort of benchmark."* The use of IoT in the scouting process is incidental and seen more as a tool rather than a crucial part of the process: *"Yes, tests are conducted here at club C. But they aren't really decisive. It's more of a tool."* These observations point to a lack of consistent and structured use of IoT technologies, mainly due to limited resources and specialized knowledge.

Vision, policy, and collaborations for IoT usage

Club C is actively working to make its vision more accessible, despite operational and financial challenges. As expert 6 notes: *"Yes, there is a certain vision. However, the football manual is so extensive that we are currently working on making it more concise and manageable."* The club faces financial constraints that make it difficult to implement technological improvements, such as hiring specialized staff: *"For things like this, there's simply no funding."* Moreover, collaboration with external parties such as the KNVB and Top Sports Gelderland is important, but the structures are not yet optimal: *"We try to collaborate more with the KNVB. But you can't do it alone."* The vision, resources, and partnerships of Club C influence the implementation of IoT technologies and talent identification.

Challenges and improvement areas with IoT

Club C's challenges include financial constraints, a lack of specialized knowledge, and inconsistent use of IoT technologies. Expert 6 summarizes: *"With us, it's often a side task. That really shouldn't be the case, but it's related to budget constraints."* There is a lack of in-depth data analysis, such as statistics on the effectiveness of passes. Expert 7 explains: *"Doing more with the statistics from the match. For example, how many passes he plays after entering the final third."* Although there has been some progress, such as the use of smart vests, the implementation remains limited by technical and financial obstacles. Expert 9 notes: *"We don't have the measurement equipment to measure with an accuracy of a tenth of a second."* To increase the effectiveness of IoT, it is necessary to invest more in policy, vision, and specialized knowledge so that the technology can truly impact talent development.

4.1.4 Summary table

The table below (Table 6) provides a summary of the current situation at three different football clubs regarding their identification processes, the use of IoT technologies, and the effectiveness of data analysis in talent identification and development. The data was collected from interviews, comparing the clubs on various aspects such as age categories, number of scouts, criteria for talent identification, and the degree of integration of IoT technologies. The table also offers insights into the policymaking, collaborations, challenges, and areas for improvement that the clubs encounter when implementing technology in their scouting and development processes.

Tabel 6: Summary table of the case studies of three Dutch professional football organizations

Aspect	Club A	Club B	Club C
Identification process			
Age categories	Lower: U8-U12; Middle: U13-U15; Upper: U16-U19	Lower: U9-U11; Middle: U12-U15; Upper: U16-U21	Talent Plan: U9-U12; Basic Plan: U13-U16; Professional Plan: U17-U21
Number of scouts	~90 volunteer scouts across 5 regions	Volunteer scouts per region	Volunteer scouts divided per region
Identification criteria	Technique, tactics, physical, mental, exceptional talent	Scouting form; potential (attributes or qualities to become good)	Motor skills, technique, and mentality (no extensive forms)
Selectie process	Trials for ~250 players per season; 35-40 selected	Regional training and U11 program with five selection rounds for U12 team	Eight regional training sessions as intake points for the academy
Integration and effectiveness of IoT			
Use of IoT devices	Limited use of sensors and cameras, mainly for older teams (U17+). Data focuses on physical and tactical insights.	Self-built IP cameras and software (myteamperformance); focus on video analysis, little IoT integration.	Minimal IoT use due to financial constraints. Smart vests with U19 team; extensive use of Veo cameras for analysis.
Data analysis use	Data from video and sensors for physical, tactical, and technical insights; integration of location and movement data with video footage.	. Match footage coded for tactical and technical analysis. Trial phase with integration of location and movement data with video footage for first team.	Limited data analysis with U19 team; video analysis with Veo cameras without integration of other datasets.
Policy formation and collaborations			
Vision and culture	Developing a vision for IoT technologies and fostering acceptance.	Lacks a clear overarching IoT strategy.	Has a football vision but lacks the resources to realize ambitions.
Collaborations	Informal collaborations with other clubs; regional partnerships and external partners like KNVB and TU Eindhoven.	Informal collaborations focused on exchanging video footage; limited internal coordination.	Collaborations with KNVB and educational institutions; further development of partnerships with wearable manufacturers.
Challenges and improvement areas			
Integration of data and human judgment	Balance between data and subjective judgment needs improvement.	Lack of knowledge among coaches regarding IoT capabilities; technology is not fully utilized.	Limited resources and capacity make effective use of technology difficult.
Costs and resources	Sufficient resources available, but investments are carefully evaluated.	Budget constraints prevent broader IoT applications, especially in youth teams.	Financial constraints prioritize investment in players over technology.
Knowledge and training	One data department responsible for technology implementation.	A few individuals with technical knowledge, but lack of collaboration.	Lack of knowledge and training in using IoT technology.

4.2 External experts

The exploratory nature of this research allows for the inclusion of external factors alongside the cases of professional football organizations, such as the role of technology companies and the national football association. The interviews took place between October 10 and 31, 2024, either on-site or online. These experts, independent of specific clubs, provided valuable perspectives on the integration of technology in talent identification. Their insights are discussed in this section, supported by key quotes that highlight important points and opportunities within the current landscape of technology and talent identification. Table 7 provides a clear overview of some characteristics of the experts and the interviews.

One expert was interviewed from each external organization. According to Hasselblatt et al. (2018), knowledge of IoT is often concentrated in a small number of individuals within an organization, meaning one conversation typically provides sufficient information. The interviewees were often identified as the most suitable experts, a common approach according to DiCicco-Bloom & Crabtree (2006). This approach ensures that the insights gained are both representative and valuable.

Tabel 7: Overview of external experts

Participant	Organization	Interview	Job	Expertise
Expert 10	D	7	Researcher KNVB	Research on talent identification, development, and the relative age effect
Expert 11	E	8	Head scout & Owner of a scouting training company	Youth scouting and scouting education
Expert 12	F	9	Chief Technology Officer at a wearable technology company	Wearable technology

In every interview, it is mentioned that technology and data analysis can play a significant role in scouting and talent development, but their integration must be approached carefully and strategically. All experts emphasize the need for consistent and objective application of data, where subjective intuition and bias are reduced by validating the data and combining it with other technologies.

1. Expert 10 (Researcher at KNVB) emphasizes the strategic use of technology, highlighting the importance of making clear agreements about the weighting of evaluation criteria in advance. Consistently applying these criteria prevents biases and ensures that data analysis and intuition complement each other effectively. As Expert 10 states: “I think you get a more complete picture of the player. You can map out some of the, how should I say, invisible things better.” This highlights how technology can help provide a broader, more objective understanding of players.
2. Expert 11 (Head scout & Owner of a scouting training company) discusses the value of collaboration and knowledge sharing within scouting to minimize bias. He also emphasizes that raising awareness among scouts about factors such as biological age can help scout more objectively, and advocates for innovation and collective efforts to improve the scouting process. He notes: “It’s very much, everyone wants to defend their own position and often rise higher themselves. Yes, it’s also a bit of an ego culture, maybe. That stands in the way of developments and collaborations.” This quote reflects the obstacles to collaboration and emphasizes how important it is to share knowledge and innovate together.
3. Expert 12 (CTO at a wearable technology company) points out the immense potential of wearables and data analysis for talent development, especially when these technologies are integrated thoughtfully. The combination of wearables and camera systems is considered particularly valuable, but requires ongoing education and practical guidance, especially with lower-division teams that are hungry for new insights. As Expert 12 explains: “We combine our data with a camera system in a project, where we collaborate to set it up. […] Heart rate is quite difficult to estimate from a camera image. Or actually, not at all. So, we can estimate internal and external load much better than a camera system.” This quote highlights the added value of combining different technologies to gain a more complete picture of players.

The interviews highlight that technology and data analysis can add significant value to scouting and talent development, provided they are used in a strategic and consistent manner. Reducing subjective bias, combining intuition with objective data, and integrating complementary technologies such as wearables and camera systems are cited by experts as important success factors. At the same time, they point to challenges such as collaboration, knowledge sharing, and technological implementation, which require attention to fully unlock the potential of IoT technologies. The core message is that a thoughtful, strategic approach and consistent application of technologies are essential for successful data-driven talent identification and development within professional football.

5 IoT-BALL analysis framework

To further structure this strategic approach, this chapter introduces and applies the IoT-BALL analysis framework. This framework builds on the results from Chapter 4 and systematically maps the internal and external factors that play a role in strategic decisions surrounding IoT technologies. The IoT-BALL analysis thus forms the bridge between the insights from interviews and literature and the eventual development of a strategic tool in Chapter 6. Through this analysis, football organizations gain a framework to better understand the value and risks of IoT technologies and make informed decisions about their implementation.

5.1 Introducing IoT-BALL analysis

This paragraph introduces the IoT-BALL analysis framework. This analysis has been developed to combine both theoretical and practical insights in a structured evaluation of IoT technologies for talent identification in football. While inspired by common methodologies such as SWOT analyses, the IoT-BALL analysis offers a focused and context-specific application of IoT in talent identification.

The analysis is divided into four categories: internal factors (benefits and related risks) and external factors (lucrative opportunities and limitations). This classification provides a systematic framework to assess both the advantages and challenges of IoT technologies.

This analysis maps out the internal and external factors that play a role in the strategic decisions regarding the use of IoT technologies within professional football organizations. The goal is to present a structured analysis that serves as the foundation for the development of the tool in Chapter 6. Therefore, the IoT-BALL analysis functions as a means, not as an end product, in this process.

5.2 Application of the IoT-BALL analysis

The data for this analysis was obtained through a systematic literature review and semi-structured interviews. As described in Chapter 2, the qualitative data was analyzed using thematic analysis. The transcriptions were reviewed, relevant sections were coded, and grouped within the four categories of the IoT-BALL analysis (Nowell et al., 2017).

The choice of this analysis focuses on combining theoretical and practical insights to provide a strategic framework for the use of IoT in talent identification within professional football organizations. It offers a detailed overview of the factors that influence strategic decisions regarding the deployment of IoT technologies.

In the following paragraphs, the four categories will be elaborated upon, with insights from the literature and interviews being linked to these categories. This provides a comprehensive view of the factors influencing the use of IoT technologies in the strategic decision-making of football clubs.

5.2.1 Benefits

From the literature and interviews, several benefits emerged that contribute to better talent identification and more efficient processes regarding IoT:

1. **Data-driven decision making**: By collecting real-time data through wearables and sensors, scouts and coaches can make better decisions about talent development. This allows them to monitor not only the physical performance of players but also their tactical and technical skills. By using advanced statistics such as Expected Goals (xG) and other IoT-driven metrics, clubs can gain a more objective view of player performance, independent of final results. This is crucial for identifying hidden talents that may be overlooked by traditional evaluation methods. Additionally, coaches and scouts can analyze trends and patterns in player performance, helping them to focus training and development efforts more effectively.

2. **Improved scouting efficiency**: Technology such as wearables and performance monitoring makes scouting more objective and targeted, saving time and costs. By using IoT technologies, clubs can gather data on players during matches and training sessions, enabling faster and more efficient talent identification. This reduces the need for extensive scouting trips and allows clubs to evaluate a broader range of players without sacrificing the quality of the assessment. Moreover, clubs can optimize their scouting strategies through data analysis, enabling them to focus on the most promising players and deploy their resources more effectively.

3. **Competitive advantage**: Clubs that effectively apply IoT strengthen their sporting and financial position by optimizing their talent development programs. By leveraging advanced technologies, these clubs can not only identify better-performing players but also accelerate their development. This can lead to a faster promotion of talents to the first team, which in turn improves the club's sporting performance. Financially, clubs that successfully develop talent can benefit from higher transfer values and greater appeal to sponsors and investors. This creates a positive feedback loop where the club can reinvest in technology and talent development, leading to even greater on-field success.

Example: A club using IoT technologies such as wearables and performance monitoring could, for example, identify a player in their youth academy who excels in speed and endurance. By analyzing the collected data, the club might find that this player also has a high xG, indicating that he is capable of scoring goals. This could prompt the club to invest additional resources in developing this player, such as specialized training and coaching. As a result, the player may progress more quickly to the first team, which not only enhances the club's sporting performance but also increases the player's financial value in the event of a transfer. By leveraging these benefits, clubs can not only improve their scouting processes but also develop a sustainable talent identification and development strategy that gives them an edge in the competitive world of professional football.

5.2.2 Associated risks

When a professional football organization chooses to implement IoT, it can bring challenges. This implementation of IoT could limit effectiveness:

4. **High implementation costs**: Smaller clubs often struggle to invest in IoT solutions due to limited financial resources. The initial costs for acquiring technology such as wearables, sensors, and the necessary software can be significant. Additionally, there are ongoing costs for maintenance, updates, and staff training. This can lead to inequality between larger clubs, which can afford to invest in advanced technologies, and smaller clubs, which may fall behind in their talent identification and development processes. This risk is further amplified by the need to invest in infrastructure and data security, which can be an additional financial burden for many clubs.

5. **Dependency on technology**: An excessive focus on technology can result in a lack of traditional scouting skills. While IoT technologies provide valuable data and insights, there is a risk that scouts and coaches become too reliant on these technologies and trust less in their own experience and intuition. This could lead to a one-sided approach to talent identification, where important human factors such as character, mentality, and team dynamics may be overlooked. It is crucial that clubs find a balance between data analysis and traditional scouting methods to maintain a holistic view of players.
6. **Limited knowledge and expertise**: Many clubs lack the necessary knowledge to interpret and apply IoT data effectively. Integrating IoT technologies requires not only the acquisition of equipment but also the development of skills and knowledge within the organization. This includes training for coaches and scouts in using data analysis tools and understanding the meaning of the collected data. Without this knowledge, clubs may struggle to fully leverage IoT data, leading to suboptimal decisions and a lack of trust in the technology. This issue is often compounded by a lack of collaboration with technology experts or data analysts, which further limits the effectiveness of implementation.

Example: A club that decides to implement IoT technologies might invest in advanced wearables for their players. However, if the club lacks the right expertise to analyze the collected data, they may miss crucial insights that could help them identify talent. Moreover, if scouts become too reliant on the technology and no longer use their own observations and experience, they might overlook talents who may not perform well in the statistics but possess valuable traits that can't be captured in numbers. This could ultimately disrupt the talent identification process and result in missed opportunities to develop promising players.

By recognizing and addressing these risks, clubs can develop a more balanced and effective approach to IoT implementation, leveraging the benefits of technology while maintaining the value of traditional scouting methods.

5.2.3 Leveraging potential

IoT offers unique opportunities for clubs willing to invest in innovation:

7. **Innovation in talent identification**: Innovations in IoT, such as machine learning, can uncover hidden talents. By using advanced algorithms, clubs can not only track players' performance in real-time but also identify patterns and trends that might otherwise go unnoticed. This enables clubs to evaluate not only current talent but also discover potential future stars who may not yet be on the radar of traditional scouting methods. The use of data analysis can, for example, help identify players with unique skills or potential who might otherwise be overlooked, especially in lower leagues or amateur teams.
8. **Collaboration with technology companies**: Partnerships with IoT suppliers and startups offer access to advanced tools and expertise. By collaborating with technology companies, clubs can benefit from the latest developments in data analysis, sensor technology, and performance monitoring. This can help them implement advanced solutions that improve their scouting processes. For example, by partnering with a startup specializing in machine learning, a club can develop algorithms tailored to their specific needs, making them better equipped to identify and develop talent.
9. **Increased focus on data analysis**: By combining IoT with data analysis, clubs can invest more strategically in talent development. The integration of real-time data with historical performance allows clubs to make informed decisions about scouting and player development. This can lead to a more targeted approach when selecting players for youth teams or investing in specific training programs. Additionally, a data-driven approach can help optimize training and improve player performance by providing personalized feedback and development plans.

Example: A club that implements IoT technologies can, for example, use wearables to track players' physical performance during training and matches. By combining this data, the club can not only evaluate the current performance of players but also make predictions about their future development. This can help them identify talents that may not yet have been noticed by other clubs. Additionally, the club can collaborate with a technology company specialized in data analysis to develop a custom platform that aids in interpreting the collected data. This can result in a more structured and effective approach to talent development, enabling the club to strategically invest in the right players and training methods.

By leveraging these opportunities, clubs can improve their scouting processes and strengthen their overall performance and competitiveness in the sports world. It is essential for clubs to foster a culture of innovation and collaboration to fully realize the benefits of IoT technologies.

5.2.4 Limitations

There are also external factors that may hinder IoT implementation:

10. **Technological changes**: Rapid technological advancements can cause existing systems and processes to become outdated, requiring clubs to continuously invest in updates and training. Sports technology evolves quickly, and what is considered state-of-the-art today can be obsolete tomorrow. This requires clubs to not only allocate financial resources for purchasing new technologies but also for training staff and scouts to effectively use these technologies. This can be a significant burden for clubs, especially smaller organizations with limited budgets and resources.

11. **Competition from other clubs**: Other clubs may also adopt IoT technologies, increasing competition and potentially reducing the advantages of early adoption. When multiple clubs invest in similar technologies simultaneously, it can become more difficult to gain a competitive edge. This can lead to a situation where clubs are in a race for technological superiority, shifting the focus from developing unique talent identification processes to simply keeping up with the competition. This can also result in increased pressure to continuously innovate and invest, which may not always be feasible for all clubs.

12. **Privacy and data security**: Collecting and analyzing large amounts of data presents risks related to privacy and data security, which can lead to legal and ethical issues. Clubs must ensure they comply with relevant data protection laws, such as the General Data Protection Regulation (GDPR) in Europe. This may incur additional costs for legal advice and the implementation of security measures. Moreover, a data breach or violation of player privacy can lead to reputational damage and a loss of trust, undermining the relationship between clubs and their players.

Example: Suppose a club decides to implement an advanced IoT system that tracks player performance in real-time. While the club benefits from the advantages of this technology, it may also face the need to regularly perform software updates and train staff on how to use new features. At the same time, another club in the region might implement a similar system, increasing competition. If these clubs do not carefully handle the collected data, they could face legal issues due to privacy breaches, which could lead to negative publicity and financial consequences.

By considering external factors, clubs can better prepare for the challenges of implementing IoT technologies. It is essential that they adopt a holistic approach, identifying and strategically managing both opportunities and limitations. The connection between the four categories highlights that strategic decisions regarding IoT are not only about leveraging benefits but also about carefully managing risks and external constraints. This requires a well-considered approach, further supported by the IoT-BALL analysis. This analysis provides clubs with a structured overview of the strategic considerations in integrating IoT technologies into talent identification and helps them develop a sustainable strategy.

5.3 Visualization IoT-BALL analysis

The IoT-BALL analysis provides a strategic overview of the key considerations for professional football organizations when implementing IoT technologies in talent identification. Table 8 summarizes the 12 points by categorizing them into four categories (benefits, associated risks, lucrative opportunities, and limitations), thereby making the complex interactions between these factors visible.

The benefits, such as data-driven decision-making and improved scouting efficiency, are attractive to clubs looking to enhance their competitive position. On the other hand, the associated risks, such as high implementation costs and privacy issues, can pose a significant obstacle. The analysis also highlights external opportunities, such as collaboration with technology companies, and limitations arising from technological changes and competition.

Table 8: Visualization IoT-BALL analysis

IoT-BALL analysis *Strategic evaluation of IoT implementation in talent identification for professional football clubs*		
INTERN	**Benefits**	**Associated risks**
	Data-driven decision making	High implementation costs
	Improved scouting efficiency	Dependency on technology
	Competitive advantage	Limited knowledge and expertise
EXTERN	**Leveraging potential**	**Limitations**
	Innovation in talent identification	Technological changes
	Collaboration with technology companies	Competition from other clubs
	Increased focus on data analysis	Privacy and data security

In summary, the IoT-BALL analysis provides valuable input for clubs to develop a thoughtful strategy for integrating IoT technologies into their talent identification processes. It offers a structured approach to map both the benefits and risks, which is essential for success in the increasingly competitive world of professional football. These insights also serve as the foundation for the development of a practical strategic tool in Chapter 6.

6 Tool

This chapter builds on the results from Chapter 5, in which the IoT-BALL analysis framework was introduced. This analysis, along with insights from earlier chapters, forms the foundation for the development of a practical strategic toolkit. The aim of this chapter is to introduce the strategic toolkit, describe it in detail, and discuss the iterative development process. Feedback from an expert in the football industry is integrated to optimize the functionality and applicability of the tool.

The structure of this chapter is as follows: first, the initial version of the toolkit is presented, with a detailed explanation of its setup and the strategic questions it addresses. Next, the iteration process is discussed, where practical feedback from an expert is incorporated to further improve the toolkit. Finally, the final version of the toolkit is presented, outlining the adjustments and improvements made based on the feedback.

6.1 The initial version of the strategic toolkit

The first version of the strategic toolkit has been developed to support professional football organizations in analyzing their current situation and making strategic decisions regarding the use of IoT technologies in talent identification processes. The toolkit serves as a self-assessment tool, with 12 strategic questions divided into the four categories of the IoT-BALL analysis: benefits, associated risks, leveraging potential, and limitations. These questions help clubs reflect on their current strategies, future ambitions, and the necessary steps to effectively integrate IoT. After completing the assessment, the tool provides insights into the opportunities, risks, and potential of IoT use, enabling clubs to make informed strategic decisions.

Below, the first version of the strategic toolkit is further elaborated. Each category contains strategic questions designed to help clubs evaluate their current situation and plan the integration of IoT technologies. These questions aim to raise awareness and assist clubs in identifying opportunities and challenges in using IoT for talent identification.

Benefits

The benefits of using IoT technologies can range from improved scouting decisions to optimized processes and increased competitive advantage. Below, in Table 9, are three questions that provide insight into how IoT is currently contributing to scouting and talent identification within your club.

Tabel 9: Initial questions strategic toolkit - Benefits

BENEFITS	**Question 1: How important is it for your club to base scouting decisions on data-driven insights?**			
	Not important (use of intuition and experience)	Basic decisions based on data (e.g., WT statistics)	Partially data-driven (combination of data insights and traditional methods)	Fully data-driven (real-time connectivity and automated analyses)
	Question 2: How advanced is your organization in improving scouting efficiency?			
	No technological support	Basic reports available for scouts	Advanced data visualizations and support	Fully automated scouting with IoT technologies
	Question 3: How strongly does IoT contribute to your club's competitive advantage?			
	No priority	Limited IoT integration	Full integration of IoT in some processes	IoT as a core strategy and differentiator

Associated Risks

Integrating IoT technologies can bring both opportunities and risks, especially in terms of investments and dependency on technology. Below, in Table 10, are three questions that explore the club's willingness to take these risks and the impact of technological dependency.

Tabel 10: Initial questions strategic toolkit - Associated risks

ASSOCIATED RISKS	**Question 4: How much is your club willing to invest in IoT solutions for talent identification?**			
	No budget	Low budget (minimal implementation)	Average budget (step-by-step implementation)	High budget (direct, full integration)
	Question 5: How dependent does your club want to be on technology for scouting?			
	No dependency (traditional processes)	Some tools, but no full dependency	Technology supports critical processes	Full dependency on technology
	Question 6: How does your club want to build knowledge and expertise on IoT in talent identification?			
	No internal knowledge	Basic knowledge available	Expertise at multiple levels	Highly qualified IoT specialists

Leveraging potential

In this section, we examine how your club perceives the potential of IoT solutions for talent identification, both in terms of innovation and collaboration with external technology companies. Below, in Table 11, the questions focus on the club's future direction and ambitions.

Tabel 11: Initial questions strategic toolkit - Leveraging potential

LEVERAGING POTENTIAL	**Question 7: How does your club view the ambition to use innovative IoT solutions for talent identification?**			
	No ambition for innovation	Basic innovations are considered	Proactive innovation in some processes	Innovation as a core focus for talent identification
	Question 8: How does your club want to collaborate with technology companies for IoT implementation?			
	No collaboration	Temporary partnerships	Structural collaborations	Strategic partnerships with multiple companies
	Question 9: How important is data analysis to the club in the talent identification process?			
	No focus on data	Data analysis is applied occasionally	Data analysis is an important component	Fully data-driven organization

Limitations

While the benefits of IoT may be clear, clubs must also be aware of the limitations and challenges associated with the adoption of new technologies. In this section, we delve deeper into the club's flexibility and how they handle changes and competition in the market (Table 12).

Tabel 12: Initial questions strategic toolkit - Limitations

LIMITATIONS	**Question 10: How flexible is your club in adapting to technological changes in scouting?**			
	No flexibility (sticking to existing systems)	Flexible adaptation based on budget and priorities	Periodic updates of technology	Continuous innovation and adaptation
	Question 11: How does your club perceive competition from other clubs in terms of IoT use for talent identification?			
	No noticeable competition	Some competitive pressure	Regular competition in specific projects	Intense competition in almost all processes
	Question 12: How important is privacy and data security within your IoT strategy?			
	No attention to privacy	Basic measures implemented	Fully integrated privacy policy	Privacy as a top priority within the organization

6.2 Iteration of the strategic toolkit

To optimize the tool, an iteration was conducted according to the Design Science Research Methodology (Peffers et al., 2007). The first version of the strategic toolkit was presented to a Data Scientist with experience in data-driven decision-making and IoT use in professional football. Through a structured interview, valuable feedback was gathered on the tool's functionality, usability, and applicability. This process provided valuable insights into how the tool could be refined to better align with the needs and challenges of football clubs, both in their current situation and with a focus on future objectives. See Appendix F for the full interview guide. The key feedback points per topic were:

Value Added: The expert emphasized that the tool is valuable for structurally measuring how far an organization has progressed in using IoT for talent identification. By making strategic aspects measurable through clear levels, the tool provides guidance for evaluating systems and processes and fosters awareness within the organization. Additionally, the tool is easy to understand and thus useful in communicating with the management, supporting decision-making: *"They don't need to understand everything. But if they understand the framework, then you're already halfway there."* The expert also stated that the tool could be used to set objectives, such as improving data security from a basic level to an integrated privacy policy. Regular application of the tool, for example, annually, can monitor progress and stimulate structural improvements.

Usability: The expert appreciated the structure and design of the tool, with the options and levels being perceived as clear. However, it was suggested to improve usability by adding concrete examples or guidelines at each level. Examples such as specifying basic measures for lower levels and requirements for higher levels would help users better determine where they fit: *"Maybe add a bit more explanation, like, okay, here's an example of what your basic level should be, and if you want to be at level 3, you need to have at least this, this, and this in place."* This clarification would contribute to better interpretation and consistency in using the tool.

Limitations: The expert pointed out a limitation of the tool: the subjectivity of some evaluations, which could lead to differences in interpretation, for example, when determining the relevance of certain aspects. To reduce this, the expert suggested using a framework like SMART (Specific, Measurable, Acceptable, Realistic, Time-bound) for more measurability and objectivity. The expert also noted that some questions align well with practice, such as: *"What happens if it's no longer there?"* which forces users to critically reflect on the impact of technologies. For other parts, more specific input could help increase consistency in interpretation.

Practical Value: The expert highlighted that the tool is not only applicable for individual football clubs but also has potential as a broader standard within the industry, similar to the CIS framework in cybersecurity. It can serve as a general benchmark through which clubs can assess and improve their status, contributing to the professionalization of the football industry. The KNVB or other central bodies could use the tool to raise clubs' awareness of their current status and encourage them to make progress. Thus, the tool can serve as a 'kickstarter' for strategic reflection and decision-making on the use of IoT technologies, and as a benchmark for comparing performance and flexibility within and between clubs.

The feedback received underscores the added value of the tool as a structured tool for assessing and improving the use of IoT in talent identification. The expert appreciated the tool's usability and applicability and suggested reducing subjectivity by adding concrete examples and guidelines at each level. The potential of the tool as an industry standard was also emphasized, which can contribute to the professionalization of the football industry and strategic reflection within the sector.

6.3 Final strategic toolkit

This section presents the final version of the strategic toolkit, which has been developed after an iterative process and the incorporation of practical feedback. The strategic questions in the tool have been adjusted and expanded. The addition of concrete examples and guidelines has improved usability, making it easier for users to determine the appropriate level.

The tool combines theoretical insights with practical experiences, helping clubs assess and optimize the use of IoT in talent identification. Feedback from a Data Scientist emphasized the tool's value in both raising awareness within organizations and communicating with management. The framework is easy to understand and supports strategic decision-making and objectives, such as improving data security. Regular use, for instance annually, can monitor progress and stimulate structural improvements.

The expert recognized the potential of the tool as an industry standard, similar to benchmarks in other sectors like cybersecurity. In this way, the tool can serve as a reference framework for football clubs and central bodies, such as the KNVB, to raise clubs' awareness of their status and support them in further professionalization. The final strategic toolkit provides insights into the four categories of the IoT-BALL analysis—benefits, associated risks, leveraging potential, and limitations—and encourages strategic choices and reflection within the football industry. The content, functionality, and applicability are described in detail in the following section.

6.3.1 Content of the toolkit

The final version of the strategic toolkit provides a structured framework that allows football clubs to analyze their current situation and make strategic decisions regarding the implementation of IoT in talent identification. The strategic toolkit is based on the IoT-BALL analysis and includes four categories: **benefits, associated risks, leveraging potential,** and **limitations.**

Compared to the initial version, an additional column has been added with descriptions. This column contains detailed descriptions with examples and criteria that help clubs identify with the different levels, but are not intended as definitive guidelines. The addition of this column offers three benefits:

- **Concrete and detailed**: The descriptions are expanded with specific examples and criteria that provide a clear picture, but they are not intended as the only way to reach a particular level.
- **Consistent interpretation**: By incorporating examples into the descriptions, it becomes easier and more straightforward to make a choice at each level, but these remain examples and not hard guidelines.
- **User-friendly**: The descriptions outline practical and recognizable situations, enabling clubs to quickly identify with a particular level, but they should not be interpreted as standard solutions for every club.

Each question in the strategic toolkit includes clear levels and answer options, ranging from a basic approach to an ambitious strategy. This makes the tool widely applicable, regardless of a club’s size, resources, or ambitions. By making strategic aspects measurable and providing concrete guidelines, the strategic toolkit helps clubs identify areas for improvement and implement targeted changes.

Below, the complete set of questions, levels, answer options, accompanying descriptions, and a summary of this information are presented in an overview.

Benefits

The Benefits section of the strategic toolkit focuses on analyzing and evaluating the strategic advantages a club can achieve through the implementation of IoT technologies in talent identification. Through targeted questions and structured levels, this section provides football clubs with insights into their current use of data and technology, as well as potential areas for improvement.

Table 13 below includes three core questions related to data-driven decision-making, the efficiency of scouting processes, and the role of IoT in gaining a competitive advantage. Each level within the table is supported by detailed descriptions that help clubs identify their current situation and take steps toward a more strategic use of IoT and data analysis.

Table 13: Strategic questions and options within the benefits category

Strategic question	***Strategic options***	***Descriptions***
How important is it for your club to base scouting decisions on data-driven insights?	Not important	The club relies entirely on traditional scouting methods, such as visual observations and the personal experience of scouts. No tools, data analysis, or statistics are used.
	Basic data-driven decisions	Decisions are partially supported by simple data, such as test results or match and training statistics, alongside traditional evaluations. This could include simple software or tools like Excel spreadsheets.
	Partially data-driven	The club combines traditional methods with data insights, such as statistics and performance metrics, where decisions are partly supported by more advanced tools, but still rely on the experience of scouts.
	Fully data-driven	The club bases scouting decisions on comprehensive data streams and advanced analyses, such as real-time tracking and automated insights provided by platforms or IoT devices.
How advanced is your organization in improving scouting efficiency?	No technological support	Scouting processes are entirely manual, without technological tools.
	Basic reports available for scouts	Scouts receive simple, standardized reports with basic information, such as physical stats and test results, possibly from a simple database.
	Advanced data visualizations and support	The club uses tools that provide detailed visualizations, helping scouts interpret complex data like match statistics. Tools like Tableau or Power BI are applied.
	Fully automated scouting using IoT technologies	The scouting process is largely automated using IoT technologies that evaluate players based on real-time data from sensors and smart cameras. These systems analyze performance and movements, providing automated insights for coaches and scouts.
How strongly does IoT contribute to your club's competitive advantage?	No priority	IoT plays no role in the club's strategy or processes. No wearables or data technologies are used.
	Limited IoT integration	IoT solutions are sporadically used in specific applications, such as wearables for physical monitoring during training.
	Full integration of IoT within certain processes	IoT technologies are fully integrated into specific processes, such as scouting or fitness tracking, but not yet at a strategic level across the entire organization.
	IoT as core strategy and differentiator	IoT is at the core of the club’s strategy. Technologies such as sensors and smart devices are widely utilized to develop innovative and data-driven scouting methods that provide the club with a strategic advantage.

Associated risks

The Associated Risks section of the strategic toolkit helps clubs gain insight into the potential risks and challenges associated with implementing IoT technologies in talent identification. This section addresses key strategic questions related to budget, reliance on technology, and the development of internal expertise, enabling clubs to better anticipate potential pitfalls and make decisions aligned with their ambitions and resources.

Table 14 below contains three questions, each accompanied by strategic options and detailed descriptions. These descriptions clarify the implications of each level, helping clubs make informed choices and strike a balance between risks and opportunities.

Table 14: Strategic questions and options within the associated risks category

Strategic question	***Strategic options***	***Descriptions***
How much is your club willing to invest in IoT solutions for talent identification?	No budget	The club does not allocate financial resources for IoT solutions and remains fully dependent on traditional methods for talent identification.
	Low budget	The club limits itself to low-cost technologies, such as basic smart vests or entry-level software, without further integration into existing processes.
	Medium budget	The club gradually invests in IoT by integrating tools like wearables and data analysis tools into certain processes, such as physical monitoring and basic data collection.
	High budget	The club focuses on large-scale investments in IoT, including advanced technologies such as sensors and fully integrated platforms for real-time data collection and analysis.
How dependent does your club want to be on technology for scouting?	No dependence	The scouting process remains traditional and fully based on observations and the personal experience of scouts, with no use of technological tools.
	Some tools, but no full dependence	Technology such as video footage or basic statistics is occasionally used as support but does not play a central role in the process.
	Technology supports crucial processes	The use of technology such as data analysis tools, tracking systems, and reporting software is integrated into key parts of scouting, while human expertise remains leading.
	Full dependence on technology	The scouting process is fully driven by technology, with automation of data collection and analysis, and IoT systems supporting decision-making.
How does your club want to build knowledge and expertise on IoT in talent identification?	No internal knowledge	IoT-related processes are fully outsourced to external parties such as technology companies, without the club building internal knowledge.
	Basic knowledge available	The club has basic knowledge through training, workshops, or using interns, enabling staff to apply simple IoT technologies such as wearables or data collection.
	Expertise at multiple levels	The club employs internal specialists responsible for the implementation and management of IoT solutions in various areas such as scouting and performance management.
	Highly qualified IoT specialists	The club has a specialized team that independently develops, implements, and maintains IoT innovations, including expertise in data analysis and system integration.

Leveraging potential

The leveraging potential section of the strategic toolkit focuses on identifying strategic opportunities that IoT technologies can offer for talent identification. This section helps clubs determine how they can leverage innovation, collaboration, and data analysis to gain a competitive edge and optimize their scouting processes.

The table below (Table 15) contains three strategic questions with corresponding options and descriptions. These descriptions provide concrete examples and scenarios, enabling clubs to assess the impact of their choices on their scouting processes. This helps clubs understand how they can strategically use IoT technologies to drive innovation, form partnerships, and integrate data-driven processes.

Table 15: Strategic questions and options within the leveraging potential category

Strategic question	***Strategic options***	***Descriptions***
How does your club view the ambition to use innovative IoT solutions for talent identification?	No ambition for innovation	The club sticks to traditional methods, such as visual scouting and personal assessments, with no interest in technological innovation.
	Basic innovations are considered	The club is exploring simple IoT solutions, such as wearables or basic data collection, which have minimal impact on the existing scouting system.
	Proactive innovation in some processes	The club is piloting IoT technologies such as wearables or automated video analysis for specific tasks, such as physical performance or tactical insights.
	Innovation as a core focus for talent identification	The club positions innovation at the heart of its strategy, leveraging advanced IoT solutions as a fundamental part of talent identification.
How does your club want to collaborate with technology companies for IoT implementation?	No collaboration	There is no intention to collaborate with technology companies; all processes remain internal or traditional.
	Temporary partnerships	The club collaborates with technology companies on a project basis without long-term commitments, such as testing a specific application like a tracking system.
	Structural collaborations	The club has long-term contracts with technology companies for continuous support and optimization of IoT systems, such as periodic updates of tracking equipment.
	Strategic partnerships with multiple companies	The club forms an ecosystem of technology partners, with various companies providing innovative solutions and training to maximize IoT usage.
How important is data analysis for the club in the talent identification process?	No focus on data	The club relies entirely on subjective assessments by scouts, without using data or analytical tools.
	Data analysis is applied sporadically	Data, such as basic performance statistics, is occasionally used to support traditional scouting reports.
	Data analysis is an important component	The club systematically collects data through IoT devices, such as wearables and tracking software, to provide scouts with comprehensive insights.
	Fully data-driven organization	Decisions are fully supported by advanced data models, utilizing IoT systems and performance analysis powered by machine learning for talent predictions.

Limitations

The "limitations" section of the strategic toolkit focuses on the constraints and challenges that clubs may face when implementing IoT technologies in talent identification. This table helps clubs gain insight into their flexibility in technological changes, the impact of competition on IoT use, and the importance of privacy and data security within their strategy.

Table 16 below provides concrete descriptions for different strategic options. These descriptions illustrate how clubs can address technological and organizational limitations, such as the pace of innovation, increasing pressure from competitors, and data security requirements. This helps clubs assess their current situation and plan targeted improvements within these constraints.

Tabel 16: Strategic questions and options within the limitations category

Strategic question	***Strategic options***	***Descriptions***
How flexible is your club in adapting to technological changes in scouting?	No flexibility	The club sticks to traditional processes, such as manual scouting and paper reports, with no intention to explore or implement new technologies.
	Flexible adaptation based on budget and priorities	The club occasionally adjusts technology based on available resources and strategic priorities, such as upgrading software or integrating new tools when necessary, without making structural changes.
	Periodic updates of technology	The club occasionally implements improvements, such as upgrading video analysis software or adding simple sensors, but without structural innovation.
	Continuous innovation and adaptation	There is a proactive culture of technological renewal, with the club regularly investing in IoT devices such as real-time tracking or advanced data analysis tools.
How does your club experience competition from other clubs in terms of IoT use for talent identification?	No noticeable competition	Other clubs use IoT sparingly, so the club feels no need to deploy technology as a competitive advantage.
	Some competitive pressure	Some clubs experiment with IoT solutions like wearables or video analysis, but their impact on competition remains limited.
	Regular competition in specific projects	Competitors systematically use IoT tools in specific domains, such as physical monitoring or tactical analysis, creating targeted competition.
	Intense competition in almost all processes	The club faces constant pressure from rivals who widely use IoT, from advanced data collection to predictive analytics, as the core of their scouting strategy.
How important is privacy and data security within your IoT strategy?	No focus on privacy	Data is collected without security, such as open access to data or no encryption, posing risks.
	Basic measures implemented	The club uses standard security protocols, such as passwords and basic encryption, to protect sensitive data.
	Fully integrated privacy policy	There is a policy that strictly complies with regulations such as GDPR (AVG in the Netherlands), with comprehensive measures like access monitoring and periodic audits.
	Privacy as top priority within the organization	The club continuously invests in advanced security measures, such as end-to-end encryption, data minimization, and regular staff training.

6.3.2 Functionality of the toolkit

The strategic toolkit is designed as a practical tool that can be easily applied in interactive sessions, such as internal strategy workshops or discussions with stakeholders. It provides a structured framework that allows clubs to not only analyze their current situation but also make strategic decisions regarding the implementation of IoT technologies in talent identification. The key functionalities are:

1. **Diagnostic Tool**: Helps clubs gain a clear understanding of their current situation and strategic goals. This includes an assessment of the extent to which technology supports critical processes and how flexible the organization is in adapting to technological changes.
2. **Strategic Guidance**: Guides clubs through key considerations for implementing IoT, such as costs, risks, benefits, and their own dependence on technology. This can help map the gap between the desired and actual use of technology.
3. **Maturity Framework**: Based on feedback from Expert 1, a maturity model has been integrated to help clubs position themselves at different levels of technological maturity. As Expert 1 noted: *"By really solidifying it into levels, you can better determine where you stand, because otherwise it often remains vague how essential something is."*. This framework provides clubs the opportunity to assess themselves based on concrete criteria and set target levels.
4. **Decision-Making Tool**: Helps clubs make strategic choices by providing them with a structured framework and questions that force them to reflect on their current situation and objectives. The answers to these questions provide insights into the strengths and weaknesses of technology use within the club. This ensures that the strategic choices made are well-founded, both for internal decision-making and for communication with external stakeholders such as management or umbrella organizations.
5. **Flexible Application**: The toolkit is designed to be adaptable to the size, budget, and specific ambitions of a club.

The strategic toolkit can be deployed digitally (e.g., in a dashboard or Excel tool) or in a paper format, depending on user preferences. An annual evaluation, as suggested by Expert 1, can ensure continuous improvement and awareness: *"It helps to have some kind of reference point in evaluating your system, and to keep doing it systematically."*.

Additionally, the strategic toolkit provides the possibility to serve as a standard within the sector. This makes it not only suitable for individual clubs but also for broader application by organizations such as the KNVB. Expert 1 indicated that such an approach could improve the professionalism of the entire football industry: *"I would see it primarily as a widely supported framework that is recognized by management and can serve as a benchmark for clubs."*. Through this strategic toolkit, clubs can not only improve their internal processes but also better anticipate future technological developments and leverage collaboration opportunities.

6.3.3 Applicability of the toolkit

The functionality of the strategic toolkit focuses on providing a structured and clear framework that allows professional football organizations to evaluate and improve their use of IoT technologies for talent identification. The strategic toolkit serves as a tool to systematically assess the current state within a club, defining levels of maturity. This makes it possible to gain insights into both the desired and actual situation, as also suggested by expert 1: *"I think it primarily helps to measure in a structured way where you stand. By really solidifying it into levels, you can better determine how far along you are."*.

Specific functionalities

In the table below (Table 17), the specific functionalities of the strategic toolkit are outlined. These functionalities assist football clubs in evaluating their current IoT strategies and planning future improvements. The toolkit provides practical tools such as self-assessment, scenario analysis, and risk management to support clubs in their strategic decision-making.

Tabel 17: Specific functionalities of the strategic toolkit

Functionality	Description
Self-assessment and benchmarking	Self-assessment module in which clubs answer questions about IoT usage and policies, with scores on different maturity levels (basic, advanced, integrated). This is inspired by frameworks like the CIS Framework.
Structured analysis and planning	Identification of strengths and weaknesses to plan targeted improvement actions. Clubs are provided with tools for formulating objectives and priorities (e.g., privacy policy, technological dependency).
Scenario analysis and risk management	Expert 1 suggests that users are encouraged to think about the question: "What happens if technology fails?". It encourages clubs to consider risks, such as the consequences of technological failure, and helps them realize their technological maturity.
Communication and strategic decision-making	Improves communication within management teams by making complex topics understandable. As expert 1 notes: "If management understands the framework, you're mostly there." This increases support for strategic decisions.
Dynamic follow-up	The tool is designed to be used annually to monitor progress and flexibly respond to technological and organizational changes.

Added value

By using a SMART approach (Specific, Measurable, Acceptable, Realistic, Time-bound), the results of the strategic toolkit become concrete and actionable. This prevents the evaluation process from being subjective and provides clubs with a solid foundation for strategic decisions. Furthermore, the strategic toolkit encourages collaboration between departments and with external parties, such as technology companies and the KNVB, further promoting the professionalization of Dutch football. As expert 1 suggests, the tool could even be used more broadly as a benchmark or standard for multiple clubs. The functionalities of the strategic toolkit therefore not only address the specific needs of clubs but can also help the entire sector optimize the use of IoT in football.

Completeness of the strategic toolkit

The completeness of the strategic toolkit is demonstrated by its iterative development and the integration of detailed descriptions, examples, and guidelines with each question. This makes the tool both widely applicable and user-friendly for different football clubs, regardless of their size or technological maturity. The four main categories of the IoT-BALL analysis—benefits, associated risks, leveraging potential, and limitations—are structured into clear levels and answer options, helping the tool not only evaluate the current situation but also make strategic decisions. The concrete examples enhance identification with the levels and promote consistency in interpretation, while maintaining flexibility to tailor the approach to a club's specific needs. As a result, the strategic toolkit is not only suitable for individual clubs but also has the potential to serve as an industry standard, promoting the professionalization of the football industry and supporting the broader adoption of IoT technologies in talent identification. The practice-oriented iterations ensure that the tool is both theoretically grounded and directly applicable to clubs in the real world.

6.3.4 Summary overview: strategic IoT questions and options

The set of 12 strategic questions and associated options provides a structured framework for professional football organizations to formulate their IoT strategies in talent identification and development. Table 15 summarizes these questions and offers an overview of potential choices within the categories: **benefits, associated risks, leveraging potential,** and **limitations**. This framework helps clubs identify the key decisions needed to effectively integrate IoT into their scouting and talent management processes.

A valuable comparison can be made with the CIS framework from the cybersecurity sector, as highlighted by Expert 1 during the interviews. This framework offers organizations a structured approach for making strategic choices in a dynamic technological landscape. Similarly, the proposed framework provides football clubs with guidance on leveraging IoT technologies while managing risks and identifying opportunities.

Although the questions are specifically tailored to professional football, they can—with sector-specific adjustments—also be relevant for other sports organizations. By applying the framework and aligning strategic choices with the unique needs of their organization, clubs can fully capitalize on the benefits of IoT, manage associated risks, explore opportunities within leveraging potential, and better address organizational limitations.

Table 18: Summary overview of the strategic toolkit

Benefits				
1. How important is data for scouting decisions?	Not important	Basic decisions	Partially data-driven	Fully data-driven
2. How advanced is your organization in scouting efficiency?	No technology	Basic reporting	Advanced visualizations	Fully automated
3. How much does IoT contribute to competitive advantage?	Not a priority	Limited integration	Full integration	IoT as core strategy
Associated risks				
4. How much is your club willing to invest in IoT?	No budget	Low	Medium	High
5. How dependent do you want your club to be on technology?	None	Some tools	Crucial processes	Fully dependent
6. How does your club build IoT expertise?	No knowledge	Basic knowledge	Multiple levels	Specialist
Leveraging potential				
7. What is the ambition for innovative IoT solutions?	None	Basic innovations	Proactively in some processes	Core focus
8. How does your club want to collaborate with technology companies?	None	Temporarily	Structurally	Strategically
9. How important is data analysis in talent identification?	No focus	Occasionally	Important	Fully data-driven
Limitations				
10. How flexible is your club regarding technological changes?	None	Flexible adaptation	Periodic updates	Continuous innovation
11. How does your club experience IoT competition?	None	Some	Regularly	Intense
12. How important is privacy in your IoT strategy?	No attention	Basic measures	Full policy	Top priority

7 Discussion and conclusion

This chapter discusses the key findings of the research and provides a reflection on the implications of the results. It is divided into four sections. The discussion addresses the theoretical and practical implications of the findings, as well as the limitations of the research. The future research section offers suggestions for further investigation, and the chapter concludes with a conclusion, summarizing the main conclusions and answers to the research question.

7.1 Discussion

This section discusses the theoretical and practical implications of the findings regarding the strategic integration of IoT in talent identification within professional football organizations. It also addresses the limitations of this study and presents recommendations for future research.

7.1.1 Theoretical implications

This research provides valuable theoretical insights into the integration of the Internet of Things (IoT) in talent identification processes within professional football clubs. The developed strategic framework offers a structured approach to evaluating and making strategic decisions around IoT, contributing to the academic literature on the strategic use of technologies in the sports industry, specifically within talent identification.

An important theoretical implication of this research is that it demonstrates how IoT technologies can not only improve operational efficiency but also play a fundamental role in strategic decision-making. The presented model, based on the four categories of the IoT-BALL analysis (benefits, associated risks, leveraging potential, and limitations), forms a robust analytical framework that builds on existing technology acceptance models and maturity models in other sectors. This offers new insights into how clubs can evaluate technology based on their maturity level, ambitions, and risk tolerance, and may serve as a foundation for the strategic deployment of other emerging technologies, such as artificial intelligence and machine learning.

This research aligns with previous work emphasizing the need for a holistic approach to talent identification (Jokuschies et al., 2017) and the importance of reflective practice in elite academies (Reeves et al., 2018). The model integrates strategic and technological choices, providing football clubs with a broader perspective on their talent identification processes. It offers practical guidance for clubs to evaluate the implementation of IoT technologies and make informed decisions about technology integration, contributing to the literature on data-driven decision-making.

Another significant theoretical implication is the need for a sector-wide standard or benchmark for the application of IoT in the sports industry, enhancing the value of the developed framework. This highlights the dynamics of technology integration, where the flexible and continuous implementation of IoT is necessary given the rapid technological advancements. This insight opens up opportunities for further research into the application of similar technologies in other sports or domains of data-driven decision-making.

In summary, this research provides a new theoretical perspective on the role of IoT in strategic decision-making and talent identification, expanding the existing theoretical framework while offering practical value for technology implementation within the sports industry. It lays a solid foundation for further research and makes a fundamental contribution to both academic knowledge and the practice of technology integration in sports organizations.

7.1.2 Practical implications

The practical implications of this research are significant for both individual football clubs and the broader football industry. The developed strategic framework provides clubs not only with a diagnostic tool to evaluate their current situation but also a practical resource for making strategic

decisions about IoT. This supports clubs in optimizing their talent identification processes, enabling them to use technology to increase efficiency and strengthen their competitive position.

For clubs at various stages of technological maturity, the framework offers clear guidance for planning future developments. It allows clubs to systematically position themselves within the four categories of the IoT-BALL analysis, enabling them to better assess both the benefits and risks of IoT. This helps them determine the right investments, develop technical expertise, and build robust processes around data security and privacy, which is often a challenge for organizations in the sports sector.

Another key practical implication is that the framework helps clubs improve their internal communication and decision-making. Through the strategic questions in the toolkit, management teams and stakeholders can develop a shared understanding of the technologies they are implementing and their long-term impact. This contributes to stronger support for technological investments within the club and fosters a culture of data-driven decision-making.

The application of the framework also has broader implications for the professionalization of the sports industry. The ability to integrate IoT as a strategic tool can help clubs not only improve their operational processes but also strengthen their role in the broader football sector. As indicated by the expert, this research has the potential to serve as an industry benchmark, allowing the KNVB and other national and international sports organizations to play a leading role in the implementation of technology in sports management.

The developed tool has the potential to function as a standard within the industry, similar to the CIS Framework in the cybersecurity sector. It provides clubs with a benchmark to assess and improve their status, contributing to the professionalization of the football industry. The KNVB or other central bodies can use the tool to raise awareness among clubs about their position and encourage them to make progress. In this way, the tool can act as a 'kickstarter' for strategic reflection and decision-making regarding IoT technologies and performance within and between clubs.

Additionally, the response options are flexible, allowing clubs to tailor the recommendations to their specific situation. This enables strategies to be adjusted based on internal capabilities and external opportunities, with continuous improvement. By completing the tool annually, clubs can monitor the impact of IoT on their talent identification processes and demonstrate how these technologies contribute to improved performance and competitive advantage.

In terms of the broader sector, the further development of the strategic toolkit can help clubs not only achieve short-term results but also better prepare for future technological advancements. The model provides clubs with the flexibility to adapt their strategies and processes to the dynamics of technological innovations and market changes, which is essential in a rapidly evolving field like sports technology.

Through these practical implications, this research offers not only theoretical insights but also operational value, enabling clubs to improve their talent identification processes and gain strategic advantages in a technology-driven environment.

7.1.3 Limitations

Although this research has provided valuable insights into the application of IoT technologies in talent identification, several limitations affect the scope and sustainability of the findings. A key aspect concerns the sustainability of the current insights, given the constant technological changes in the IoT landscape. The technologies discussed in this research may quickly become outdated as new innovations emerge. This raises the question of how relevant the findings will remain in the long term, as the speed of technological advancement directly impacts the applicability of the conclusions. The research offers valuable insights for the current situation, but the application and relevance of the results will depend on how technology develops in the future.

Additionally, the scope of the findings is within the context of professional football in the Netherlands, meaning that the conclusions cannot be directly generalized to other sectors, countries, or levels of sport. Specific practices and technological integration may vary by region, and it would be valuable to expand this study to other countries or to amateur and lower professional levels to gain a broader perspective. The geographic and sector-specific focus of the research limits the wider applicability of the findings.

Another point of reflection concerns the choice of semi-structured interviews as the primary research method. This flexibility allowed for in-depth insights, but also introduced variation in the responses and approaches. This meant that some nuances may not have been fully captured, which affected the consistency of the data. While this method was suitable for exploratory research, a broader methodological approach, such as surveys or objective performance measurements, could have further substantiated and refined the findings.

Finally, the research focused on the existing practice of early talent identification, despite scientific criticism of this approach. For example, the work of Güllich et al. (2022) suggests that early selection does not always lead to better performance, and that a broader sports experience at a young age may be more beneficial. The limited focus on this subject means that the discussion about the effectiveness of early talent identification was not addressed in depth. This constitutes a limitation in the broader implications of the research, particularly given the existing scientific questions surrounding the value of early selection.

In summary, the main limitations of this research are the speed of technological changes, the geographic and sector-specific focus, the choice of methodology, and the limited attention to the effectiveness of early talent identification. These factors affect the sustainability and breadth of the findings and should be considered when interpreting the results. Practically, the research would benefit from a larger sample size and expansion to other sectors or countries, as well as additional research methods for a more robust foundation of the conclusions.

7.1.4 Future research

Future research on the role of IoT technologies in talent identification within football can focus not only on the technological aspects but also on broader strategic applications across various domains of sports organizations. This study has shown that the integration of IoT in talent identification is not only relevant for improving scouting processes but also provides valuable insights for broader strategic decision-making issues. One possible direction for future research is to further develop the proposed model and test it in other sports disciplines or organizations to explore the extent to which the findings from this study are applicable outside the context of talent identification. This would not only contribute to the general validity of the conclusions but also enhance the broader relevance of the strategic use of IoT in the sports sector.

Additionally, longitudinal research could provide valuable insights into the dynamics of IoT adoption, both technologically and organizationally. This would not only help anticipate future trends but also identify critical factors for successful or less successful IoT implementations, which is crucial for the long-term strategic use of technology. Investigating the effectiveness of technology integration in talent identification processes over a longer period would contribute to refining the model and improving its applicability at various stages of technological maturity.

An expansion of the sample size, both in terms of scale and diversity, is also necessary to validate the results more broadly. This could contribute to a deeper analysis of the impact of IoT across diverse sports contexts, both nationally and internationally. Differences in culture, infrastructure, and technology adoption between countries and regions could provide new insights that enhance the value of the model and optimize the integration of IoT in different organizational environments.

Finally, future research could benefit from a more comprehensive combination of data collection methods, such as surveys, interviews, and performance measurements, to strengthen the objectivity and reliability of the findings. Integrating different validation methods could further improve the practical applicability of the developed model and facilitate its implementation within the sports sector.

By exploring these directions further, future research can contribute to a holistic approach to IoT integration, where the strategic use of technology is optimized to enhance the effectiveness of talent identification and other sport-related processes. Understanding how technologies like IoT can be strategically deployed will help sports organizations make informed decisions and contribute to a sustainable future for the development of sports talent.

7.2 Conclusion

The aim of this research was to explore how a strategic tool can be designed to support professional football clubs in strategic decision-making about the use of IoT, with talent identification as a key case study. The central research question was:

How can a strategic tool be designed to support professional football clubs in strategic decision-making about the use of IoT, with talent identification as a key case study?

The conclusions present the key findings, including the role of both subjective and objective criteria in talent identification, as well as the internal and external factors influencing the implementation. The developed strategic model provides a structured framework for clubs to effectively integrate IoT technologies, carefully weighing both the benefits and risks of these technologies.

Strategic Toolkit

The developed strategic tool, based on the IoT-BALL analysis, provides a valuable resource for professional football clubs in making strategic decisions about the use of IoT, with talent identification as a central case study. The tool has been evaluated for validity, usability, and completeness, with practical feedback confirming its value and applicability. Its usability is high, especially in the context of strategic decision-making, though there is room for further refinement, such as adding indicators for less explored IoT applications. The validity of the tool is demonstrated through the integration of concrete examples and guidelines, which enhance its practical applicability. This makes it useful not only for clubs in their current situation but also relevant for future implementations in the football world. The flexibility of the tool allows for customization and facilitates broader adoption of IoT technologies, contributing to the professionalization of the sector. The strategic toolkit offers a structured framework that helps clubs assess their technological maturity and make strategic choices. It has the potential to serve as an industry standard, increasing the knowledge and application of IoT in sports organizations. This makes the tool valuable for both practice and as an important theoretical contribution to the field of IoT integration in sports organizations.

Internal and External Factors

Internally, the IoT-BALL analysis framework provides an effective tool for clubs to evaluate and improve the implementation of IoT technologies. The model allows for weighing both the benefits and risks of technological adoption, focusing on enhancing data-driven decisions while not overlooking the human factor. This helps clubs optimally use technology for talent identification and process improvement. The benefits of real-time data analysis, more efficient scouting, and strengthening competitive advantages can support clubs in achieving their strategic goals. At the same time, the model helps mitigate risks such as excessive reliance on technology and the loss of traditional scouting qualities, ensuring a balanced and holistic approach.

External factors play a crucial role in the successful integration of IoT within football clubs. The IoT-BALL analysis framework allows clubs to effectively assess and strategically leverage these external influences, such as partnerships with technology providers and privacy regulations. Collaborations

with tech companies can give clubs access to advanced tools and expertise, helping them leverage the latest innovations and optimize their scouting processes. At the same time, clubs must be aware of the challenges that come with technological change, increasing competition, and privacy concerns. The model helps clubs prepare for these external factors, ensuring they are well-positioned not only technologically but also legally and ethically.

Conclusions from Theory and Practice
The literature shows that IoT technologies can improve talent identification in football by providing detailed, objective data. Smart devices, such as vests and connected balls, contribute to accurate performance assessments, enhancing the effectiveness of traditional scouting methods. This approach, combining technology with traditional methods, offers opportunities for a more efficient and fair talent identification process. However, in practice, the application of IoT in talent identification is still limited. Interviews with experts revealed a need for a holistic approach that integrates both dynamic, time-sensitive data and traditional methods. This research has translated that need into a strategic model that helps clubs effectively integrate IoT into their processes. The theoretical findings confirm the need for a holistic strategic model, which aligns with the developed strategic toolkit. This model supports clubs in evaluating and improving their IoT strategies, which not only boosts scouting efficiency but also enhances their competitive advantage. The research offers both theoretical and practical value by presenting a framework that allows clubs to evaluate and further develop their technological maturity. The connection between theory and practice is clearly demonstrated, and the model serves as a valuable tool for the broader adoption of IoT in Dutch professional football.

Key IoT Applications
IoT devices, such as wearables and smart cameras, play a central role in collecting data on players, offering insights into speed, endurance, biometric information, and tactical aspects. The use of these technologies varies by club, depending on strategic priorities and available resources. For example, smart vests measure speed, distance, and movement intensity, while analysis tools like the connected ball provide insights into ball trajectory, speed, and impact, contributing to technical skills and referee decisions. Smart cameras analyze passing sequences and team formations, while interactive training tools, such as smart walls and cone systems, enhance ball control, agility, and reaction time. Section 1.3.2 provides a comprehensive overview of these applications and their impact on performance, strategic choices, and talent identification.

The Role of Subjectivity in Talent Identification
Talent identification is a complex process in which both subjective and objective criteria play a role. While IoT technologies can provide detailed data on player performance, such as physical and tactical characteristics, subjective assessment remains essential. Data alone does not always tell the full story, as exemplified by a player who may statistically contribute little but can make crucial moments. This combination of data and subjective insights forms the basis for a more holistic evaluation. This highlights the importance of balance between technology and human expertise in talent identification.

Final Conclusion
This research emphasizes the importance of a strategic approach when adopting IoT in talent identification. The developed strategic tool enables football clubs to assess their current use of IoT, identify areas for improvement, and develop a clear strategy for integrating IoT technologies. It provides a structured framework that allows clubs to evaluate the benefits, risks, and limitations of IoT usage. As a result, they can better capitalize on the opportunities that IoT offers, both within talent identification and broader strategic areas. This research lays the foundation for both scientific progress and practical improvement in professional football.

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Appendices

A. Systematic literature review protocol

Research goals:

- Summarize the existing knowledge.
- Identify potential gaps in the current literature.
- Position new research activities.

Research strategy/process:

The focus is on gathering the most relevant papers by searching scientific databases. The papers are then evaluated based on established inclusion and exclusion criteria. The selection occurs in several phases: first, the titles are screened, after which the abstracts of the remaining papers are read to further refine the selection. Finally, the remaining papers are reviewed in full, and the selection is completed through forward and backward referencing.

Scientific databases:

Scopus
IEEE Xplore
ACM Digital Library
AIS e-Library

Keywords:

Internet of Things (IoT)
Football | Soccer
Football player | Soccer player
Talent identification | Talent development | Talent scouting

Search key:

- (iot AND football OR soccer AND identification) OR (iot AND football OR soccer AND development) OR (iot AND football OR soccer AND scouting)
- (iot AND "football player" OR "soccer player" AND identification) OR (iot AND "football player" OR "soccer player" AND development) OR (iot AND "football player" OR "soccer player" AND scouting)

Inclusion/exclusion criteria:

Include	Exclude
Papers about Internet of Things and sport	Papers that only conceptualize data-driven decision making
Papers about Internet of Things and talent identification	Papers that only conceptualize machine learning
Papers about football/soccer and sensor data	Papers that only conceptualize Internet of Things
Only include sources published in the period 2015-2024	Papers outside of the topic and not in English or Netherlands

Academic databases search results

SEARCH PROCESS	AMOUNT
Papers found	87
After screening on title	44
After screening on abstract	27
After screening on full text	13
Adding forward & backward referencing	21

B. Implementation of the snowball method for the literature review

This appendix describes step-by-step the application of the snowball method in this research. The aim is to substantiate the validity and reproducibility of the approach.

1. Overview of the Snowball Method

The snowball method was used as a complement to the systematic literature review (SLR). It helped identify additional relevant studies that may have been missed during the initial search in selected databases. This method includes two directions:

- **Backward snowballing**: Analyzing the references cited in the initially selected articles.
- **Forward snowballing**: Identifying studies that cite the initially selected articles.

2. Step-by-Step Execution

The following steps were systematically followed to implement the snowball method:

Step 1: Selection of Base Articles

- A systematic literature search was conducted in databases such as Scopus, ACM Digital Library, IEEE Xplore, and AIS e-Library, based on predefined search terms.
- Inclusion and exclusion criteria were applied to filter relevant studies (see Table 1 in the main text).
- A core set of 13 articles was established as the starting point for the snowball method.

Step 2: Backward snowballing

- All references from the base articles were extracted.
- Each of these references was evaluated based on the following criteria:
    - Relevance to the research objective (IoT applications in football and talent identification).
    - Compliance with the inclusion and exclusion criteria.
- Titles and abstracts of the references were screened, with relevant studies added and duplicates excluded.

Step 3: Forward snowballing

- Tools like Google Scholar and Scopus were used to find studies that cite the base articles.
- The same evaluation criteria as in backward snowballing were applied:
    - Screening of titles and abstracts of these studies.
    - Inclusion of relevant studies and exclusion of duplicates.

Step 4: Iterative refinement

- For each newly identified study, backward and forward snowballing were performed again. This process was repeated until no new relevant studies were found.
- All steps and decisions were documented to ensure transparency.

3. Documentation and validity

- **Consistency**: The inclusion and exclusion criteria were consistently applied throughout the process.
- **Reproducibility**: Although exact results may vary due to changes in citation patterns, the step-by-step approach provides a solid foundation for repeatable results.
- **Validation**: The 13 additional papers found through snowballing were assessed for relevance and quality in relation to the original research objectives.

4. Challenges and solutions

- **Subjectivity**: The selection of articles contains subjective elements. This was minimized by strictly adhering to the predefined criteria.

5. Conclusion

The snowball method complemented the systematic literature review by expanding the depth and breadth of the literature. The documented process provides a robust framework for reproducibility and validity, contributing to transparent and purposeful research outcomes.

C. Systematic literature review results and paper classification

The tables below (Tables 16 and 17) provide an overview of the papers selected for the literature chapter. Each article is briefly described, along with its classification. The papers are also categorized by type: conference papers (C), journal papers (J), books (B), thesis papers (T), and whitepapers (W). The first table (Table 16) was primarily used in the first part of the literature review on the Internet of Things in combination with football. The second table (Table 17) was primarily used in the second part of the literature review on talent identification in combination with football.

Table 19: Selection and classification of papers for the systematic literature review (part 1)

PAPER	TYPE	DESCRIPTION
Chanal en Kakkasageri (2020)	Journal paper	This paper provides a comprehensive survey of the security and privacy challenges in the Internet of Things (IoT). The authors discuss key issues such as confidentiality, integrity, authentication, and availability. They also propose various solutions to address these challenges, emphasizing the importance of robust security protocols and privacy management schemes for resource-constrained IoT devices.
Decroos et al. (2019)	Conference paper	This paper presents a new approach to evaluating soccer players by valuing their actions based on context and impact. It introduces SPADL for action descriptions and VAEP for quantifying their effects on games, providing a more detailed analysis of player performance.
Gyarmati en Hefeeda (2016)	Conference paper	This paper presents a method for analyzing soccer players' physical movements using event-based data. It finds that despite differences in market value, Cristiano Ronaldo and Ruben Castro had similar movement patterns. The study also reveals extensive variety in attacking strategies used by teams, providing new insights into player performance and tactics.
Hossain et al. (2017)	Conference paper	This paper investigates using wrist-worn accelerometer devices to assess soccer players' skills. By applying deep learning to classify events like passing and dribbling, it shows how wearables can enhance player evaluation beyond traditional visual methods.
Ikram et al. (2015)	Conference paper	Proposes an IoT-based architecture, IoT Football, for monitoring football players' health by integrating sensing devices, telecommunication technologies, and cloud computing. This system aims to detect and address health issues during matches and training. The findings are based on a literature review and a proposed architectural framework.
Konzag en Schütz (2024)	Conference paper	The paper explores the use of tracking technologies in 13 German Handball-Bundesliga clubs. It finds that while these technologies have potential, their actual value depends on various factors. The study offers early insights into how these technologies can enhance sports performance and decision-making.
Lim (2023)	Conference paper	This paper investigates the importance of various features in predicting the future performance of professional soccer players. Using the FIFA dataset, the study analyzes player attributes and performance metrics across different age groups. The findings highlight age-related variations in feature importance, providing insights for talent identification and development in soccer.
Macuri et al. (2024)	Conference paper	Proposes an IoT-based solution for real-time optimization of soccer training using GPS vests. The

		system collects and analyzes performance data, comparing amateur players to elite standards. Findings are based on system design, development, and validation through user feedback.
Merhej et al. (2021)	Conference paper	This paper introduces DAxT, a new metric for valuing defensive actions in soccer using deep learning. By analyzing event data from the English Premier League, DAxT quantifies the impact of tackles and interceptions based on what they prevent, offering a more accurate assessment of defensive performance.
Pappalardo et al. (2019)	Journal paper	PlayeRank is a framework for evaluating soccer players using extensive event data. It offers a multi-dimensional assessment that considers player roles, outperforming existing methods and providing insights into performance and versatility.
Robberechts et al. (2023)	Conference paper	Introduces the Creative Decision Rating (CDR) metric to measure soccer players' creativity in passes using machine learning on StatsBomb 360 data. The CDR evaluates pass originality and impact, offering a new angle on player skills and aiding in recruitment and development.
Stein et al. (2016)	Journal paper	The paper explores how advancements in sensor technology and video analysis enhance soccer game analysis. It presents a visual analytics tool that automates the annotation of key elements like player interaction spaces, free spaces, and pass options, aiming to improve efficiency and accuracy in evaluating player and team performance.
Tawalbeh et al. (2020)	Journal paper	This paper discusses the challenges and solutions related to privacy and security in the Internet of Things (IoT). The authors identify key issues such as insufficient device updates and weak security protocols. They propose an IoT layered model to address these issues, which is tested using Amazon Web Services (AWS) and Raspberry Pi. The model effectively enhances security and privacy in IoT environments.
Wilkerson et al. (2018)	Journal paper	This study uses IoT data to improve sports injury prevention. It analyzes data from 43 college football players, including self-reported injury impacts and postural stability tests. The model improves injury prevention by identifying high-risk athletes and guiding interventions.
Xie et al. (2023)	Journal paper	The study presents a low-cost AI + IoT system for recognizing football motions and analyzing intensity using wearable sensors. The multitask learning model effectively handles both tasks simultaneously, demonstrating high efficiency in football motion analysis.

The information in Table 17 below is primarily found in the second part of the literature review.

Table 20: Selection and classification of papers for the systematic literature review (part 2)

PAPER	TYPE	DESCRIPTION
Baker et al. (2017)	Journal paper	This paper discusses the challenges in identifying and selecting talent in sports, emphasizing the flawed assumption that talent is a fixed trait identifiable early. It highlights biases in selection processes, the inadequacy of current statistical methods, and the negative impact of short-term priorities on long-term athlete development.
Bergkamp et al. (2019)	Journal paper	This study critically evaluates the methodology of soccer talent identification research, highlighting four key issues: operationalization of criterion variables, isolated performance indicators, range restriction effects, and base rate impact. The authors suggest improvements for future research to enhance the validity and utility of talent identification procedures.
Bergkamp et al. (2021)	Journal paper	This study examines how soccer scouts identify talented players, focusing on the age at which performance predictions can be made, relevant attributes, and the prediction process. Scouts often rely on observable technical attributes and use a structured approach, but ultimately make intuitive decisions, which may reduce prediction accuracy.
Ford et al. (2020)	Journal paper	This survey examines talent identification and development processes in youth academies of professional soccer clubs worldwide, revealing age-specific strategies and multidisciplinary approaches. The study highlights the importance of local and regional scouting for younger players and a broader, international focus for older players.
Forsman et al. (2016)	Journal paper	This study identifies key technical, physiological, tactical, and psychological traits that contribute to career progression in young soccer players. Skills like passing, centering, agility, and motivation are highlighted as crucial for success.
Jokuschies et al. (2017)	Journal paper	This study explores how top-level youth soccer coaches use subjective criteria to assess player talent, revealing the multidimensional nature of their talent concepts. The findings indicate a high correlation between coaches' assessments based on their criteria and their evaluations of players' overall potential, demonstrating the validity and reliability of these subjective assessments.
Jonker et al. (2019)	Book chapter	This chapter examines how elite youth football players develop the skills needed for success. It highlights the importance of physical, technical, tactical, and psychological characteristics, and emphasizes the role of self-regulation in learning. The study followed 525 players in Dutch academies, showing that those with strong self-regulatory skills were more likely to succeed.
Kelly et al. (2023)	Book chapter	This chapter provides an international perspective on talent identification and development in youth soccer, examining diverse talent pathways and the influence of national youth sport cultures. It highlights the importance of designing optimal developmental environments and understanding the complexity of talent selection.

Reeves et al. (2018)	Journal paper	This study investigates talent identification in junior-elite football within English category one academies, identifying four key themes: league structures in junior grassroots football, reflective practice, holistic player evaluation, and the role of luck. The findings suggest that improvements in these areas could enhance talent identification processes.
Roberts et al. (2019)	Journal paper	This study uses a modified e-Delphi method to establish consensus on position-specific predictors for elite youth soccer in England. The findings highlight that psychological and technical attributes are deemed more important than physiological or anthropometric ones for talent identification.
Verbeek et al. (2023)	Journal paper	This paper provides a systematic review of the current knowledge on talent development in soccer. The authors classify existing research into static or dynamic, and inter- or intraindividual perspectives. They found that most studies focus on static, interindividual factors, and recommend more research on dynamic, intraindividual processes to better understand talent development over time.

D. Interview guide

Introduction:

Welcome and introduction

- Introduce yourself.
- Briefly explain the purpose of the interview:
  - The purpose of this interview is to gather insights from [ORGANIZATION NAME] [INTERVIEWEE NAME] regarding IoT in talent identification.
- Assure confidentiality and explain that the data will be used for academic research.
- Request verbal consent to record the interview.

Interview Questions:

Talent identification process

1. **An online scouting form by Piet de Visser is available (see the image at the bottom of the document). This form consists of four aspects: technical, tactical, personality traits, and physical attributes.**
   a. How do the steps in your identification process relate to this form?
   b. What steps are involved in your talent scouting/identification process?

2. **Is there a specific definition of talent? When is someone considered a talent?**
   a. Does this definition include the same aspects as your identification process? Specifically, technical, tactical, personality/mental traits, and physical attributes.

3. **Do you focus on static-interindividual or dynamic-intraindividual perspectives?**
   - Static-Interindividual: This perspective looks at a snapshot of player groups, comparing fixed characteristics or traits that distinguish talented players from others at that specific moment.
   - Dynamic-Intraindividual: This perspective looks at talent development over time within an individual and how various factors change and interact over time to influence future skills.

Example:

Static-Interindividual Perspective

Example: Club X

- **Focus:** Club X may focus on fixed characteristics of players at a specific moment to identify talent.
- **Scouting Method:** Scouts observe youth matches and select players based on physical attributes (such as speed and strength), technical skills (such as dribbling and passing), and psychological traits (such as motivation and self-confidence).
- **Process:** Scouts use standardized tests and evaluation forms to compare and rank players. They assess how players perform in matches and training at that specific moment.
- **Example:** A scout from PSV might notice a youth player who excels in speed and ball control during a tournament and invite the player for a trial training session at the club.

Dynamic-Intraindividual Perspective

Example: Club Y

- **Focus:** FC Twente may focus on the development of talent over time within an individual.
- **Scouting Method:** Scouts track players over a longer period, observing how their skills and attributes evolve.
- **Process:** Scouts maintain detailed records of players, including their performance in various matches and training sessions, their response to different training methods, and their mental and physical development.

- **Example:** A scout from FC Twente might follow a youth player who consistently improves in technical skills and game intelligence over several seasons. This player is not only evaluated based on current performance but also on the potential for further development.

Knowledge about the Internet of Things (within the entire talent identification process)

4. What do you understand by the concept of "Internet of Things" (IoT) in football?

5. How is the Internet of Things integrated within your organization for talent identification and development?

a. Which aspects of the scouting/identification process are currently being measured by IoT? And with which devices?
b. Which aspects of the scouting/identification process could potentially be measured in the future? And with which devices?

6. On a scale of 1 to 10, how important do you consider the use of IoT for talent identification within your organization?

a. Why did you give this score?

Importance of IoT (within the role)

7. Why do you think IoT is important within your role and within company X?

a. Which Internet of Things technology is particularly important for your role?
b. Or where do you see opportunities for IoT technology within your role?

Effectiveness of IoT in talent identification

8. How does the information collected through IoT devices influence your decision-making and player evaluation?

a. How do you experience the effectiveness of IoT technologies in talent identification and scouting processes within your organization?

9. Do you notice a difference compared to five years ago?

a. Has this rapid development also affected the accuracy and results of your scouting?
b. Is the development happening so fast that no policies or guidelines can be established?

Experiences and challenges

10. Are there specific obstacles or challenges you encounter when implementing IoT technologies?

11. What are the benefits and challenges of Internet of Things technologies in talent identification?

a. Consider aspects such as integration, costs, and personnel.

Improvements and future perspective

12. In which areas do you think the application of IoT within your club can be improved, specifically regarding talent identification?

13. What is your vision for the use of IoT technologies in the future of talent identification?

a. What impact do you expect on the scouting and development processes?

Policies and procedures

14. Do you see the value of standardized policy documents for the use of IoT data within scouting processes?

15. Which procedures do you think are crucial for effectively using and interpreting collected IoT data?

Change management and training

16. Do you already have any training or programs related to the Internet of Things?

If yes:

a. How important are training and development programs in supporting coaches and scouts in the use of IoT technologies?

If no:

b. Would it be useful to provide training and programs for different staff members?

Collaboration and knowledge sharing

17. Has your organization collaborated with other clubs or organizations in the field of IoT technologies for talent identification?

a. Can you provide examples of such collaborations and what the outcomes were?

Closing

18. Is there anything else you would like to add about IoT and talent identification that we haven't discussed yet?

E. Key quotes with benchmark tables

Identification process

This paragraph compares the three clubs regarding the identification process. Benchmark Table 6 below provides an overview of the key aspects, followed by a brief explanation of each club.

Table 21: Comparison of the identification process

Aspect	Club A	Club B	Club C
Age categories	Lower: U8-U12; Middle: U13-U15; Upper: U16-U19	Lower: U9-U11; Middle: U12-U15; Upper: U16-U21	Talent plan: U9-U12; Basic plan: U13-U16; Pro plan: U17-U21
Start of official academy teams	From U10	From U12	From U9
Number of scouts	~90 volunteer scouts divided across 5 regions	Volunteer scouts per region	Volunteer scouts divided by region
Identification criteria	Technique, tactics, physical, mental, standout ability	Scouting form; potential (conditions or traits to become good)	Motor skills, technique, and mentality (no detailed forms)
Scouting report process	Four-eyes principle mandatory; scouting reports placed in Soccerlab	Four-eyes principle depends on age group	Four-eyes principle mandatory
Selection process	Players go on trial; talent program for U9 with 40 children, evaluation after 6 sessions; ~250 players on trial per season, 35-40 selected	Regional training for U9-U10; U11 program with five rounds to select U12 team	Eight regional training sessions for selected players, which serves as intake for the academy
Number of players in lower age groups	~100-110	No official teams in U9-U11, but wide involvement through regional training	Most intake in the talent program (U9-U12). Around 50-60% advance to higher teams.
Focus on potential vs. performance	Difference between performance and potential players; awareness of birth month effect	Strong focus on potential and socio-emotional development	Focus on potential; awareness of birth month effect
Unique characteristics	Talent program U9 with flexible intake; trials for 250 players per season, 35-40 selected	Regional training supports amateur clubs; U11 program leads to first official academy team (U12)	Focus on early intake and development-oriented policy, with gradual outflow starting from U14.

Club A

The identification process at Club A is characterized by a structured approach, incorporating voluntary scouts, the four-eyes principle, a standardized scouting form, and talent development programs. Both performance and potential are evaluated when assessing young players. The club aims to balance performance-driven decisions with the long-term development of talent.

Expert 2 highlights the importance of identifying core qualities while managing differing preferences among scouts:

“But what you see very much is: each scout really does it quite well report in his own way. And that in itself is fine, because we have to take into account when you have ninety scouts. One scout is 80, another is 20, there's a difference in that. But what we want in any case, is that when we read a report, that we have a bit of an image proof of: That's what that player looks like and that's his core quality and excelling.”

This focus on core qualities and the application of objective principles, such as the four-eyes principle, demonstrates how Club A strives for a fair and meticulous selection process, despite the challenges of personal preferences and the birth month effect.

Club B

Club B distinguishes itself by placing a strong emphasis on potential and socio-emotional development in young players rather than immediate performance. This is evident, among other things, from the decision to form an official academy team only from the U12 level onwards. As highlighted on the club's website (FC Twente Heracles Academy, n.d., https://fctwenteheraclesacademie.nl/regioplan/):

"Club B has made a conscious decision to start with an academy team only from the under-12 age group. We believe it is important for the social-emotional development of young children to let them play at their own amateur club during their early years."

Additionally, Club B invests heavily in regional training sessions and the U11 program, providing young talents with the opportunity to develop broadly before eventually progressing to the academy. Expert 5 explains:

"It is a pre-selection for our first academy team under 12. So, for a year, we are very intensively involved, training on both Mondays and Fridays, to see if we are making the best choice. And then those are the 16 to 18 boys for our first under-12 team."

This approach reflects Club B's vision of not only selecting players but also supporting amateur clubs in the region and improving the overall level of football.

Club C

Club C has a structured development system in which players are divided into three phases: the Talent Plan (U9-U12), the Basic Plan (U13-U16), and the Professional Plan (U17-U21). The majority of intake occurs in the Talent Plan, with a focus on the youngest age groups. This is confirmed by Expert 8:

"We have the largest intake starting from the under-9 age group. So, the biggest influx is from under-9, under-10, and under-11. In addition, we do have some lateral intake through the basic plan and the professional plan, but that's naturally a bit smaller."

The identification process at Club C focuses on observations of motor skills, technique, and mentality in young players, without the use of extensive forms. Scouts work according to the four-eyes principle. How they proceed is explained by Expert 8:

"Yes, just observing. Especially with the younger kids, they look closely at good movers. Whether their motor skills are on point. If their motor skills are good, that's already a plus. If they're also technically skilled, that's a double plus. Then, if they're not only technically strong but also mentally driven, always giving their best, that's another plus. Then it's pretty much decided right there."

To facilitate intake, Club C organizes regional training sessions consisting of eight sessions, where talents can showcase themselves. This also provides insight into important aspects, such as the relative age effect, as Expert 8 points out:

"If among the younger players at the regional training there are a few boys born in November or December, they stand out to us even more. That's because they have a year of developmental lag compared to someone born in January. So, they might still have more potential to develop."

Club C's policy is focused on early intake and a development-oriented approach, with players remaining in the program until U14 without the stress of annual outflow. This strategy emphasizes the importance of potential over immediate performance, which is unique to their training structure.

Integration and effectiveness of IoT in talent identification and organization

In this paragraph, the three clubs are compared in terms of the 'integration and effectiveness of IoT in talent identification and organization'. The benchmark table 7 below provides an overview of the key aspects, followed by a brief explanation of each club.

Table 22: Comparing the integration and effectiveness of IoT in talent identification and organization

Aspect	Club A	Club B	Club C
Use of IoT devices	IoT is applied to a limited extent. Physical data is collected via sensors and cameras; academy players and trial players undergo physical tests such as jump and sprint measurements. For older teams (U17+), video data is used for physical and tactical insights.	IoT applications are limited. The club uses self-built IP camera setups and software like myteamperformance. The focus is on video analysis and match coding, with little automatic IoT support.	IoT usage is minimal due to financial constraints. Location and movement data is used for the U19 team through smart vests, but without specialized analysis. Smart cameras (Veo's) are frequently used to record matches for analysis, supported by manual coding by assistants. Initiatives for younger teams (such as U17) have been discontinued due to budget cuts.
Use of data analysis	Data from video and sensors is processed for physical, tactical, and technical insights, such as distance and accelerations. The data is supplemented with manual input for specific statistics (e.g., successful dribbles). There is integration between location and movement data and video footage.	Match footage is coded during games using shortcuts to capture actions (e.g., ball loss or attack). Video data is primarily used for tactical and technical analysis, not directly for talent identification. Integration of location and movement data with video footage is being tested with the first team.	Location and movement data is used minimally with the U19 team, primarily to establish benchmarks for physical performance and recovery from injuries. Video analysis with Veo cameras is used to generate tactical insights and structure training sessions. There is no integration of location and movement data with video footage.
Scouting processes and IoT	Scouting for U9-U12 primarily focuses on physical tests; for older age groups (U13+), cognitive tests and discussions with pedagogues are used. IoT is employed for performance analysis and validation, but technical staff play a leading role.	Scouting mainly relies on traditional methods, such as observation and sporadic use of video footage. Physical tests are conducted for U9-U12 scouting. IoT is used for analysis and performance validation, but technical staff play a leading role.	Scouting mainly depends on observations at amateur matches and subsequently during regional training sessions. Tests (such as jump or sprint tests) are conducted sporadically and are not decisive. IoT plays a subordinate role in the scouting process and is only used occasionally.
Application of technology in teams	In addition to testing, advanced technologies such as Aura rings are used from U17 to the first team. This	Technology at the academy teams is primarily focused on video recordings and manual coding. IoT and	At the U19 team, smart vests are used to measure physical performance. Analysis is conducted by an intern without specialized

	technology helps measure sleep, stress levels, and physical performance. Smart cameras are placed around all fields to collect data for physical, tactical, and technical parameters.	automation are underdeveloped, and data is used occasionally for player comparison.	knowledge. Veo cameras play a significant role in analyzing matches, with additional coding done by assistants. Other teams have limited access to technology due to budget cuts.

Club A

Club A uses various technologies, including IoT, to collect data that contributes to the talent identification process. While IoT is applied in a limited way, its use is evident in specific devices and methods. For example, Expert 1 emphasizes the importance of the Aura rings, which are used starting from the U17 team:

"It's a ring that players should wear at least at night, and maybe also during the day, and it measures... just like a smartwatch, but more precisely, and it also tracks sleep behavior, heart rate, variability, stress levels, and things like that."

Additionally, video analysis plays a crucial role in the older age groups, where physical and tactical insights are obtained from camera footage. As expert 1 states:

"Based on the camera footage, you can translate that into physical components. For example, total distance covered, distance covered at high intensity, accelerations, and decelerations."

However, the use of IoT technology is mainly applied to older age groups. In the actual scouting process itself, very little is done with IoT. During regional training sessions, physical tests are conducted, but this rarely involves IoT. Systematic data, such as that from the Oura rings and video analysis, helps to objectively evaluate and compare players, contributing to a more scalable and informative talent identification process.

Club B

Although Club B acknowledges some applications of IoT technology, the interviews reveal that the integration and automation of these technologies is still limited. As expert 3 pointed out, the club uses IP cameras and software like myteamperformance for video analysis, but these systems are primarily manual and not yet fully integrated:

"We built our own system. We don't really have a name for it, but we created a setup ourselves using IP cameras. On Saturdays, we simply use a regular handheld camera for recording. Additionally, we use various software from different providers. For example, myteamperformance is one of the tools we use to code our matches."

This highlights that while IoT devices are present, their deployment is still far from an automated and streamlined process. It was also noted that the coding of match footage takes place during the matches, with specific actions being recorded using shortcuts, resulting in a manual data analysis process:

"We have a laptop, and on that laptop, we use various shortcuts. These shortcuts are all set up for different actions."

The limited application of IoT is also evident in the scouting process. Expert 5 mentions that although some physical measurements, such as speed and explosiveness, are already conducted in youth teams, this is not yet a structural part of the broader talent identification process for the club:

"Incidental, not structural. It's not yet part of our program."

This illustrates that IoT technologies are mainly focused on monitoring performance within the academy teams, but are not yet systematically used on a broader scale for scouting new talent, such as in younger age groups outside the academy.

These observations emphasize that while Club B is taking important steps towards digital technologies, the full potential of IoT in talent identification and development is not yet fully realized.

Club C

For Club C, it is clear that the use of IoT technologies, despite some willingness, is strongly hindered by financial constraints and a lack of specialized knowledge. As expert 9 points out:

"Last year, I believe they did have data for the under-17s as well, but they cut back on it. I think that's also because they didn't have the manpower to analyze it all."

This statement highlights the impact of limited resources on the effectiveness of IoT usage, leading to the discontinuation of initiatives with younger teams.

In the case of the U19 team, location and movement data from smart vests are used to establish benchmarks and monitor recovery after injuries, but without the necessary specialized analysis. Expert 9 states:

“I’m really into testing, and I want to see if we can establish some sort of benchmark, both for future players and for players who, for example, get injured during the season. They can refer back to: hey, this is how my old level was, and this is what I need to get back to in order to be fully fit.”

This indicates that while the technology is being used, the integration with other forms of analysis, such as video footage, is lacking, limiting the applicability of the results. Additionally, the role of technology in the scouting processes at Club C is considered subordinate, with IoT being used only occasionally. As expert 8 states:

"Yes, tests are conducted here at club C. But they aren't really decisive. It's more of a tool."

The combination of observations and irregular tests forms the foundation of the scouting process, but IoT technologies contribute only marginally to the objectivity or effectiveness of this process.

These statements reflect the underlying issue at Club C: while there are initiatives to integrate IoT technologies, their use remains sporadic and heavily dependent on available resources and personnel capacity. Financial cutbacks and the lack of specialized knowledge prevent a structural and more effective deployment of technologies that could be crucial for the further development and precision in talent identification.

Vision, policy, and collaborations for IoT usage

In this paragraph, the three clubs are compared in terms of 'vision, policy, and collaborations for IoT usage'. The benchmark table 8 below provides an overview of the key aspects, followed by a brief explanation of each club.

Table 23: Comparison of vision, policies and collaborations for using iot in talent identification

Aspect	Club A	Club B	Club C
Vision and Culture	Club A develops a football vision in which IoT technologies are increasingly accepted and understood.	Club B lacks a clear overarching strategy on IoT, data, and technologies that integrates departments.	Club C has a clear football vision, but the extensive manual is perceived as too complex. A more concise version is being worked on.
	Data is used to assess players on position-specific characteristics.	Lack of uniformity limits the use of data and technology.	The limited budget and lack of expertise hinder implementation.
	In the culture, there is a strong focus on detailed information and data insights, especially due to financial implications.	Application of technology such as video footage is consistent, but gadgets and IoT are dependent on individual choices.	Ambitions like more data usage are present, but financial limitations prioritize short-term goals.
Talent Identification: Policy and Practice	Investments in technology and data analysis are limited to what has proven effective.	Technology is not structurally integrated into scouting.	Club C performs four-weekly measurements for younger players to monitor growth and injuries.
	IoT mainly focuses on older players, as the 'gray area' in talent identification shrinks as they get closer to the first team.	Measurement starts at young ages, but investments in advanced technologies are missing due to practical and financial limitations.	The club lacks resources and expertise to fully implement a detailed, data-driven approach.
			Scouts have a limited role, focused on initial identification, without involvement in further development of players.
Collaboration and External Engagement	Collaborations with other clubs are informal, such as direct contact between data analysts.	Collaborations with other clubs are informal, mainly focused on exchanging video footage.	Collaborations with other clubs are informal, mainly focused on exchanging video footage.
	Regional collaborations are focused on exchanging knowledge and inspiration.	They claim to have the largest regional plan in the Netherlands (collaboration with partner clubs).	Collaboration with partner clubs is being further developed but is still in an early stage.
	External collaborations with KNVB, ASML, TU Eindhoven, Fontys, and Anna hospital.	Lack of central coordination, both within the club and with external partners, limits effectiveness.	Club C actively seeks collaborations with KNVB, educational institutions, and wearable manufacturers.

		The first team uses more advanced technologies, but there is little exchange with the academy.	There is access to external data, but a structured approach is lacking.

Club A

The vision and culture within Club A emphasize continuous innovation and testing of IoT technologies in talent identification. As expert 1 notes:

"Every component that we could measure better, we try to improve by creating a more advanced Internet of Things solution."

This illustrates the drive to use technology to assess players more effectively and objectively, for example by measuring specific characteristics per position.

Furthermore, the club shows a strong focus on collaboration and communication, both internally and externally. Internally, the importance of translating data into practical insights is emphasized:

"Look, in the end, the practice just wants to know: Is someone fast or not? Very simply put. Or: Is someone strong or not? Or: Will someone become strong or not? So they often think in very simple terms. The most important thing is: How do you ensure that the things we measure properly support that opinion? That's why the translator is crucial. We can measure a lot of things, but how do we compare them properly? How do we present them correctly? And it's just very important that this intermediate step exists. Because if you throw raw data directly at a coach, it's basically useless."

Externally, the club collaborates with parties such as ASML and the KNVB to develop new IoT solutions and refine existing methods.

These quotes illustrate how a widely shared vision and collaboration are essential to effectively integrate IoT technologies into the scouting process, and support the points in the table.

Club B

Club B lacks a clear, overarching strategy to effectively deploy data analysis and technology. This is evident from a lack of coordination between departments and inconsistent policies. Expert 4 states:

"I assume there is a vision from expert 3's department, but not within our department."

However, this statement is contradicted by expert 3, who points out that there is no policy or procedure in the club regarding how the collected data is utilized. In his words:

"There is nothing for that."

Although some initiatives, such as standardizing football terms and using footage, are well-developed within individual departments, there is no uniform policy that integrates these efforts. Expert 3 emphasizes:

"Every coach uses footage. Everyone, every day. Whether it's footage of their own team, footage of the opponent, or footage of the player, players need to be working with footage every week. It's just become so important because footage is the most ideal feedback tool to teach a player something. You can see exactly what they did wrong and what they can improve."

However, the use of more advanced technology, such as IoT devices, remains limited and dependent on individual choices:

"It is up to the coach to decide whether to use their own code, coding program, download their own footage, or use their own keynote or whatever else."

Collaborations with other clubs and regional initiatives provide valuable inspiration but lack central coordination, for example, from the KNVB. According to expert 4:

“Every now and then, let's say once every six months, we have a meeting with all the clubs, for example from North/East Netherlands, to see: What are you doing, and what are we doing? To learn from each other.”

However, the lack of uniform standards and vision limits the impact and consistency of these collaborations. These insights highlight the importance of a holistic vision and better alignment within Club B, as shown in the table above.

Club C

The challenges and opportunities within Club C, as described in the research, highlight the complexity of balancing a clear vision, financial limitations, and partnerships. Below are some key insights that strengthen the analysis in the table.

As one of the experts notes, it is difficult to fully implement a comprehensive vision without the necessary resources:

"Yes, there is a certain vision. However, the football manual is so extensive that we are currently working on making it more concise and manageable because it’s not feasible for anyone to learn it all. As a youth coach, you’re sometimes just passing through, so as a club, we want a shorter and more straightforward manual, a vision that clearly represents what we aim to convey. This way, both new players and those joining later can quickly get on board with it.”

This shows that Club C is actively working on making their vision more accessible, despite operational challenges. Additionally, financial constraints play a significant role in realizing technological improvements and hiring experts:

"If you want everything, there's a price tag attached to it.” & "Right now, we're focused on possibly hiring a head of youth development, so let's prioritize finding someone for that first. Hopefully, the rest will follow. Ultimately, everything comes down to finances. A couple of years ago, they had a debt of 1.7 million euros. So, you have to pay everything off, and the budget gets severely tightened. For things like this, there’s simply no funding."

This remark emphasizes how budgetary considerations shape the club’s strategies, including investments in IoT technologies.

Finally, the role of collaboration and external involvement is crucial, but not yet optimally structured:

“Yes, sometimes expertise is requested. We have worked with Paul van Zwaan before, and collaborated with Top Sports Gelderland. We try to collaborate more with the KNVB as well. So, we are looking for partnerships in that regard. But you can't do it alone. There are also so many new things to consider.”

This demonstrates that there is potential to further professionalize and leverage partnerships for talent development. These quotes illustrate how vision, resources, and partnerships influence each other in the approach to talent identification and the use of IoT technologies within Club C.

Challenges and improvement areas with IoT

In this paragraph, the three clubs are compared in terms of 'challenges and improvement areas with IoT'. The benchmark table 9 below provides an overview of the key aspects, followed by a brief explanation of each club.

Table 24: Comparison of challenges and areas for improvement in using iot for talent identification

Aspect	Club A	Club B	Club C
Integration of data and human judgment	Data should complement scouting methods, not replace them. There is room for improvement in the balance between data and subjective judgment by scouts.	Limitations in coaches' knowledge of IoT possibilities. The technology is not fully utilized.	Lack of structural capacity and resources to effectively deploy technologies. Coaches have limited time and expertise.
Access to data	Limited access to international tracking data, making it difficult to compare foreign players.	Different codings of match footage by different individuals, affecting data reliability.	Limited use of data for tactical and technical development, mainly due to financial constraints.
Technological complexity	Technical gap between the data department and other staff without a technical background.	Lack of uniformity in technology usage within the club, leading to fragmentation.	Lack of resources and specialized roles makes it difficult to apply technology effectively.
Expansion to youth teams	IoT data is used only for the first team; expansion to youth teams would improve scouting.	Technological applications for youth are limited by budget constraints and insufficient resources.	Limitations in using data for the academy; focus is mainly on the first team.
Knowledge and training	There is one data department responsible for broader technology implementation.	There are some individuals with technical knowledge, but they rarely collaborate.	Lack of knowledge and training, especially in using IoT technology for player analysis.
Costs and resources	Sufficient resources are available, but before an investment is made, the potential impact is carefully evaluated.	Budget constraints prevent broader use of technology, especially for youth teams.	Financial constraints make it difficult to invest in IoT technologies; priority is given to acquiring players.
Collaboration and integration	There are various internal collaborations, such as physical and tactical.	Closer collaboration between the physical and video analysis departments would be useful.	Collaboration between different departments is hindered by limited resources and lack of specialized roles.
Reliability and gray area	Data does not always provide the full picture; human judgment remains important in the decision-making process.	Despite detailed data, there remains a 'gray area' in player assessments, especially for youth players.	Despite IoT data, there is still uncertainty in predictions and decision-making.
Tactical insights	Limitations in obtaining tracking data from other competitions (due to regulations), with room	Tactical analyses for youth teams are lacking, while first teams are better supported by	Limitations in using data for tactical analysis; mainly focused on injury prevention.

	for improvement in measuring tactical aspects, especially for youth.	technology through the integration of location and motion data with video footage.	

Club A

The challenges at Club A highlight how complex it can be to effectively integrate IoT technologies into scouting and talent development processes. As Expert 1 emphasizes, it is crucial to view data as a complement to traditional methods:

“Of course, a scout needs to complement certain aspects and perhaps challenge them as well, but it should become much more of a combination for making a judgment, rather than: data says one thing, and the scout says another. I think there’s still room for improvement in that area.”

This balance between data and human judgment represents a key area for improvement. Additionally, access to international tracking data limits the ability to compare players outside the domestic league. According to Expert 1:

"You can process data from anywhere we have it, and then you automatically get that information out. And that's where the real power lies. And if we had that for all players in Europe, we could make much better comparisons and more substantiated decisions when selecting a player from Switzerland than we can now."

Finally, the use of IoT data for tactical purposes is currently mainly applied to the first team, while the youth development benefits little from it. This presents opportunities for improvement, as Expert 1 states:

“But that is not possible for the youth, only for the first team, but not for the youth. So, there is definitely room for improvement in that area.”

In summary, these quotes underscore the key challenges from the table, such as the integration of data with human judgment, access to tracking data, and the expansion of applications to youth teams.

Club B

Although IoT and data analysis offer many opportunities for Club B, there is a clear disparity in their use and application within the club, particularly between the first team and the youth development program. This is evident from various challenges, such as limited knowledge and inconsistency in data analysis. Expert 3 emphasizes:

"They use very few gadgets, they really just use a laptop and that's it. And many people don't know how to use it very well either. They don't know what is possible."

Additionally, budgetary constraints play a significant role in the limited use of IoT within the youth program:

“In first teams, everything is possible and everything is filmed, recorded, measured, and weighed, you name it. And even there, yes, undoubtedly, technical and tactical aspects are assessed beyond just observation. But in youth football, we have such a large pool of players to work with. It's simply impossible for us to cover it all.”

Another critical issue concerns the reliability of data analysis due to variable coding, as confirmed by Expert 3:

"You have a margin of 20% for errors. During a match, we average 1,000 codings. So that's a thousand inputs."

The combination of these factors indicates that significant improvements are needed in knowledge sharing, collaboration, and uniformity, so that IoT technologies can more effectively contribute to talent development at Club B.

Club C

The challenges at Club C highlight a complex interplay of limited resources, knowledge, and implementation issues when using IoT technologies. As Expert 6 aptly describes:

"With us, it's often a side task. That really shouldn't be the case, but it's related to budget constraints."

This lack of priority and funding makes it difficult to establish a robust strategy, which is crucial for effectively deploying IoT. Additionally, Club C lacks in-depth analyses that go beyond injury prevention, as indicated by Expert 7:

"Doing more with the statistics from the match. For example, how many passes he plays after entering the final third, stuff like that."

Although some progress is being made, such as the use of smart vests in the academy, the implementation remains limited. Expert 9 states:

"We don't have the measurement equipment to measure with an accuracy of a tenth of a second, so that's a bit challenging at the moment."

The combination of financial constraints, limited expertise, and a lack of resources creates a challenging environment for Club C. This makes it essential to invest more effectively in policies, vision, and specialized roles, so that IoT technologies can truly make an impact on talent development.

Perspectives of external experts

To gain a broader understanding of the use of IoT and data analysis in talent identification and development, three external experts were interviewed in addition to the case studies. These experts do not represent specific clubs but offer valuable insights into the integration of technology in scouting processes from their own areas of expertise. This section discusses their perspectives, each illustrated with key quotes from the interviews. These contributions provide additional insights and highlight important issues and opportunities within the current landscape of technology and talent development in football.

Researcher KNVB

The key takeaway from the interview with expert 10, a researcher at the KNVB, is that the integration of technology and data analysis in scouting and talent development must be approached carefully and strategically. While technology can provide valuable insights, expert 3 warns against hasty implementation without a clear vision and strategy. He emphasizes that it is essential to deploy data and technology in a structured and consistent way, aligned with a club's specific goals. As expert 10 states:

"I think you get a more complete picture of the player. You can better map out, how should I put it, the more invisible aspects." And, *"Less based on opinion. You can double-check things, so you can place an intuition next to an actual number. Of course, the important thing is that the number is accurate, it has to be valid. But I think that's possible.".*

This highlights that technology can contribute to a more objective foundation for intuition, as long as the reliability and validity of the data are ensured. Expert 10 argues that consistency in the application of evaluation criteria is crucial to maximizing the value of data analysis:

"Agreeing in advance, like: Okay, you know, something like this— you could decide for each of these points how important you find it. So, you can assign a weight to each of these aspects. But you have to apply that weighting consistently and in the same way, of course. And then it becomes very interesting.

For example, this could depend on the vision of a club. So, if you primarily think that top-level football is mainly about intensity and sprint speed, then you let sprint speed carry more weight.".

Additionally, expert 10 warns about the risks of inconsistent assessments when criteria are not weighed clearly. He explains:

"You introduce bias. It's great that things are being measured and increasingly mapped out. But you need to place everything on the same scale each time and not say: 'Wow, this player has an excellent sprint speed. Yeah, then they must be really good.' While for the next player, you weigh something else more heavily, you know? That's the risk with this.".

According to expert 10, it is necessary to make clear agreements in advance regarding the weighting of different factors so that data analysis and subjective evaluations can complement each other effectively.

These insights emphasize that a strategic vision and consistent application of technology are key to successful integration in scouting and talent development. Clubs should not only adopt technologies but also critically reflect on their processes to make the most of the benefits of data analysis.

Head scout & owner of a scouting training company

The interview with the head scout and owner of a scouting training company highlights the crucial role of collaboration and innovation within the football world, specifically regarding scouting. The expert criticizes the current situation in which clubs often operate independently, and competition hinders cooperation. He advocates for a collective approach and technological integration to professionalize scouting and minimize biases. As expert 11 states:

"It's very much like everyone wants to defend their own position and often aim to move up themselves. Yes, it's perhaps a bit of an ego-driven culture. This can hinder development and collaboration. Because, well, together you're always stronger, and if everyone has to figure everything out on their own to do it right—while you could also just ask your neighbor, who has much more knowledge about it—then everything would become a lot easier. I also think the development would progress much faster that way.".

This quote emphasizes that knowledge sharing and collective efforts can significantly improve scouting practices. Additionally, expert 11 explains how raising awareness among scouts can contribute to reducing bias in talent identification. The expert illustrates this with a real-world example:

"Well, in the training, I really try to teach the scouts first what it is, what the effect is, and how significant those effects are. They also get assignments, like scouting a team where they can identify who the oldest and youngest players are and then observe the differences—things like that. Recently, during some matches, we watched an under-12 game, then an under-13 game, and then an under-14 game. We also make the scouts aware of this: we were just watching the under-12s. It's a small field, and it's all clustered play. Then we go to the under-13s. It's a bigger field, more structured, but then biological age comes into play. Puberty—one kid is still small, and another is already really tall. So, we try to make the scouts aware: okay, we were watching the under-12s. It could be that the oldest player was born in January and just missed being eligible to play with the under-13s on the big field. Maybe they stand out a lot in the under-12s, but if you placed them with the under-13s, they might just be one of the many.".

By raising scouts' awareness of factors such as biological age, relative age effects, and the influence of different playing environments, they can make more objective assessments, according to the expert. Furthermore, expert 11 points out that innovative training programs and awareness assignments play a crucial role in this.

In summary, reducing bias in talent identification requires targeted training, collaboration between clubs, and a critical view of the evaluation criteria used. By promoting innovation and knowledge sharing, scouting can evolve into a more inclusive and objective process that provides a stronger foundation for the future of football.

Chief Technology Officer at a wearable technology company

The interview with expert 12, Chief Technology Officer at a company specializing in wearable technology, highlights the crucial role of data analysis and wearables in football. Expert 12 emphasizes that effectively utilizing these technologies requires technical expertise and continuous innovation.

Expert 12 also looks ahead to the future of wearables and data analysis in football. The expert expects these technologies to become more widespread, particularly due to improvements in data interpretation and the growing skills of users:

"What I expect is that these kinds of systems will become widely used. I think more parties, more teams, will start using them because it will become standard practice to do so, and the data will improve and become easier to interpret. More people will also develop the skills to interpret it. We will continue to estimate more parameters as well. That's already something we're seeing now. For example, if you look at the wearable consumer market, you see more and more features. Take the Apple Watch, for instance—they can detect more and more. The same will happen in professional sports, where we'll be able to detect an increasing number of things.".

The expert's message is clear: wearables and data analysis offer enormous opportunities for talent identification and development. Innovation plays a key role, particularly in data collection and interpretation. Furthermore, expert 12 highlights that professional football organizations already using these technologies apply them both in their professional first teams and in academies:

"We already see many academies connecting to our system, using it to estimate, as you mentioned, whether a person is good enough and physically developed enough to progress toward their first team.".

Another key insight from the interview is the increasing combination of wearables and camera systems, which together provide a more complete picture of player performance. Expert 12 outlines the benefits of this integration:

"We combine our data with a camera system in a project, where we're collaborating to set it up. […] Heart rate is quite difficult to estimate from a camera image. Or rather, it's not possible. So, we can estimate internal and external physical load much better than a camera system can. And when you combine the two, you get a really nice insight. For your own team, you then have maximum information. For opponents, you can estimate some things like tactics and physical aspects, such as speeds and accelerations, but not in the level of detail that you can for your own team.".

The technologies also offer opportunities for lower levels of football. Expert 12 notes that the system is gradually filtering down to these levels, even among enthusiastic amateurs. However, he emphasizes that guidance and training are essential to effectively implement the technology. At the same time, he points out that higher division teams sometimes do not fully utilize the potential of these technologies, while lower division teams are often more eager to use the information, despite limitations in expertise and resources:

"Lower division teams need more guidance and tools regarding what they can do with the data. But on the other hand, you also see in those lower division teams a strong eagerness to use the information and do something with it, while at higher levels, you sometimes see people not fully utilizing such a system.".

The message from expert 12 is clear: wearables and data analysis offer tremendous potential for talent development but must be carefully integrated. Innovations such as the combination of trackers and camera systems enhance the data-driven approach in football, but require thoughtful policy, education, and practical support to unlock their full potential.

F. Interview guide for feedback tool

1. **Added Value**

Question: To what extent do you think this tool can support your organization in making strategic decisions regarding IoT usage in talent identification?

- **Goal:** This question evaluates the added value of the tool for the expert and the organization.

2. **Usability**

Question: How user-friendly do you find the tool in terms of structure, questioning, and clarity?

- **Goal:** This question focuses on the usability and accessibility of the tool for practical users.

3. **Limitations**

Question: Are there specific aspects of the tool that you think could be improved or that do not align well with practice?

- **Goal:** This question identifies any limitations and provides space for constructive feedback.

4. **Practical Value**

Question: Do you think this tool is applicable in practice for football clubs, and if so, how could it be concretely implemented?

- **Goal:** This question explores the practical applicability and how the tool can be integrated into daily processes.