Universiteit Utrecht

Fast Forward

Factors influencing an institutional innovation's legitimacy in sports communities: a comparative study of video referee systems in three different sports.

Sjors van 't Hag
Master thesis

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"I don't think it's a penalty."

"I do."

"I don't think it's a red card."

"I do."

– Thijs Zonneveld on mid-game analyses –

Document details

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Before deep diving into the sea of video referees, rules, legitimacy and sports communities, I feel obliged to express my gratitude to quite the number of people.

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Signed the 23rd of December 2021
Utrecht

Sjors van 't Hag

Preface

The last couple of years I have been active as a competitive rower, full-time master student and part-time employee whilst still trying to be a friend and family member. A strange mixture of eight training sessions a week, following lectures, sleeping, compiling Excel reports and keeping bodyweight up to the marks. This mixture left little room for spare time, free to spend. However, the little time I had, I would spend watching any type of sports as long as it involved others delivering efforts for a change.

Besides a general interest in sports, I was particularly fascinated by major football events such as knock-out Champions League matches. Just like seasons before the most recent, the role of the video referee received great attention with an apparently negative approach. Wondering why so much drama could exist in a sport that has so many regulatory boundaries was the starting point for writing this thesis. Jarno Hoekman, PhD having the topic of 'innovation in sports' on his list of thesis topics and being very enthusiastic about it, sealed the deal

For almost an entire academic year I have been conducting research, writing, rewriting and fact-checking. The combination of media analysis and experts delivering their contributions on the topic provides a strong basis for both this research as well as future research, which I think is vital to conduct in the future.

Someone at the Dutch football association 'KNVB' told me that there is a huge amount of quantitative data regarding the video referee, but that nobody ever investigated the "why" and "how" behind effectiveness and failures. I sincerely hope that this modest piece of research aids in understanding sports technology better, also hoping that insights from this study will help improve future technology adoptions in sports communities.

Abstract

This research uses institutional innovation theory and a sociomaterial angle to study legitimacy development of the video referee systems in tennis, field hockey and football as a consequence of different interactions between actor groups and the video referee taking place. Furthermore, the role of sports associations in legitimising the video referee in the sports community is studied by making use of legitimisation strategy theory. Based on the analysis of game regulations and the combination of qualitative interview input and the quantification of media sentiments, it was possible to determine whether an interaction would cause a negative or positive sentiment in the sports community. It was found that legitimacy increases when user actor groups are involved both in-game and during the innovation trajectory. Moreover, legitimacy appeared to increase when the complexity of the system was diminished in order to make the implementation of the video referee within the existing regulations easier. Also, centralised governance by the international sports association seemed to increase legitimacy. With regard to the role of sports associations, framing the situation without the video referee implemented appeared to be a preliminary condition before starting the innovation trajectory. Collaboration as a strategy was considered vital, due to a significant decrease in legitimacy when not deployed and a significant increase when deployed. Limitations and (practical) recommendations are mentioned in the discussion, the most important being the different lengths (and maturities) of the innovation trajectories. This makes future reproduction of this research necessary.

Key words: *Actor groups; Innovation governance; Institutional innovation; Interaction-based analysis; Legitimacy; Legitimisation; Sociomateriality; Sports; Video referee.*

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1 Introduction

Fairness is a top priority in every type of sports, which means that innovations that intend to give cheaters or rule breakers less of a podium are usually a welcome addition to the game (Murray et al., 2020; Richard et al., 2020). A typical case is the video referee. As referees may be influenced by their direct surroundings when executing decisions, including spectators (Nevill et al., 2002), previously executed decisions (Plessner & Betsch, 2001) and team reputations (Jones et al., 2002), the video referee has been implemented in several sports communities in order to correct on-pitch referee errors, spot game rule violations missed by the on-pitch referee and to provide in-game arbitrary decision making processes (Spitz et al., 2020).

Video imaging (in sports) has been around for decades, mainly for broadcasting sporting events. In more recent years, video imaging has been used for enforcing game rules in numerous sports. The role of an external, video-aided match official is perceived and valued in completely different manners throughout various professional sports communities. Whilst Hawk-Eye in tennis and field hockey's Video Umpire have been accepted and appreciated instruments, discussion in football about the Video Assistant Referee (VAR) continues. In multiple European countries, the VAR is being criticised for continuous interference and not showing the video images to i.e. athletes and spectators (Nu.nl, 2018; Reuters, 2020). Multiple media sources state that football should at least consider copying some of the concepts of field hockey in order to make the VAR a success, but a solid argumentation for this kind of quotes remains largely absent.

The apparent differences in acceptance of this innovation throughout the various sports communities makes that one starts to wonder how and why these differences have emerged over the course of the innovation trajectories. For the sake of clarity, an innovation trajectory is here defined as the process from ideation until ongoing usage and development. These differences in perceptions and valuations of the video referee can be studied in the field of innovation studies. This field of science provides the means necessary for understanding how technology perceptions and valuations rise differently in different (sports) communities.

Institutional theory in particular can be used to explore the acceptance of a technology in an already existing system containing actor groups, norms, values and institutions (Deephouse & Suchman, 2012). According to Scott (1995), institutional theory explains how innovations become embedded in systems that have already "symbolic systems, relational systems, routines, and facts" in place. De Jonge (2015) adds that institutional theory also describes "how and why change occurs." The institutional character of the video referee is explained by the fact that the video referee observes and interferes according to the game regulations, thereby influencing the decision-making process. On top of that, the innovation is implemented and governed by governing actor groups: institutional actors. Institutional theory considers the role of different types of actor groups being users, producers and institutional actors

(Binz et al., 2016; Pelzer et al., 2019; Tzur, 2019). As these actor groups interact with the video referee, it becomes part of a social system consisting of users, producers and institutional actors (Pelzer et al., 2019) in which it needs to become embedded and aligned with regulations, beliefs and perceptions (Markard et al., 2016).

Sociomateriality specifically addresses the interactions between material technology and actor groups and is thus a very suitable concept for exploring the acceptance of this institutional innovation (Aldrich & Fiol, 1994; Leonardi et al., 2013). Material technology has an influence on social concepts such as decision-making processes and relationships (Leonardi et al., 2013). It affects the relationships and regulations between actor groups and the material technology in question (Leonardi et al., 2013; Moura & Bispo, 2020), which causes people to "construct a perception that a technology either constrains their ability to achieve their goals, or that the technology affords the possibility of achieving new goals" (Leonardi, 2011). As earlier mentioned, the work of Bergek et al. (2008) and Markard et al. (2016) mentions the understanding of a technology by a community and it becoming aligned with regulations, beliefs and perceptions, which is clearly linked to the construction of perceptions.

For an innovation to become institutionalised and functional, it needs to obtain a certain degree of legitimacy. Legitimacy is received when an innovation is understood, accepted by a society and regulatorily supported (Bergek et al., 2008; Markard et al., 2016). Several typologies of legitimacy have been identified in science, the typology developed by sociologist and institutional theory expert Suchman concerns pragmatic, moral and cognitive legitimacy (Suchman, 1995). The reason for opting for this typology is the fact that Suchman managed to incorporate an institutional approach, which opposes to the traditional view of legitimacy being an "operational resource" (Suchman, 1995) that can be deployed as a strategic instrument. The institutional view sees legitimacy as "a set of constitutive beliefs" (Suchman, 1995) which corresponds better with sports communities and the role of the institutional actors, because sports generally revolve less around profits (and thus corporate strategies) compared to other communities, which is illustrated by the fact that only a small part of sports communities is professionalised.

Institutional actor groups involved can influence the process of legitimisation by deploying a variety of legitimisation strategies. Pelzer et al. (2019) describe five institutional strategies aimed at legitimising innovations: framing, theorisation, collaboration, lobbying and negotiation. When assessing the effectiveness of the institutional actors in the case of the video referee, it is necessary to link their actions and strategies to the different degrees of legitimacy identified in the cases.

Previous research specifically aimed at innovation in sports mainly focuses on product innovation and specifically adoption, with special regard to i.e. technological improvements in extreme sports such as kite surfing (Schreier et al., 2007) or the incorporation of modern technologies such as cellular phones (Ha, 2018). Other research, with more of a management focus, looks at the role of strategic management in sports and innovation, i.e. general innovation strategies maintained by sports associations. However,

research in this direction is broad and emphasises the importance of innovation management in sports (Tjønndal, 2016), i.e. the development of innovations and how this development should be managed and guided. An attempt to merge innovation sciences and sports by Ratten (2019) discusses subjects like technology effectiveness, commercialisation and social entrepreneurship. However, this work also does not provide insights into the deeper sociomaterial structures that for instance enable legitimisation and institutionalisation of innovations in sports.

With regard to institutional theory in general, authors acknowledge the importance of institutional context, i.e. Geels (2004), but limit the amount of attention paid to the role of institutional actors to a minimum. Hargrave & Van de Ven (2006) acknowledge the role of institutional actors in the process of technology embedding, but do not address other types of actor groups such as users and producers. Some innovation literature does dive into institutional innovations, i.e. Suchman (1995) and Markard et al. (2016), but the number of authors and quantities of work remain limited.

The gap in scientific knowledge is thus clear. Firstly, institutional innovation in itself is relatively underexplored in innovation sciences as is shown in the previous paragraph. Secondly, it has also become clear that the role of interactions between material technology and actors as part of successfully embedding an innovation in a sports community remains to be explored. Thirdly, although some research has been conducted regarding the role of sports associations in innovation trajectories, this has been mainly in the direction of general innovation management. The role of institutional actors and the role they play in legitimising innovations is still very much underexplored as well, which is linked to the relative underexposure of institutional actors in innovation literature. This also provides a practical knowledge gap for sports associations about the effective usage of legitimisation strategies.

The practical questions posed in the preceding introductory paragraphs lead to the research question:
How are the different degrees of legitimacy of the video referee in different sports communities established from a sociomaterial angle and what is the influence of sports associations on legitimisation?

In order to keep this research both comprehensive as well as workable, the main research question needs to be broken down into sub-questions.

Firstly, within communities different actor groups can be distinguished. These actor groups interact with the video referee system and influence the process of legitimisation. The subquestion can thus be formulated as: How do different actor groups within a community interact with the innovation?

Secondly, having established what interactions between the actor groups and the institutional innovation are present, it is now possible to look at the degrees of acceptance of the video referee system. Literature (Aldrich & Fiol, 1994; Markard et al., 2016; Pelzer et al., 2019) shows a great variety in legitimacy types and thus a difference in character and influence is expected among the different communities. Investigating the different degrees of development of the various legitimacy types may

point towards a direction in which reasons for an increased or diminished acceptance of the innovation can be found. The differences in development may be assigned to different actions and events of various stages of the innovation implementation trajectory. The research question that needs an answer thus is: What are the individual degrees of legitimacy for each case and how have these degrees been established?

Thirdly and lastly, institutional actors play a role in the general acceptance of the innovation. Therefore, one can assume that legitimisation strategies have been deployed by the implementing overarching sports associations in the legitimisation process of the innovation, providing a regulatory framework for instance (Richard et al., 2020). Part of the differences are expected to be the consequence of sociomaterial interactions, emerging from the new material technology being introduced in an existing social system. Another part however is expected to come from the strategies deployed as the sports associations play an important role in shaping sociomaterial interactions within the communities (Richard et al., 2020). The actor group that can be held accountable for the functioning and success of a video referee system is the overarching sports association, as it represents the sports community, the community's hard and soft institutions and provides the regulatory frameworks. The third research question is thus: What legitimisation strategies have been deployed by the various sports associations within the communities?

Sub1: How do different actor groups within a sports community interact with the institutional innovation during the match and during the innovation trajectory?

Sub2: What are the individual degrees of legitimacy of the innovation for each case and how have these degrees been established?

Sub3: What legitimisation strategies have been deployed by the various sports associations within the communities during the entire innovation trajectory?

Having introduced the background and relevance of this research as well as related work, the second section builds on this by providing a clear and concise theoretical framework. This framework has provided the opportunity to conduct research within clear and strict borders. Section three entails the methodology that has been used to execute the research itself and operationalise the theoretical framework. Section four shows the results obtained from executing the methodology, whilst section five addresses the conclusions, limitations and opportunities for future research.

2 Theoretical framework

Several relevant concepts will be explained before the actual case-study can be conducted. First, the base concept of institutional innovation is to be explained

2.1 Institutional innovation and the sociomaterial perspective

This paragraph provides an introduction regarding institutional innovation as well as the characteristics of sports communities. By providing this information, a contextual framework for other theory is being made.

2.1.1 Institutional innovation

As stated in the introduction, the video referee is considered an institutional innovation. Although relatively little research has been conducted in the specific direction of institutional innovation, some relevant literature has been consulted to provide context to the following paragraphs in the theoretical framework.

An *institutional innovation* is defined as a "change in state" that affects norms and/or rules over time and "is a novel or unprecedented departure from the past" (Hargrave & Van de Ven, 2006). This indicates that the introduction of the innovation cannot take place within existing regulatory and institutional frameworks, but that these have to become congruent with one another (Markard et al., 2016) as this forms the basis of legitimisation which is shown in paragraph 2.2. Moreover, the innovation should be aligned with relevant actor groups and their interests and norms (Pelzer et al., 2019). Newly introduced material technologies "are often incongruous with these structures" (Binz et al., 2016).

The typology of actor groups, that interact with the institutional innovation, maintained by Pelzer et al. (2019) consists of the following three groups:

- Users;
- Developers;
- Regulators.

Although research concerning institutional innovations is rare, this typology is frequently used in other work, i.e. by Binz et al. (2016) and Tzur (2019).

The three actor groups should be defined, as they play a major role in this research. The various actor groups are important to consider, as their interactions with the innovation influence legitimacy (Van den Belt & Rip, 1987; Zelizer, 1978). It is therefore expected that differences in the degrees of legitimacy occur between the three cases in this research.

According to Binz et al. (2016), legitimisation of an institutional innovation in the actor group of *users* is a preliminary condition for success. Users are not extensively defined in other work. Work

by Binz et al. (2016) and Pelzer et al. (2019) suggests that users are the hands-on end-users of the innovation. They interact directly with the technology that is part of the institutional innovation and thereby operationalise it.

Producers, also called 'engineers' (Binz et al., 2016) or 'developers' Pelzer et al. (2019), form the supplying actor group in the system. The actor group consisting of producers is involved in the development, engineering, production and selling of the technology that is part of the institutional innovation. This definition is not explicitly mentioned in literature, but becomes clear from the frequent usage of the term 'user-producer relationship' in the articles of both Pelzer et al. (2019) and Tzur (Tzur, 2019).

Finally, the definition and role of the institutional actor group should be explained. This actor group consists of the parties governing the innovation at hand and are also referred to as 'regulators' (Pelzer et al., 2019). This designation comes from the fact that the institutional actor groups provide and oversee the regulatory frameworks needed for the innovation to function.

2.1.2   Sociomaterial perspective

All of these actor groups interact with the material technology as part of the institutional innovation and thereby affect its embeddedness and congruence with the actor groups and institutional surroundings. These interactions affect legitimacy which is shown in paragraph 2.2.

In the context of technology, the concept of legitimacy should be considered in a broader setting, sociomateriality being a suitable one as it focuses on describing links between technology and social elements like "…institutions, norms, discourses…" (Leonardi et al., 2013). Sociomateriality as a concept is a useful way of thinking for finding and analysing structures like roles, power relations, (communication) networks and other so-called institutional forces (Leonardi et al., 2013; Moura & Bispo, 2020) but not practically applicable as it is more a way of thinking rather than an applicable tool. An early attempt to address human and technological interactions in a systematic way has an industrial production system as a basis, in which operations are sequenced and related to human nodes as well as machinery (Cooper & Foster, 1971). Cooper & Foster (1971) utilise an order-based approach in which the first-order is the direct interaction between production personnel and machinery, second-order comprises of activity bundling and thus 'jobs' whilst higher orders represent the social system within the firm. All of this together represents the sociotechnical system (Cooper & Foster, 1971) and forms the basis of the community in which legitimacy can be obtained.

Following the line of sociomateriality theory 'interaction' can be interpreted in a broader way than Cooper & Foster (1971) did. Their work mainly focuses on direct, operational interactions between technology and people. However, following the line of sociomateriality theory, multiple categories of interactions are possible. Interactions can be one-way and two-way (Leonardi et al., 2013). The one-

way interaction means that either the actor group influences the technology or the technology influences the actor group without a direct form of feedback (Leonardi et al., 2013). Two-way interaction means that they both influence one another by interacting, which is a relationship as pure sociomateriality theory would want to see it as it makes technology and society inseparable (Leonardi et al., 2013). The final element that should be considered whilst examining interactions is the effect type. Effect type is based on the principle of divergent and convergent dependencies (Cooper & Foster, 1971). In this context, divergent dependence means that the actor group is indirectly affected by interaction with the material technology. Convergent dependence entails a direct effect of the interaction with the material technology (Cooper & Foster, 1971). Effect type relates to the 'distance' between actor groups and technology, expecting that a relatively small distance results in an increased concern about legitimacy.

The concept of institutional legitimacy, accompanied by the sociomaterial perspective, offers the basis for a dive into theory concerning legitimacy and legitimisation.

2.2 Legitimacy

Legitimacy as a concept originates in Weber's work (Deephouse & Suchman, 2012). In essence Weber's conclusion is that legitimacy is an explanation of the rightfulness of obedience by people. This abstract definition has been adapted frequently later on, but forms the basis of all legitimacy theory. Later research on this topic provides more comprehensive definitions. Important work to consider has been compiled by Aldrich & Fiol (1994), stating that the degree of acceptance depends on the amount of legitimacy obtained among various actor groups. A compact and comprehensible description of legitimisation has been provided by Markard et al. (2016) who state that legitimacy occurs when a material technology has become congruent with its direct institutional surroundings, thereby establishing the direct link between institutional innovations and legitimisation.

Over time a system, containing material technology, actor groups and regulations, becomes institutionalised and grows towards a state of legitimisation in which it can be analysed using several typologies (Deephouse & Suchman, 2012; Markard et al., 2016; Suddaby et al., 2017). Based on Aldrich & Fiol (1994) three types of legitimacy provide an opportunity for a structural study of the cases and were first introduced by Scott (1995) and later adapted by Suchman (1995): pragmatic legitimacy, moral legitimacy and cognitive legitimacy. Although aimed at organisational entities in first instance, these types of legitimacy are suitable for application to this setting which entails not only organisational legitimacy but also institutional.

Pragmatic legitimacy is achieved by an innovation having the practical effect as desired and expected by the actor group(s) in question (Díez-Martín et al., 2013; Suddaby et al., 2017). In other words, a problem has occurred and the relevant actor groups expect the solution to that problem to

perform in a certain manner. Pragmatic legitimacy can be described in terms of exchange: the actor group will grant the technology with legitimacy if it delivers the desired output (Suchman, 1995).

Moral legitimacy is closely related to pragmatic legitimacy in the sense that this type of legitimacy is also linked to societal expectations. However, the expectations in this context are rooted more deeply. Actor groups check whether the artefact meets their norms and values regarding what is rightful and correct in the context given (Díez-Martín et al., 2013; Suddaby et al., 2017). The innovation should behave according to the norms and values in the social system at hand (Díez-Martín et al., 2013). In this specific research it is thus important that the innovation enhances fairness and maintains or adds to the level of pleasure experienced by actor groups. The innovation in question should not only meet output demands (pragmatic legitimacy) but the way it achieves this, should be in line with what the actor groups expect and demand from the innovation.

Cognitive legitimacy is knowledge-based in contrast to the other two types of legitimacy (Aldrich & Fiol, 1994). This type of legitimacy is achieved by the innovation simplifying decision-making processes and/or by creating transparency about the embeddedness and performance of the innovation (Díez-Martín et al., 2013; Suchman, 1995). Within cognitive legitimacy, a number of approaches is available. Most of those are aimed at organisational legitimacy (M. B. Scott & Lyman, 1968), which is why only 'comprehensibility' is the only viable approach needing to be discussed (Suchman, 1995). Comprehensibility refers not only to practical knowledge about the innovation, but also how well the actor groups understand the innovation, its purpose and its functioning itself (Markard et al., 2016).

The importance of legitimacy for a novel technology as an institutional innovation is evident. For a firm or government being to mobilise necessary resources – either physical or regulatory – legitimacy and thus all-round support for the technology is a key variable for it to become successful. Research regarding legitimisation has been conducted before; technology should be aligned with a community's norms, perceptions and values for it to become successfully adopted (Bergek et al., 2008; Markard et al., 2016). An essential process identified by Markard et al. (2016) in this context is called "Formation and change of the focal technology and other institutional structures in the technological innovation system." It entails the introduction of the material technology in the social system and thereby the first steps of legitimisation.

Following the line of sociomateriality theory, multiple categories of interactions are possible. Interactions can be both formal and informal (Deephouse & Suchman, 2012), one-way and two-way (Leonardi et al., 2013). Formal interactions are interactions taking place within a set of predefined rules and/or laws, processes or protocols. Informal interactions have lesser of an official status and rely on unwritten rules and agreements based on shared norms and values (Contreras-Castillo et al., 2004). The one-way interaction means that either the actor group influences the technology or the technology influences the actor group without a direct form of feedback (Leonardi et al., 2013). Two-way interaction means that they both influence one another by interacting, which is a relationship as pure

sociomateriality theory would want to see it as it makes technology and society inseparable (Leonardi et al., 2013). The final element that should be considered whilst examining interactions is the effect type. Effect type is based on the principle of divergent and convergent dependencies (Cooper & Foster, 1971). In this context, divergent dependence means that the actor group is indirectly affected by interaction with technology. Convergent dependence entails a direct effect of the interaction with the technology (Cooper & Foster, 1971). Effect type relates to the 'distance' between actor groups and technology, expecting that a relatively small distance results in an increased concern about legitimacy.

2.3 Legitimisation by institutional actor groups

Now that the concepts institutional innovation, sociomaterial perspectives and legitimacy have been elaborated upon, obtaining knowledge about legitimacy creation is the next objective. Due to the institutional nature of the video referee, it is expected that institutional actor groups will have played an active role in legitimising the innovation. This means that a search for deployed legitimisation strategies is needed.

As mentioned in the introduction, the introduction of a video referee system is considered an institutional innovation as the institutional context of the sports in question has changed due to technology implementation. It is therefore possible to utilise institutional legitimacy strategies as proposed by Pelzer, Frenken & Boon (2019). Pelzer et al. based their strategies on the legitimacy typology as created by Scott (1995), which in its turn formed the basis for the typology used in this research created by Suchman (1995). Five strategy types used to cooperate with or influence actor groups have been identified by Pelzer et al. (2019).

Framing entails placing emphasis on the problem at hand and clarifying the effects and consequences of the problem. This concept is thus closely related to cognitive legitimacy. On top of that, the current unsolved situation is being highlighted and the weaknesses are being emphasised (Pelzer et al., 2019). Framing relates to "the selection and connection of context structures" (Markard et al., 2016). In other words, some contextual elements are deemed important by the actor groups in question whilst others are disregarded. Paying attention to or disregarding the wrong factors results in a loss of legitimacy. Framing as part of cognitive legitimacy connects to and conflicts with the other two types of legitimacy in times of historical transitions (Suchman, 1995). In the case of the latter, norms, values and desired outputs determine which factors are deemed (un)important by the actor groups.

Theorisation emphasises the functioning of the technology that needs to be implemented. The institutional entrepreneur should provide information regarding how the technology could and should function within the given context. This type of strategy is thus closely linked to pragmatic legitimacy as it concerns the predefined functional purpose of technology and how this is perceived by actor groups. However, it also relates to moral legitimacy. Theorisation can also be used to translate norms and values

to categorical and more tacit concepts (Suddaby et al., 2017), which is suitable for increasing or decreasing moral legitimacy.

Collaboration refers to cooperation with relevant stakeholders and actor groups in order to make implementation a success. Note the fact that this also entails collaboration with communities other than the one the institutional entrepreneur is involved with. Other communities for instance may already have implemented a technology which could provide valuable information. In line with STS theory, collaboration thrives on the network component of the social system. Collaboration is an institutional strategy having a potential influence on all three types of legitimacy, but cognitive as the most prominent type. Using the network for obtaining information about what the community wants from the technology and what values it deems important is a major advantage in this matter (Markard et al., 2015). On top of that, communication with the network will ease the enhancement of transparency about the new technologies and the accompanying processes.

Lobbying entails creating some type of (political) leverage at important actor groups. Whenever an entrepreneur is changing formal regulations (rules, laws etc.), this type of strategy is of particular importance. Lobbying is suitable for gaining support among powerful actor groups, in order to convince other actor groups still doubting about the newly introduced technology. This may sometimes concern specific actor groups within the community, but more generic powerful actor groups can be identified such as mainstream media, influential opinionmakers and associating unions that are concerned with serving the interests of other actor groups (Pelzer et al., 2019). Lobbying has a strong connection with cognitive legitimacy, i.e. spreading knowledge via established institutions such as mainstream media.

Negotiation refers to the search for consensus. The entrepreneur interacts with relevant actor groups and tries to come to an agreement regarding the implementation of the new technology. Concrete outcomes of such negotiations are slightly altered rules and laws keeping actor groups' interests in mind or arrangements compensating for negative effects experienced by actor groups through newly installed technology and accompanying institutions. Negotiations may also have the effect of the newly implemented technology being less effective than originally planned due to the consensus that had to be found at one or more actor groups. This implicates that negotiation may have a significant effect on pragmatic legitimacy.

3   Methodology

This chapter addresses the operationalisation of the theoretical framework and introductory chapter. By providing a strategy concerning data collection, analysis and quality assurance, a solid base for the following section, the results, is being provided. Also, by documenting methods and approach, this chapter contributes to future reproduction and extension of this research.

3.1   Research design & case selection

The research design consisted of a mixed approach, as the approach differed per (type of) research question. The most prominent component however was a multiple-case study, with attention to the legitimisation processes of video assistant referee systems in different sports. The main reason for this type of research is the ability of this method to compare actor group interactions and legitimisation processes across different sports. On top of that, multiple case studies provide a stronger foundation for the concluding section and add to the robustness of this thesis when little to no research regarding a specific topic has been conducted (Tellis, 1997), which is the case. The geographical scope of this research has been the Netherlands for two reasons. Firstly, an international scope would add severely to the amount of work and thus add to inaccuracy in research activities. Secondly, although it may affect generalisability to international context, keeping the scope on a national level means that cultural and geographical influences do not have to be considered. This added to the ease of research conduction and added to the accuracy of the analysis of the results.

In order to answer the main research question, multiple cases were selected. The selection criteria have been listed below:

- Presence of video referee system

  Many sports have implemented a video assistant referee system of sorts, others are still in the process of consideration or do not feel the need. The video referee system should already be in place and in use. This will make it possible to analyse the legitimisation process in retrospect.

- Sports type

  The sport is required to be a ball game. The reason for this is that similar sports have an increased chance of having similar characteristics than sports that differ by nature. This aids in making solid comparisons between the cases.

- Match management

  The sport should have a referee, able to interfere with the game, and have a rule-based element to it as well. This means that a distinct actor should be in place in order to supervise the athletes when it comes to following the rules of the game. The latter is important in order to include emotional engagement by the actor groups and thus address moral legitimacy in certain ways.

- Relative community size

    The larger the relative community size, the larger the chances for obtaining solid information become. It is expected that a larger community size correlates with more media attention. For the case selection, community size is measured by using recent sports association membership data in the Netherlands (NOC*NSF, 2019).

The four conditions provided a selection of four suitable sports: Tennis, field hockey, football, and volleyball. Exploratory research in Nexis Uni was conducted before starting the actual research in order to check the suitability for research of each of the four sports. This exploratory research indicates that there is enough information available for conducting the actual research. The largest case was represented by football in terms of published articles with over 10,000 Dutch articles published concerning the video referee in the period of 2012-2020. Furthermore, in the period 2006-2020, more than 10,000 articles have been published regarding the video referee in field hockey. The case of tennis provided 479 usable articles over the period of 2004-2020. However, volleyball provided less than 100 articles over its respective period which led to the final selection of tennis, field hockey and football. An overview of the case selection can be found in Table 1.

Table 1: Case selection overview

Case	Year of technology introduction (worldwide)	Sports characteristics	Community size in number of memberships of Dutch sport association
Tennis	First trial: 2004 Official: 2006	Ball-game, limited pitch, referee needed.	527.000 (# 2)
Field hockey	First trial: 2006 Official: 2010	Ball-game, limited pitch, referee needed.	244.000 (# 6)
Football	First trial: 2013 Official: 2018	Ball-game, limited pitch, referee needed.	1.184.000 (# 1)

3.2 Data collection

Data collection has been executed by a combination of multiple methods, in order to increase both saturation and validity of the results:

- Official documentation;
- Semi-structured interviews;
- Media analysis;
- Observation of events.

The analysis of in-game interactions is based on the 2020 situation, due to a lack of game regulation documents for the case of tennis which is explained in paragraph 3.2.1. Other analyses have been conducted in a longitudinal manner because this enabled the possibility of investigating (legitimacy)

developments over time. Whenever a single event, evolution and/or change is being discussed, this has been indicated explicitly for each case individually accompanied by the corresponding year or timeline.

3.2.1   Official documentation

Rule documents published by the relevant sports associations were analysed, with a specific focus on the actor group-video referee interactions. The documents provided insights regarding:

- In-game functioning of the video referee system;
- In-game interactions between actor groups and the video referee system;
- Game rule development over the years.

Rule documents have been obtained at sports associations, either by downloading from their respective websites or by requesting the documents per e-mail at the association. The case of tennis formed an exception when it comes to 'game rule development.' Only the most recent documents were available. KNLTB representatives were not able to provide the necessary historic data sources. An attempt at international association ITF also did not deliver the data necessary as the documents requested could not be found, which results in an analysis of only the most recent game regulations. An overview of the documents consulted can be found in Appendix I.

3.2.2   Semi-structured interviews

Semi-structured interviews have been vital for finding information regarding several topics:

- In-game functioning of the video referee system;
- In-game interactions between actor groups and the video referee system;
- Trajectory from ideation up until usage & development;
- Legitimacy perceptions within communities;
- Legitimisation strategies.

A semi-structured approach has been used for conducting interviews. The main reason for this is that semi-structured interviews are best suitable for exploring insights in interviewee perspectives and perceptions (DeJonckheere & Vaughn, 2019) which corresponds with the purpose and angle of this research. Topics and questions provided a general direction and were made specific to the relevant context on the spot. Additionally interviewees were provided room for elaboration beyond the borders of the questions as posed, so that they could provide as much information and context as possible. The topics and questions were constructed after the official documentation analysis. This meant that questions concerning actor groups and interactions have been constructed in such a way that they aimed to confirm or disprove the findings from the official documentation analysis. Questions regarding legitimacy development were composed with the aim to identify events, changes and trends that could have affected legitimacy. Furthermore practical questions about regulation changes were composed in

order to find out about institutional fit. The last part of the interview protocol contained questions with literal references to legitimisation strategies, but formulated in a practical way as interviewees were unlikely to be familiar with the work of Pelzer et al. (2019). The protocol as stated in Appendix II has been modelled after *Creating Qualitative Interview Protocols* (Hunter, 2011). An overview of interviews and attended events, the organisations and organisational actors involved can be found in Table 2.

Table 2: Overview of interviews and attended events serving the purpose of data collection.

Event type	Organisation	Interviewee function(s) or attendees
Interview	KNLTB (field hockey)	Embedded scientist
Interview	KNLTB (tennis)	Performance analyst
Interview	KNHB (field hockey)	Sr. staff member arbitration
Interview	KNVB (football)	Knowledge development & innovation and member FIFA VAR working group
Interview	KNVB (football)	Sr. press officer
Press briefing	KNVB (football)	- National press representatives (i.e. De Telegraaf) - Referees invited by KNVB - Referee coordinator
Interview	National supporters collective (football)	Board member
Match	KNHB (field hockey)	Video referee

3.2.3   Media analysis

Media analysis has been conducted with the following objectives:

- Determining sentiments about the video referee system for each case;
- Identifying and analysing trends in sentiment development.

Written mainstream media articles have been the source for both analyses, as is shown in Table 3. Not all available media sources have been used for the purpose of maintain an operable amount of articles. Therefore, the search was limited to five main media sources that could represent Dutch media due to the respective characters of these sources. Again, for the sake of maintaining an operable scope, articles had to be written in Dutch. The articles have been obtained from the database of Nexis Uni, downloaded in .docx format and then converted into .txt format. For each case the articles were categorised into periods of three years before downloading. This has been done as it enabled the monitoring of development of the sentiments and key events could be assigned to changed sentiments in specific periods. Selection has been performed making use of the query terms as mentioned in Table 3. However, some articles contained the correct query terms but did not contain any useful information with regard to the respective case. This meant that an additional manual selection had to be performed, by means of reading into the article's body text, in order to make sure that the article did provide the information

necessary. This process delivered 15 usable articles for the tennis case, 24 for the field hockey case and 15 for the football case. A complete overview of the corpus can be found in Table 4.

Table 3: Search query for media analysis, serving the purpose of data collection in Nexis Uni.

Case	Source	Geographical & lingual scope	Temporal scope	Query terms *(in Dutch)*
Football	Algemeen Dagblad, AD Sportwereld, De Volkskrant, NRC, De Telegraaf	The Netherlands, Dutch	2012-2020	Voetbal AND videoscheids* OR VAR OR video-scheids
Tennis		The Netherlands, Dutch	2005-2020	Tennis AND Hawke* OR Hawk-*
Field hockey		The Netherlands, Dutch	2006-2020	Hockey AND videoscheids* OR video-scheids OR video umpire

Table 4: Corpus overview.

Case	Temporal scope	Number of articles
Tennis	2005-2007	5
	2008-2010	5
	2011-2013	3
	2014-2016	0
	2017-2019	2
Field hockey	2006-2008	5
	2009-2011	5
	2012-2014	5
	2015-2017	4
	2018-2020	5
Football	2012-2014	5
	2015-2017	5
	2018-2020	5

3.2.4 Observations and events

In addition, several events have been attended. A press briefing organised by KNVB has been attended, by invitation, to observe inter-actor group interactions between the press and the football association and pose questions if necessary. Also, a field hockey match between the Netherlands and Belgium has been witnessed from the video referee area. This provided the opportunity to talk about and with the video umpire and observe its functioning during the match. Attending the field hockey match also provided the opportunity for informal conversations with high-level officials at KNHB. The data has been collected for the purpose of complementing the other types of collected data. The attended events have also been included in the overview in Table 2.

The nature of this research has been qualitative, therefore saturation of data should be adequate. Data saturation has been achieved in two ways. Firstly, a check of the background of the interviewee. This background check entails a look at the direct involvement with the research subject and the interviewee's role within the organisation. Most of the cases required more than one interview with multiple interviewees, due to the fact that not everyone was involved in the video referee trajectory from the start or because of the fact that the position within the organisation was relatively distanced from the subject. In the case of field hockey this has turned out to be different, as the single interviewee plays a major high-level role in the field hockey community both as a (video) referee as well as a video referee developer and can thus be considered the expert. Furthermore, saturation and increased validity has been achieved by means of triangulation. The combination of conducting interviews, document analysis, media analysis and observations has provided input from a variety of sources and angles.

3.3 Data operationalisation and analysis

The collected data has been operationalised and analysed for the purpose of answering the three sub-questions as defined in the introduction.

3.3.1 Actor groups and interactions

The first subquestion concerned the identification of interactions between actor groups and the video referee systems in each case. For the sake of structure, the analysis has been divided into two categories: 'in-game interactions' and 'innovation trajectory interactions'. The reason for this was the fact that the operational usage, which is very much focused on the user-producer relationship, involved a different combination of actor groups compared to the implementation trajectory (process from ideation until usage and development). This difference could also indicate different insights into the degrees of legitimacy.

Analysis of the *in-game interactions* has taken place by making use of two data collection methods: official documentation and semi-structured interviews. The description of the practical functioning of the video referee for each case has been composed by reading and summarising the chapters in official game regulations concerning the actual functioning of the video referee. The following items have been investigated:
- How the video referee system observes and enforces regulations;
- When, how and by whom the video referee system can be deployed;
- Uniformity of deployment in terms of venues, tournaments and competitions.

In order to check for completeness of the description and potential unwritten rules, interviewees have been asked about the functioning of the video referee. These questions can be found in section 'c' and 'g' of the interview protocol in Appendix II.

Having compiled the description of the general functioning of the video referee for each case, a detailed exploration of in-game interactions was conducted. First, relevant chapters concerning the video referee systems in rule documents were analysed according to the coding scheme in Appendix III. Second, serving the purpose of validity and saturation, the interview output was analysed making use of the same coding scheme as depicted but then applied on the interview output. Both the official documentation and interviews were processed through NVivo. The analysis has been complemented by information gathered during the events attended, through observations and informal conversations.

In order to come to a thorough overview of the compositions of the various sports communities and the interactions with the video referee taking place in-game, data on the following subjects has been gathered as mentioned in paragraph 2.1.2:

- Actor group designation;
- Description of interactions;
- Direction of interaction;
- Effect type.

Firstly, Actor group designation is an important piece of information as it provides identifiable actors to interactions that have been found. The analysis of actor group designation is twofold. The type of actor group has been determined first from reading the sentences containing (inter)actions concerning the video referee system in the rule documents and later interview output. This provided concrete actor groups such as 'athletes'. Afterwards, these labels were then bundled into codes relevant to the literature as mentioned in the theoretical framework: users, producers and institutional actor groups, depending on their respective roles.

Secondly, in order to be able to understand the complexity, directions and effects of the identified interactions, a plain description of what the interactions entails had to be included. This provided information about the actual role of the actor group when interacting with the innovation.

The third item on the list was the Direction of interaction. This formed an important part of the analysis as it provided information about the authorities within the interactions with the video referee systems. A one-way direction, i.e. an actor group being unable to watch the video images as watched by the video referee, indicated an unequal balance of power during the interaction. A two-way direction, i.e. when an actor group is able to refuse a video referee advise, was considered having more of a equalised power balance. Official documentation provided the initial results. These were then confirmed and adapted where needed based on the interview output.

Fourthly, the actor group categorisation also depended on the Effect type. The effect type related to whether the identified actor group had an active or passive interaction with the video referee. Direct interaction, i.e. requesting a video referee review during a match, has been considered a direct effect. Indirect effect, i.e. being frustrated as a spectator because of a video referee's outcomes, has been considered an indirect effect. Again, official documentation provided the initial results. These were then

confirmed and adapted where needed based on the interview output. An overview of the operationalisation of this part of the analysis can be found in Table 5.

Table 5: Operationalisation of the analysis of in-game interactions.

Parameter	Operationalisation
Actor group designation	Actor group characteristics according to institutional theory.
Actor group type	Actor group characteristics according to regulations documents.
Direction of interaction	One-way or two-way interaction between actor group and video referee.
Effect type	Assessment of influence on match progress

Analysis of interactions between the institutional innovation and various actor groups during the implementation*,* referred to as *innovation trajectory*, was conducted by applying the coding scheme in Appendix IV to interview output. This provided not only confirmation of the information found in official documentation but also additional information, i.e. additional actor groups that were not present in official documentation. The analysis has been complemented by information gathered during the events attended, through observations and informal conversations. This complementation of the initial analysis aids in increased saturation and validity. Both the official documentation and interviews were processed through NVivo. The following aspects have been analysed:

- Actor group designation;
- Interactions description;
- Trajectory stage.

First, the Actor group designation provided information about actor groups that had to be identified, similar to the in-game analysis. This identification to be performed again, because the implementation trajectories and the respective actor group roles proved to differ from the in-game situations.

For the sake of structuring the analysis, trajectory stages have also been identified. This process was iterative and has been conducted by coding according to the coding scheme in Appendix IV. The identification of implementation stages has proved to be helpful in the compilation of timelines and for having a structured writing approach. Through coding the following trajectory stages have been identified: 'ideation', 'implementation' and 'usage and development'. The identified trajectory stages form a simplified representation of the innovation management trajectory as defined by Westerski et al. (2011). The stage of ideation revolves around the initiation and early resistance. The stage of implementation concerns the phase of pilots and implementation preparations. The stage of usage and development revolves around the actual usage experiences, critical events, criticism and evaluation methods. For a clarification of this categorisation, consult Appendix IV containing the coding scheme.

A chronological description of the innovation trajectory follows according to the identified trajectory stages. Per trajectory stage relevant actor groups and their respective interactions with the

institutional innovation in that stage is identified as well as consequences of these interactions. Moreover, criticism and key events are being identified and elaborated upon for the sake of providing context to the later described legitimacy developments. An overview of the operationalisation of this part of the analysis can be found in Table 6.

Table 6: Operationalisation of the analysis of the innovation trajectory interactions.

Parameter	Operationalisation
Actor group designation	Actor group characteristics according to institutional theory.
Trajectory stage	Determination of point in time regarding innovation trajectory by designating the period 'ideation', 'implementation' or 'usage and development'.
Interactions description	Qualitative, chronological description of trajectory stages, critical events and criticism.

3.3.2 Degrees of legitimacy

The second subquestion concerned the different degrees of legitimacy received by the institutional innovations in each case. In order to find out about the different degrees of legitimacy throughout the three cases, both interviews and media analysis have been conducted.

First, media analysis has been conducted in order to identify sentiment development in media as an indicator for general acceptance of the institutional innovation. The .txt formatted articles for each case were processed in R, making use of package 'Syuzhet'. This package is able to analyse text documents and scan the overall sentiments present. An output of $\mu < 0$ indicated a negative sentiment for the article, whilst an output of $\mu > 0$ indicated a positive sentiment. The media analysis results were later compared between the cases in the conclusion in order to provide an indication about the general acceptance of the institutional innovation. The programming code used in R can be found in Appendix VII.

Second, after transcribing the interviews, the interviews were analysed making use of the coding scheme as depicted in Appendix V. Having scanned the transcripts, keywords and/or expressions related to the question posed were labelled. Initially a vast amount of codes was generated, which meant that deduction had to take place for patterns to emerge. The codes were accommodated in overarching labels named after the three types of legitimacy, based on where they would fit best. However, this provided again a scattering of legitimacy types and subjects even though the amount of codes was diminished due to the labelling. Again, by making use of axial coding three main themes consisting of multiple types of legitimacy were found: complexity of embedding, governing power balance and non-governing actor group involvement. The coding scheme including the steps towards the three overarching themes can be found in Appendix V. The coding scheme has been operationalised in a comprehensible way as depicted in Table 7, thereby providing the structure for the analysis in the Results section.

Table 7: Operationalisation table with regard to the legitimacy of the innovation.

Parameter	Clarification	Operationalisation
Complexity of embedding	Difficulty of making the innovation fit and congruent with the current institutions.	Addressing of grey areas in regulations
		Uniform deployment of innovation
		Congruence of regulations with innovation
Governing power balance	Spread of institutional power in the system.	Actor group authorities
		Controlling mechanisms
Non-governing actor group involvement	Involvement of (end) users and producers by the institutional actor groups in the innovation trajectory.	Regulatory transparency
		Feedback/input requests by institutional actor groups

3.3.3 Legitimisation strategies by institutional actor groups

The third subquestion concerns the legitimisation strategies as deployed by the overarching sports associations, being the institutional actor groups. The five legitimisation strategies as proposed in the theoretical framework form the basis of this analysis. Legitimisation strategies have been identified by compiling specific questions and incorporating these in the interview protocol as depicted in Appendix II. The operationalisation of the strategy analysis can be found in Table 8. The operationalisation came forth from coding interview output. The coding scheme can be found in Appendix VI.

First, the type of legitimisation strategy according to the theoretical framework has been identified. This provided a comprehensible structurisation of the analysis as well as a clear link to the theoretical framework.

Second, the actual deployment of the strategy type had to be described. As the five legitimisation types provide a general structure, the operational deployment of the strategy had to be substantially described. The description contains an identification of the actor group deploying the strategy as well as the practical deployment, i.e. communication tactics.

Third, aiding in the description of the operational deployment is the identification of the trigger, thereby looking for the reason why the strategy had to be deployed in the first place. This also provided insight into whether the strategy deployment had a reactive or proactive nature.

Fourth and finally, the effect of the strategy deployment had to be determined. This part of the analysis consisted of merely a cause-and-effect analysis. It was mainly interview output that provided the answers to this, making use of the concrete answers that were given to the questions as stated in the interview protocol.

The coding scheme as mentioned in Appendix VI was made by processing the data in NVivo, thereby structuring the data and making it operational. The entire Results section has been finalised by combining all results in a visualisation of the innovation trajectories in the form of a timeline. These timelines provide insight into the development of legitimacy, significant events and correlations with

legitimisation strategies. Situated above the timeline is an orange line, representing the sentiments present about the institutional innovation at different moments in time.

Table 8: Operationalisation table with regard to the legitimisation strategies.

Parameter	Operationalisation
Strategy type	Designation of the type of legitimisation strategy according to the typology by Pelzer et al. (2019)
Strategy deployment	Description of the actual operationalisation of the strategy type by linking actor groups to events and actions.
Trigger	Reason for strategy deployment in terms of trigger events.
Effect	Consequences in the sports community due to the strategy deployment and where possible the consequence regarding legitimacy.

3.4 Ethical aspects

In order to ensure an ethical approach to the research, some measures have been taken to do so. All interviewees have been informed about their GDPR rights according to the informed consent form as provided by Utrecht University in Appendix VIII. During conversations that turned into unplanned interviews, the interviewee has been asked explicitly for permission to be asked questions. Moreover, interview recordings and transcriptions have been stored in a cloud storage with password encryption. After the research has been finished, these recordings and transcriptions have been deleted. Interviewees have not been mentioned by name in this research in order to ensure privacy and diminish speaking restrictions.

4 Results

The results follow from the execution of the methodology, within the boundaries of the theoretical framework and with the aim to provide enough information to answer the research questions. The first two sections provide information about the actor groups and their interactions with the video referee systems. The third section revolves around the various degrees of legitimacy of the institutional innovations throughout the cases, whilst the fourth section focuses on the legitimisation strategies.

4.1 In-game interactions

The first section of this paragraph contains a description of the in-game functioning of the video referee in each case. The sections following identify the users, producers and institutional actor groups and their respective interactions with the video referee during the game.

4.1.1 Tennis

The tennis federation 'ITF' and the Dutch national association 'KNLTB' make use of a video referee system called 'Hawk-Eye', developed by Dr. Paul Hawkins and later procured by Sony. A simplified overview of the scoring system is as follows: players have to win four points in order to win a game and six games in order to win a set. Depending on the type of tournament and gender, players have to win two or three sets in order to win the match in general.

Hawk-Eye is used to observe whether the in/out rule is applied correctly by the referee. A ball is considered 'in' when it lands within or on the borders of the tennis pitch. A ball touching the line fractionally is considered as 'in' and thus valid. During the match, tennis players have the opportunity to request a Hawk-Eye review at the referee. They can do this three times per set. Players may ask the referee for a review when they think that the referee's or linesman's call is incorrect. In the case of a 'successful' request (thereby correcting the referee), the player does not have one of the requests deducted from the total amount of requests. For example, if the player has three requests at its disposal and puts in a correct request, the player still has three review request for the remainder of that set. One should bear in mind that it is only the players who are able to ask for a Hawk-Eye review, the referee and coaches are excluded from this.

Hawk-Eye is a universal system, consisting of ten cameras enabling to track the ball. The Hawk-Eye system is designed for use at relatively large venues, which means that it cannot be deployed at smaller tennis clubs. The latter results in the technology being applied during grand tournaments and not on amateur level.

Regarding the in-game context, the *users* actor group consists of the following actors:

- Athletes;
- Referees;
- Coaches/team management;
- Spectators.

The athletes have the power to request a review by the video referee system, but are also subject to its outcomes. This means that the direction of interaction is two-way. Both the request itself as well as the outcome of the video referee review affect the match progress immediately which implies a direct effect type.

Referees have a one-way relation with the video referee. As athletes request the review, the referees are subject to the review provided by Hawk-Eye because their decision either stands or becomes rectified. In essence, the referee does have the possibility to overrule the decision but this only happens when a decision by the technology is not possible. As is the case with the athletes, the outcome of the review affects the referee's decisions and match progress which means that a direct effect type is assigned to this relation.

The third actor group consists of coaches and/or team management. This actor group is not allowed to request or interfere with the deployment of the video referee. Also, this actor group is only able to witness the process of the decision-making and the outcome. Their interaction with the video referee does not influence match progress and has therefore been assigned an 'indirect effect type'.

Spectators form a major part of the community and their perception of the video referee may affect the acceptance of the video referee within the community. Their interaction with the video referee is designated as being 'one-way'. The reason for this is that do not influence the operation or deployment of the video referee but they are able to visually witness both the process of the decision-making as well as the outcome. This does not directly influence the match results, but the decision being (in)correct does influence the general sentiments among the spectators.

The role of *producers* in the in-game context is relatively small. In the case of tennis, the producers actor group is formed by:

- Hawk-Eye operators.

The Hawk-Eye operator manually initiates the process of recording every time a tennis player is about to serve, making use of the ten cameras needed for Hawk-Eye to be operational. The operator does not communicate with the referee during the match. The operator is autonomous, by regulations, in initiating and terminating the recording procedures thereby making video images available in the case of a review request. It can therefore be stated that the direction of interaction with the video referee is one-way, as no feedback loop has been established. The effect type is direct, because a wrongfully executed recording procedure affects the functioning of the video referee and thereby the progress of the match. An overview of the in-game interactions is provided in Table 9.

Table 9: Actor groups and their in-game interactions with the video referee system in the tennis case.

Actor group designation	Actor group type	Interaction with innovation	Direction	Effect type
User	Athletes	Power to request review, limited frequency.	Two-way	Direct
User	Referees	Advised by video referee system; power to overrule.	One-way	Direct
User	Coaches/team management	Passive, able to see the decision-making process on-screen.	One-way	Indirect
User	Spectators	Passive, able to see the decision-making process on-screen.	One-way	Indirect
Producer	Hawk-Eye operator	Controls the technology operations.	One-way	Indirect

4.1.2 Field hockey

The field hockey community has been using arbitral video aids for quite some time. This paragraph describes the usage of the video referee in 2020. During a hockey match, the video referee is able to interfere in three specific situations:

- Goal or no goal;
- Penalty situations;
- Penalty corner situations.

All of these situations take place within the 23-meters area of the pitch, which means that any foul outside this area automatically does not apply for video referee review.

The video referee is situated near the field and makes use of television broadcasting images and functions as a support to the two referees (further referred to as 'referee') situated on the pitch. The referee however is not in the position to call for a review or inspection of a situation. Both teams have one review request, keeping the request in case of a correct challenge. The rulebooks state that the referee has the authority to make the final decision, however in practice it is the video referee who makes the decision for the referee. The conversation between the referee and the video referee and the video images are always broadcasted on television and in the stadium, which results in the fact that everybody has real-time knowledge about the decisions being made at that moment.

Regarding the in-game context, the *users* actor group consists of the following actors:

- Athletes;
- Referees;
- Coaches/team management;
- Spectators.

In the case of field hockey athletes also have the power to request a review and are subject to the outcomes the review. This implies a two-way relation with the video referee. Any hockey player on the field is able to call for a review when he/she suspects that the referee did not make the correct decision. The request put in and the following decision by the video referee influence the progress of the match, which indicates a direct effect type.

The referees also have a two-way interaction with the video referee. In the very essence, the referee is not in the position to call for a review or inspection of a situation. The only time the referee can ask for a review is in the case of a penalty situation or a goal/no goal situation, when both teams have run out of review requests which is not an unlikely scenario. During the review moment the referee is not able to see the video images. In practice the referee advises the athlete who put in the request about his/her chance of succeeding of getting a positive outcome. Another non-written rule, which is stated to be applied in 99% of the cases, concerns the authority of decision-making. The rulebooks state that the referee has the authority to make the final decision, however in practice it is the video referee who makes the decision for the referee. All of this could affect the outcome and progress of the game, implying a direct effect type.

The role of coaches and/or team management is marginal during the game. Team management cannot request a review, but is allowed to instruct players to ask for one. The fact that team management does not have the authority to request a video referee review implies a one-way relation with the video referee. The outcome however may be a cause for a change in tactics or team line-up. Therefore a direct effect type applies.

The spectators are the people that watch the professional match at home or at the venue. Their interaction with the video referee is designated as being 'one-way' because the spectators do not influence the operation or deployment of the video referee. However, they are able to witness both the process of the decision-making as well as the outcome. Inter-referee communication and video referee images are being broadcasted in the stadium and on television, thereby informing the spectators. The interaction in itself does not influence the outcome of the match, which indicates an indirect effect type.

The *producers* actor group is formed by:

- Television broadcasters.

The television broadcasters provide the necessary technology for the video referee to execute its job. A communication line between the video referee and the television broadcaster is present during the game, allowing the video referee to request certain angles or replay speeds to which the broadcaster can

respond. This means that the direction of interaction is two-way. The effect type is considered direct because the television broadcaster not being able to deliver the angle needed, results in the call "decision not possible" which influences the game progress directly. An overview of the in-game interactions is provided in Table 10.

Table 10: Actor groups and their in-game interactions with the video referee system in the field hockey case.

Actor group designation	Actor group type	Interaction with innovation	Direction	Effect type
User	Athletes	Power to request review, limited frequency.	Two-way	Direct
User	Referees	Advised by video referee system; power to overrule but never do so. Power to request review, but under very strict conditions.	Two-way	Direct
User	Coaches/team management	Passive, able to see the decision-making process on-screen.	One-way	Direct
User	Spectators	Passive, able to see and hear the decision-making process on-screen.	One-way	Indirect
Producer	Television broadcasters	Providing images to spectators and video referee.	Two-way	Direct

4.1.3 Football

The video referee system in football is called Video Assistant Referee and is designed to help the on-pitch referee executing game rule governance. In the specific case of football in 2020, the VAR continuously (during the match) looks for situations either missed or misjudged by the referee. It can do so in four specific situations:

- Goal or no goal;
- Penalty kick or no penalty kick;
- Direct red card;
- Mistaken identity.

Within these four situations, the VAR thus checks for missed offences as well as misjudged offences. The latter being an interesting component as it should concern a 'clear referral error' which has not been further defined in the rules of the game.

The VAR is situated outside the venue where the match is being played and accompanied by two others: an Assistant Video Assistant Referee (AVAR) and the Replay Operator (RO), the latter being in charge of the process of showing video images. The VAR continuously checks for situations in which it should interfere and provide advice to the referee. There is no limit to the amount of interventions by the VAR. The entire in-game decision-making process is shielded from all actors

mentioned, meaning that video images and communication between the video referee and referee are not visible and audible during the game, mostly due to (lacking) broadcasting rights.

The following *user* actor group was identified during the investigation of game rules and the analysis of interviews:

- Athletes;
- Referees;
- AVAR;
- RO;
- Coaches & team management;
- Spectators.

The athletes on the pitch do not have the power to request a review by the video referee on the basis of game regulations, as the video referee continuously checks for referral mistakes. However, the athletes are subject to the decisions made by the referee and advise provided by the video referee. All in all, this indicates that the interaction is one-way, but the effect type proves to be direct.

Like the athletes, the referee on the pitch does not have the authority to ask for a review. Instead, in the case of the VAR suspecting a missed or misjudged situation, it advices the referee to have a closer look at the screen situated near the pitch. On this screen the referee is able to see close-up images from various angles, provided by the VAR, to check which decision should be taken. The referee is able to reject this advice, thereby having the choice to stick with his/her initial decision without a check. This interaction can thus be labelled 'two-way'. Given the fact that the influence of the interaction may consist of dismissed goals or penalties given, the effect type is direct.

The AVAR provides the video referee with assistance. The AVAR double checks the images seen by the video referee, thereby increasing the chances of making the correct decision. The VAR and AVAR discuss situations and influence each other, which indicates a two-way interaction. On top of that, the interaction directly influences the decisions made by the VAR and thereby the progress of the match which means that the effect type is direct.

The RO is responsible for the actual operations, providing the VAR and AVAR with the video images they need. The video referee puts in a request for specific images, which the RO then provides. This implies a one-way interaction, but a direct effect type due to the influence the RO's images have on the decision-making process of the video referee.

The fifth group of users consists of coaches and/or team management. Team management is not able to request a video referee review, which implies a one-way relation with the video referee. The outcome however may be a cause for a change in tactics. Therefore a direct effect type is assigned to this relation.

The final user actor group consists of spectators. Spectators are the people that watch the professional match at home or at the venue. Spectators do not influence the operation or deployment of the video referee, nor are they able to witness the decision-making process either visually and/or audibly.

All of this indicates a one-way interaction. The interaction does not influence the outcome of the match, which indicates an indirect effect type.

The actor group of *producers* is small compared to the users actor group. It consists of the following actor:

- Television broadcasters;

In the Netherlands, broadcaster ESPN provides the technological infrastructure for the video referee to be operational. ESPN follows the protocols as provided by the Dutch football association, but within its technological possibilities. As stadiums differ, the camera setup also differs. Explanation on this phenomenon is provided in paragraph 4.2.3. Given the fact that the television broadcaster does not interact directly with the video referee during the game, but provides a setup in advance of the match, the interaction is a one-way type. However, as the camera setups differ across the stadiums, this affects the reviewing possibilities and thus possibly the match result. Therefore, the effect type is direct. An overview of the in-game interactions is provided in Table 11.

Table 11: Actor groups and their in-game interactions with the video referee system in the football case.

Actor group designation	Actor group type	Interactions description	Direction	Effect type
User	Athletes	Passive. No information about decision-making process provided.	One-way	Direct
User	Referees	Advised by video referee system; power to overrule; no power to request review.	One-way	Direct
User	AVAR	Assisting and controlling the VAR.	Two-way	Direct
User	RO	Operation of technological equipment.	One-way	Direct
User	Coaches/team management	Passive. No information about decision-making process provided.	One-way	Direct
User	Spectators	Passive. No information about decision-making process provided.	One-way	Indirect
Producer	Television broadcaster	Providing images to video referee.	One-way	Direct

4.2   Innovation trajectory interactions

This paragraph identifies and describes the different actor groups and their respective roles during the implementation of the institutional innovation. As indicated in the methodology, the innovation trajectory has been set apart from the in-game usage. This results in the fact that each paragraph starts off with a brief additional check for actor groups as some actor groups were potentially not identified during the actor group identification in the previous paragraph. Following the actor group identification, the implementation trajectory including actor groups and their respective roles has been described, thereby providing the basis for the other paragraphs in the Results section of this report.

4.2.1   Tennis

In addition to the already identified actor groups, the following additional actor groups were found by rerunning the actor group identification analysis as described in paragraph 3.3.1:

- User: athletes committee;
- Institutional actor group: International Tennis Federation (ITF);
- Institutional actor group: Dutch tennis association (KNLTB).

The roles of these newly identified actor groups are explained in the description of the implementation trajectory below.

Not much information about Hawk-Eye is known or documented by KNLTB and/or ITF, especially about earlier stages such as *ideation*. News articles dating back to the early 2000's indicate that the initiative for researching the application of a video referee came from a desire "to keep up with other innovative sports, such as rugby." For Hawk-Eye to be eligible for testing in the first place, the manufacturer "should be able to back up the technology with solid quantitative performance data" concerning the functional effectiveness of the technology, i.e. rectified mistakes. When the quantitative data is sufficient in the eyes of ITF, an advice is asked for at the athletes committee. The athletes committee is an additional actor group based on the actor group of athletes. This is an actor group that consists of selected top-tier athletes representing the interests of the athletes actor group. Their role is to be informed and consulted regarding important changes.

In the case of a positive advice and thus general support, ITF was able to start the *implementation* by means of a testing phase and pilots to test the effectiveness of the technology. ITF is an additionally identified institutional actor group and is the main governing actor group, being the international tennis association. It designs, implements and governs regulations concerning the video referee. In the context of the entire implementation trajectory, the ITF consults other relevant actor groups such as the 'rules of tennis committee'. It is also informed by users (i.e. the athletes committee) and producers (Hawk-Eye), about video referee performance and acts upon that feedback.

In the period from mid-2004 till late 2006 Hawk-Eye and its predecessor, AutoRef, were tested on international level. The testing phase was relatively short-termed. Official deployment of Hawk-Eye at a grand slam took place in 2006. Some expected criticism has been anticipated by ITF and KNLTB and then avoided. Criticism was expected in the case of the manual operations required to operate Hawk-Eye becoming publicly known. Athletes and the rest of the community are not aware of this fact and them knowing it could lead to general concerns about human errors in the process. When asked, KNLTB representatives state that "this information has been kept away from the community, as it could distract athletes and cause concern among other community members." KNLTB is the Dutch national tennis association. Its role in the implementation trajectory of the institutional innovation is quite small as ITF imposes the rules worldwide. KNLTB therefore conducts incremental research with regard to the video referee system.

When conducting the research regarding rule development during the *usage and development* stage of the institutional innovation, KNLTB was not able to provide historic game rule documents mainly due to the fact that ITF forms the central organ compiling and distributing rules. However, when contacting ITF, they were also not able to find/provide historic rule documents, which means that some assumptions will have to be made. The fact that it proved to be difficult to obtain historic documents, leads to the assumption that not many significant rule changes regarding Hawk-Eye have been made. If that had been the case, it would have made sense to carefully store these documents for evaluation sessions. Hawk-Eye technology is able to detect a ball being hit 'in' or 'out' and is not required to do anything else, thereby limiting the degree of interpretation. Also, Hawk-Eye has been developed specifically to enforce the already existing rules in tennis. Therefore, the only rule changes have a procedural nature and are more of an addition to the game rules rather than a change, i.e. the amount of review requests per set.

As described in paragraph 4.1.1, Hawk-Eye is a universal system that cannot be deployed at lower-tier tournaments and clubs. This poses no problem as the technology is "not meant to be deployed at literally every level of tennis" in the first place. Due to the limited capacity of Hawk-Eye distributor, it may very well happen that the system is only deployed at the so-called centre court of a tournament. As tournaments, especially in the earlier phases, host large numbers of athletes, multiple courts are used at the same time. Not all of the courts have Hawk-Eye present, which could cause various actor groups (i.e. athletes and spectators) to argue that the deployment of the system is not fair. However, as this is a known fact and because the general attitude within the sport "also entails comprehension for the possible unfairness" within top level sports, as was stated by a KNLTB representative. On top of that, the surface of the tennis court does play a role. Clay courts, such as Roland Garros, are not suitable for Hawk-Eye as the surface is too loose. This however is accepted as a traditional court type by the tennis community and "its disadvantages (and the impossibility) for deploying Hawk-Eye are widely accepted."

Based on the interviews, no major source of resistance has been identified over the entire innovation trajectory. An additional, unplanned search in the media articles also did not provide any sources of resistance. The negative sentiments had other causes, which is explained in paragraph 4.3.1. Remarkably, some resistance and criticism has been encountered during the stage of usage and development, but not towards the technology. Instead, 'the old ways' were criticised. I.e. "the presence of the considerable amount of linesmen was criticised. During the Covid-19 pandemic linesmen were not allowed and people had to rely on Hawk-Eye entirely. This worked out very well, which caused the return of linesmen to be criticised.

Not much is known about the evaluation processes. Interviews indicate periodic evaluations but only on ITF level, KNLTB (national level) does not do such thing. This indicates in its turn that technology deployment and the accompanying rules cannot differ between different national associations. This is underpinned by the fact that it is difficult to contact Hawk-Eye as the manufacturer, even for KNLTB employees.

Important to note is the fact that KNLTB lacks a full-time Hawk-Eye specialist. Naturally this is partially due to the fact that ITF holds all of the power, but also due to the fact that the technology has been developed over more than a decade. Currently, ITF (and KNLTB's embedded scientists) are investigating the possible deployment of enhanced technologies, in order to minimise the already small margin of error posed by Hawk-Eye. The reason for this is not explicitly mentioned. Interview output suggests that KNLTB culture is predominantly science-based, from which a desire to continuously improve comes forth. Alternate technology 'FoxTenn' finds itself in the stage of testing at this moment and still needs to prove itself quantitatively. FoxTenn also makes use of various cameras, but produces live video images instead of ball tracking simulations. This reduces error possibly produced during the processing of images into simulations. If the quantitative evidence has been delivered, it is expected that FoxTenn gradually replaces Hawk-Eye resulting in the video referee system in tennis reaching more pragmatic legitimacy. An overview of the innovation trajectory interactions can be found in Table 12.

Table 12: Actor groups and their interactions during the innovation trajectory in the tennis case.

Actor group designation	Actor group	Role in innovation trajectory
User	Athletes (committee)	Consulted and controlling ITF actions.
User	Referees	Unknown.
User	Coaches/team management	Unknown.
User	Spectators	Unknown.
Producer	Hawk-Eye (Sony)	Providing technology test results and improving where asked by ITF.
Institutional actor group	Sports association ITF	Worldwide ideation and implementation, continuous search for improvements.
Institutional actor group	Sports association KNLTB	Incremental research.

4.2.2 Field hockey

In addition to the already identified actor groups, the following additional actor groups were found by rerunning the actor group identification analysis as described in paragraph 3.3.1:

- User: athletes committee;
- Institutional actor group: Fédération Internationale de Hockey (FIH);
- Institutional actor group: Dutch field hockey association (KNHB).

The roles of these newly identified actor groups are explained in the description of the implementation trajectory below.

The athletes committee was responsible for the *ideation* and initiation in the early 2000's, as they "highly requested the introduction of the video referee." Clubs and players were the first to put in the request for video technology assistance for the referees. Central to the implementation process stood the question "what can we do to make our sport even better?" Before planning and starting the implementation and answering the question, the foundation of a task force designated to investigating the possibilities of video referee systems was necessary. The task force consisted of three actor groups:

- Association (FIH) officials;
- Athletes committee;
- Television broadcaster representatives.

Relevant association officials were those who had some form of responsibility and authority regarding game rules and/or innovation introduction. The athletes committee consists of actively playing representatives from top tier teams and is a vital organ to the FIH and field hockey community in general. All major initiatives are passed by this organ and some are, like in this case, initiated by it. The television broadcaster representatives were important to include in the process from the start as these were the most accessible resource for images that could be used for a video referee system.

Official implementation of the video referee in field hockey took place in 2010. At the start of the *implementation* stage, FIH made it a clearly defined target that spectators and the majority of the field hockey community should be as much involved in the game and its decisions as possible. Referees were not consulted in the very beginning due to the concept of "having the sport and the athletes central to every case." Referees being not involved from the start resulted in a certain degree of resistance by the referees as the video referee was seen as a way to "publicly correct referral mistakes" and not as a supportive piece of technology. Throughout the years, by experiencing the usage of the video referee as well as significant rule changes, "this attitude from the referees altered towards an attitude in which they embrace the video referee."

After the implementation stage, years of official *usage and development* followed. Initially hockey players were allowed to challenge every single decision made by the referee, making use of an unlimited amount of referrals. The result of this was a continuous stream of interruptions caused by teams challenging referral decisions out of hope/despair or tactically. The match duration increased significantly due to all of the stoppages which was a reason for irritation with referees and the spectators. From then on (approx. from 2013 and on) teams were limited to only one review request per match and could only challenge decisions within the 23 metres area of the pitch. All of this helped the game to become more attractive and did not compromise the intended involvement of spectators.

One important issue could be pointed out, which is the grey area of interpretation the referee sometimes finds him/herself in. From time to time, matches contain a situation during which the referee interprets the situation differently compared to the video referee and/or the athletes. This is cause for discussion and a risk for losing cognitive legitimacy as spectators and athletes cannot understand decision-making. However, these interpretation issues have been overcome by discussions between referees and the athletes committee. These discussions can take place at any moment (even during the season) and allow FIH and KNHB agile rule adaptation, which increases chances of maintaining overall legitimacy of the video referee. During these discussions the referees inform the top tier teams' representatives about the situations subject to interpretation and how they will handle these situations from that moment on in the future.

The current setup of the video referee in field hockey allows itself for usage at every venue if needed. This is a consequence of the fact that the video referee makes use of tv broadcaster's images and can only be deployed, on regulatory basis, during national play-off matches and during international tournaments. Briefly the FIH made use of Hawk-Eye as the video referee system, but only for a couple of years. Due to a lack of financial resources, Hawk-Eye could not be maintained as the standard video referee technology. This meant that tv broadcaster's images were then again set as the standard. Both "hockey players and referees prefer the Hawk-Eye system as it significantly reduces the margin of error." It would therefore add to both the speed and fairness of the game.

Evaluation sessions are being held every tournament and provide the basis for rule alterations if needed. FIH rules (again together with the athletes committee) allow for making small rule alterations at any given moment, providing the agility to respond to hick-ups in the system. Besides earlier mentioned ad hoc evaluation, the rules committee plays an important role regarding the development of the video referee. This committee is renewed every four years and its main task is to "explore and find opportunities to organise processes better." This also includes improvements with regard to the video referee, but "it is only placed at the top of the agenda when corrective measures are to be taken" due to the earlier mentioned lack of financial resources. Therefore, the video referee gradually evolves. The basic idea for improving the video referee system would be "looking at other sports, absorb elements and improve these elements," according to KNHB representatives. An overview of the innovation trajectory interactions can be found in Table 13.

Table 13: Actor groups and their interactions during the innovation trajectory in the field hockey case.

Actor group designation	Actor group	Role in innovation trajectory
User	Athletes committee	Initiation of the entire trajectory and consulted by FIH.
User	Referees	Not involved during implementation, involved during evaluations.
User	Coaches/team management	Involved during evaluations and rule changes.
User	Spectators	Not involved, but focal group for FIH.
Producer	Television broadcaster	Facilitating video images and part of initial task force.
Institutional actor group	Sports association FIH	Compilation of task force and imposer of rules.
Institutional actor group	Sports association KNHB	Incremental research.

4.2.3 Football

In addition to the already identified actor groups, the following additional actor groups were found by rerunning the actor group identification analysis as described in paragraph 3.3.1:

- User: athletes committee;
- Institutional actor group: Fédération Internationale de Football Association (FIFA);
- Institutional actor group: International Football Association Board (IFAB);
- Institutional actor group: Dutch football association (KNVB).

The roles of these newly identified actor groups are explained in the description of the implementation trajectory below.

The initiative and thus *ideation* came from top management within the Dutch national football association 'KNVB'. In 2012 the domestic competition and referee manager (DCR manager) proposed the introduction of the VAR. At that time, a tendency was present that "everyone could see that the VAR would be a major improvement," as other sports communities had already successfully adopted or were testing the video referee system. Although the football community in general expected the VAR to be an improvement, several high-profile actor groups were not convinced. Referees were "not very enthusiastic about the prospect of introducing the VAR nor were the more traditionally conservative top managers" at the international football associations such as FIFA and UEFA. According to KNVB representatives "the perseverance of the DCR manager eventually paid off", putting less emphasis on introducing the VAR and instead focusing on emphasising the importance of research in the direction of a VAR.

KNVB was the first in the world start experimenting with the video referee in 2013 and thereby started the *implementation* stage as defined in the methodology. However major changes, such as technology introductions or rule alterations, can only be made when the FIFA and the IFAB authorise them. It is important to note that, although the athletes committee was formally informed, players and referees were not asked to provide input during the ideation and implementation stages. This means that two key actor

groups – referees and athletes – were not thoroughly consulted from the start and KNVB did have the authority to operate partially independently from international associations. The athletes committee did not pose any major objections to the plan, which sufficed for KNVB to continue introducing the VAR.

KNVB then set up a series of experiments, initially testing goal line technology in cooperation with Hawk-Eye. During these experiments referees could start practicing without interfering with the match and the referee's functioning. This was achieved by having a television van near the stadium and letting the referees practice with in-game situations, whilst not being in contact with the referee on the pitch. The experiments showed that the expected improvements were actually achieved, although it is unclear what metrics were used. Based on the attended press briefing (which is discussed later in this paragraph), it is assumed that no clearly defined metrics were used when measuring pilot performance, as KNVB was pioneering and historic data were not available yet, instead numbers like effectiveness and correct interventions have probably been used. These effectiveness and intervention numbers, obtained in the period of 2013-2016, "made the FIFA and IFAB reluctantly agree" to introducing the video referee officially as technology in multiple competitions and granting KNVB permission to continue experimenting. KNVB successfully framed the 'old' situation as being inferior, forcing FIFA and IFAB to tack. Having conceded the fact that the VAR would have a positive impact on rule enforcement, FIFA decided to allow KNVB further exploration and partial implementation as the "effectiveness figures were not ignorable anymore."

However, resistance was already met in 2013. Referees thought the VAR was not there to help them but to control and correct them publicly. They communicated their concerns during meetings by stating that they were "afraid to lose their authority on the pitch" as players would see the VAR as the highest authority instead of the referees on the pitch. Another source of resistance came from a higher level in the football community: FIFA. "Concerns rose about whether a VAR could be deployed at all levels" in the football community as it would be an expensive novelty. Questions like 'Would all national competitions be able to deploy the VAR?' emerged. Eventually this led to extensive freedom at national level regarding VAR rules, which is discussed later in this paragraph. Football's video referee was then officially implemented in 2018.

Official Eredivisie implementation in 2018 took place, marking the start of the usage and development stage. Some changes and rules have been compiled in order to institutionalise the VAR in the football community. These changes were mainly technological by nature, mostly protocols in order to help the VAR being functional. Protocols have been developed for "camera positions" in stadiums, "latency of the video images" and synchronicity of different camera angles; the latter being tested with "stroboscope experiments."

It became clear from the interview sessions and the attended press briefing at KNVB that a recent issue is the "processing time of VAR decisions." Spectators and players have been complaining about these processing times being too long and incomprehensive. This is a consequence of

communication not being open towards players and spectators. Both video images and audio are shielded from everybody except the referee and VAR who are communicating. Video images are not being published because of broadcasting rights, whilst audio communication is not open mainly because of the fact that "referees resist to it as they feel controlled." All of this results in a minimal degree of cognitive legitimacy, especially with spectators. KNVB acknowledges that they have seen that better informed people are more likely to accept a longer processing time. They also state that it would be "undesirable to have a fixed amount of time available for the decision" to be made. KNVB's approach is based on delivering "the correct decision, not a quick one." Over a period of approximately a year, KNVB attempted to respond to this criticism by a weekly upload on Twitter: "Weekly VAR moment." This upload contained a video referee decision (which was either good or bad) and an explanation of the decision-making process, thereby trying to create comprehension for all video referee based decisions and offering the possibility to react. Mid-2020 this uploading scheme was terminated due to unknown reasons. A field hockey representative (KNLTB) has stated that this strategy probably does not work, because the comment section on Twitter is still too far away from the actual video referee processes for the actor group of spectators.

Related to this issue is the frequency by which the VAR interrupts a match. "Spectators have the perception that the VAR interrupts too often" to their taste, thereby slowing the game and compromising moral legitimacy due to a lowered degree of entertainment. The discussion about working with a "challenger system is a logical one." A challenger system provides both teams with a fixed number of review requests, putting all power to deploy the VAR into the hands of the players. KNVB does not want to work with such a system as it might "result in crucial match events not being corrected by the VAR" just because of the possible situation in which a challenge cannot be requested anymore, which in their eyes compromises moral legitimacy in another way.

Another frequently heard piece of criticism entails the grey area in the game rules, affecting cognitive legitimacy for the sport in general. Rulebooks indicate that the VAR can interfere whenever a situation is missed by the referee or when he/she is under the impression that the referee has made a considerable mistake. The latter not being further defined causes "confusion and irritation" among the football community members. According to the chairman of the Dutch supporters collective, the combination of the grey area and the lack of transparency (no communication and video images) is the reason that people do not understand what is happening during the decision processing times and therefore the outcomes are often disputed and/or rejected. Analysing the rule books, it can also be found that game rules are being changed every year (i.e. offside and hands rules) trying to make the VAR more embedded instead of changing VAR deployment rules.

Closely related to the grey areas, is the observation of official protocols. An example of such a protocol entails the number and type of cameras that have to be in place for the VAR to be allowed to operate. However, at smaller stadiums it might not be possible to have a camera focused on the penalty box, which is an ideal camera for checking for offside situations. ESPN is currently "able to station these

cameras at the 'bigger, more important' matches." This means that other matches do not have this camera present, which appears to be unfair. KNVB has tried to solve this problem by positioning its own cameras at the other stadiums, attempting to be able to have the VAR available anywhere. Then again, smaller stadiums are not suitable for these KNVB operated cameras. Although this clearly affects moral legitimacy, this does not seem to worry KNVB because the FIFA gladly "provides dispensation" which means that the VAR is still allowed to operate even without the regulatory cameras present.

The innovation team at KNVB seems to be determined to improve the functioning of the VAR. Therefore frequent evaluations are being executed. The majority of the evaluation is based on statistics. Reports and presentations are provided to all interested parties about the effectiveness of the VAR, which only targets pragmatic legitimacy. Based on the attended press meeting at the KNVB Campus, during which VAR performance over the 2020-2021 season was discussed, some assumptions regarding performance metrics can be made. Currently performance, i.e. missed fouls or incorrectly given cards, is measured by comparing it to previous seasons as well as foreign football competitions. Evaluation processes are focused on what is functioning and not focused on the processes surrounding (the implementation of) the VAR. Expertise about improvements is mainly searched for within the walls of KNVB. Other sport associations and communities are not contacted frequently "because of the scale difference." Evaluations take place with referees and sometimes with spectators when the annual questionnaire concerns the VAR. Also, KNVB evaluates with other national football associations and with the UEFA VAR task force. Questions that are asked mainly concern topis like VAR operations and effectiveness statistics. This indicates an internal focus when it comes to the functioning of the VAR and again a strong focus on pragmatic legitimacy only. An overview of the innovation trajectory interactions can be found in Table 14.

Table 14: Actor groups and their interactions during the innovation trajectory in the football case.

Actor group designation	Actor group	Role in innovation trajectory
User	Athletes (committee)	Informed.
User	Referees	Not involved during implementation, involved during evaluations.
User	Coaches/team management	Not involved.
User	Spectators	Sometimes consulted during annual questionnaires.
Producer	Television broadcaster	Providing technology during pilots and testing.
Institutional actor group	FIFA	Governance in general.
Institutional actor group	KNVB	Imposes rules within degree of freedom provided by FIFA, UEFA & IFAB. Governance regarding Dutch competition.
Institutional actor group	IFAB	Compilation of formal rules and governance in general.

4.3 Degrees of legitimacy

Now that the various actor groups have been identified, categorised and linked to their respective interactions with the institutional innovation, it is possible to analyse the different degrees of development throughout the three cases. The analysis will be executed using the structure as determined in the methodology, thereby combining the several legitimacy types in relevant overarching themes.

4.3.1 Media analysis

Although the media analysis turned out to be incomplete to the pre-set standards for the case of *tennis*, it provides some useful information. After almost six years into the innovation trajectory, the amount of articles not only containing match results diminished greatly. This has proved to be difficult to overcome, as the removal of a search filter (i.e. 'language') immediately compromised the geographical scope as well which would cause unfair research.

The first period of the innovation trajectory, including the stages of ideation, implementation and partially usage and development, shows a pattern of positive sentiments about the introduction of the institutional innovation, with all analysed articles from the period of 2005 till 2010 having a positive tone. After this period, the number of published articles diminished greatly. Articles were available, but they only contained tennis match results instead of reports and/or interviews indicating sentiments around the acceptance of the video referee. For the period of 2011-2013 only three articles were found, two of which had a positive tone. The other article was mainly negative, but this could be assigned to the reporter feeling pity for the superstar that was eliminated from the tournament in question. The period 2014-2017 provided no useful article at all, whilst the period 2018-2020 provided two positively written articles. The number of articles diminishing indicates that no issues have occurred after the initial usage period. This is also confirmed by the interviews, during which it was indicated that currently "no problem solving is happening, just looking for better technologies." The overall pattern, visualised in Figure 1, shows a relatively steady positive sentiment over time. The unprocessed output as retrieved from R can be found in Appendix IX.
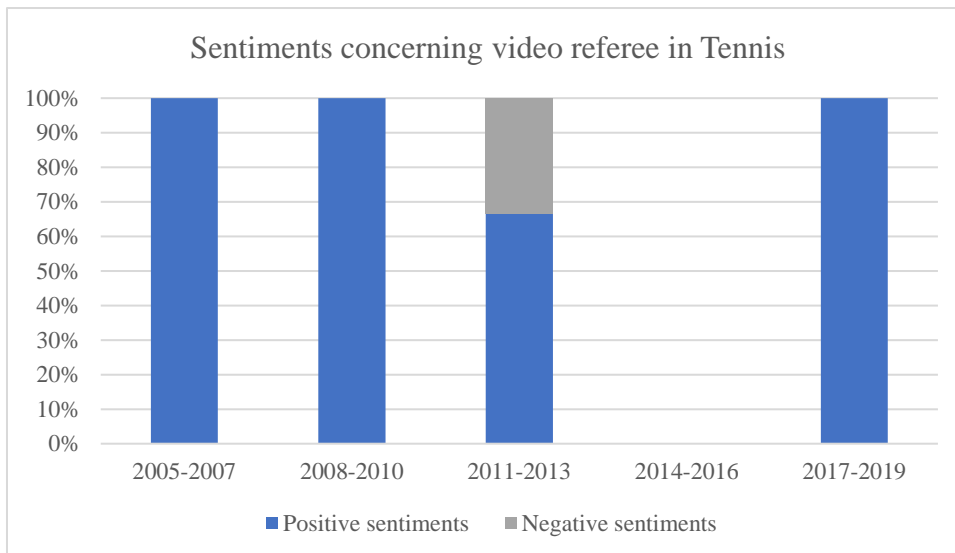
Figure 1: Sentiment development in the tennis case. The higher the percentage, the more positive the sentiment has been.

In the case of *field hockey*, media analysis confirms the positive and optimistic picture sketched in the factual analysis in the paragraphs above. The sample for the period from 2006 till 2011 (ideation and implementation) shows no negative sentiments with regard to the video referee. In the period from 2012 till 2014 one negative article has been found, but the negative tone to the article is assigned to a lack of tension and troublemakers in the Dutch domestic competition. Period 2015-2017 contains only four usable articles, which in itself shows that no relevant issues were present at that time to write about. The final period (2018-2020) again shows one article with negative sentiments, assigned to the elimination of a Dutch team in European competition due to a call made by the video referee. The overall pattern, visualised in Figure 2, thus shows a relatively steady positive sentiment over time. The unprocessed output as retrieved from R can be found in Appendix X.
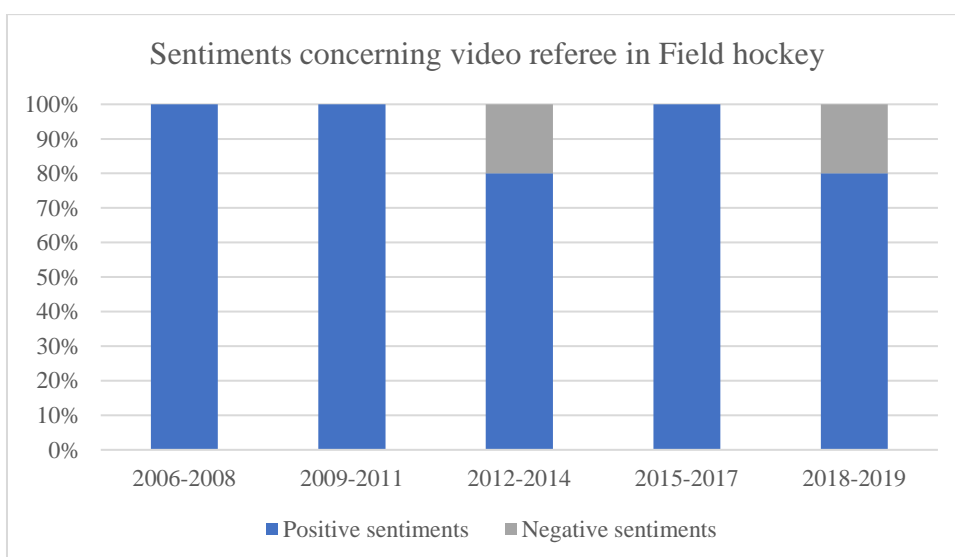

Figure 2: Sentiment development in the field hockey case. The higher the percentage, the more positive the sentiment has been.

The media analysis in the case of *football* shows an interesting pattern. During the period of ideation and the first tests (2012-2014), the majority of articles (approx. 80%) contained a positive sentiment. This became an even larger majority in the period of pilots and testing, during which effectiveness results caused an increased pragmatic legitimacy. From the moment of official implementation on (2018), the sentiment changed for the worse with the majority of the articles having a negative note to them. Deep diving into the analysed articles shows that the lack of in-game transparency was the main reason for this. Both media representatives and spectators had become irritated by the fact that the decision-making process were not made visible and/or audible on television and at the venue. It becomes clear from the combination of interviews and media analysis that there has been given little to no attention to other forms of legitimisation than 'pragmatic legitimisation' by KNVB as the institutional actor group. KNVB has tried to overcome this by introducing 'VAR moment of the week', but the diminishing of positive sentiments is connected to the lack of specifically cognitive legitimacy. This is indicated by the statements made by the Dutch supporters collective and the attempts by KNVB to respond. Also, the articles with a negative tone from 2018 and on are unanimous in their criticism towards the lack of transparency of the video referee operations. The overall pattern, visualised in Figure 3, shows a relatively positive sentiment during the innovation trajectory stages of ideation and implementation, but a relatively negative sentiment during the stage of usage and development. The unprocessed output as retrieved from R can be found in Appendix XI.
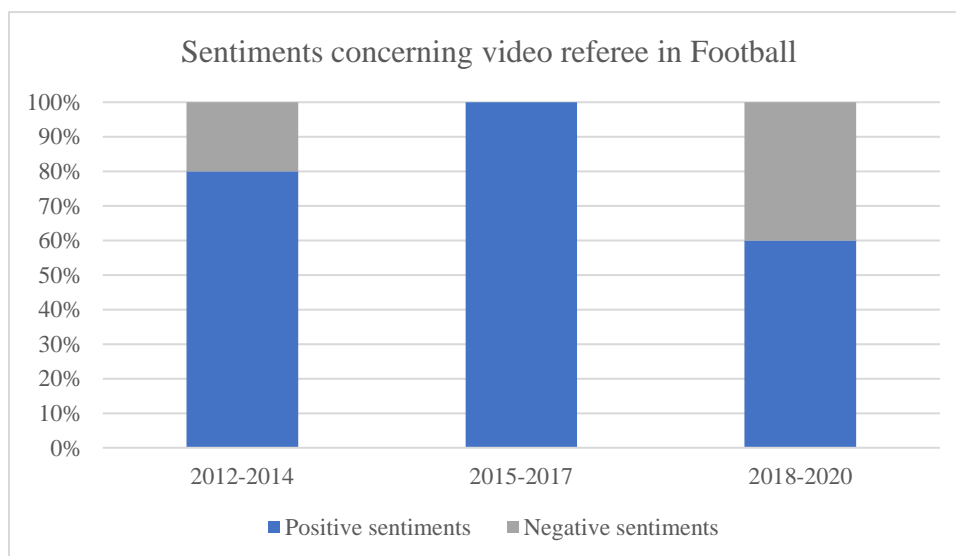
Figure 3: Sentiment development in the football case. The higher the percentage, the more positive the sentiment has been.

4.3.2   Complexity of embedding

Tennis forms the least complex case, with the technology only helping the referee to decide whether a ball has been hit in or out. This also meant that no game rules had to be adapted, only few rules regarding the challenger system had to be implemented. The rules and general setup of the tennis game provides very little room for interpretation, because of the fairly static character (i.e. players have to stay on their side of the net, thereby reducing player interactions). This means that the game rules can be understood

relatively easily by the various actor groups, which in itself aids cognitive legitimacy. The fact that the deployment of the video referee is limited in frequency and amount of actor groups being able to deploy it, enhances this degree of cognitive legitimacy as the limitations do not add to complexity. Another indication for the fact that the technology has not been difficult to embed, is the current producer-user relationship. During this research KNLTB has stated that "…we struggle to contact Hawk-Eye, the relationship is not perfect." It is assumed that, due to the maturity of the institutional innovation, the disturbed relationship does not pose problems. However, Markard et al. (2016) stated that a material technology should adapt to its surroundings continuously for it to become legitimised. Therefore, it is assumed that in a situation with more complexity of embedding, a disturbed user-producer relationship would have caused more trouble. However, both media and interviewees indicate that the technology is functioning according to standards, indicating that the lack of user-producer interaction does not obstruct technology embeddedness and legitimisation in general. This is underpinned by section 4.3.1, in which the media analysis states that after years of positive attention, attention in general diminished which in its turn indicates that no disruptive events have taken place.

Field hockey seems to have the same level of complexity as the football case with a broader application of the video referee and rule interpretations. In order to actively respond to this complexity, FIH has taken some measures. Although the video referee is being applied in a broader way (the variety of situations), its deployment is limited due to the fact that only athletes (and in exceptional cases referees) are allowed to request a review. Also, the number of requests is limited to one per match, thereby making sure that the video referee is only requested when it really matters to the players and thus probably to spectators. Moreover, with regard to limiting its deployment, the video referee can only be used during national play-offs and international tournaments, "because despite not being operated by Hawk-Eye, the video referee remains an expensive system." These limitations make it possible for the field hockey community to comprehend the functioning of the video referee which adds to cognitive legitimacy. A KNLTB representative stated that "field hockey is incredibly difficult for people who do not know much about it. You should therefore not overcomplicate things."

Another response to the complexity is formed by the strictly framed situations in which the video referee is able to interfere, i.e. the 23 metres rule as mentioned in paragraph 4.1.2. The rule interpretation issue is addressed by making agreements on interpretation whenever a doubtful situation has been encountered during a match. These agreements are made by FIH, the referees and the athletes committee. By doing so, it is ensured that no party is not aware of the agreements made on the interpretation of grey areas in the rulebooks. Because of the agreements on interpretations, "less unnecessary and long video referral interruptions have to be made" which causes the match to be both fair and entertaining. Increased comprehension for the game rules and the functioning of the technology increases the degree of cognitive legitimacy, whilst also making sure that the technology performs the way it should.

An additional significant development was the type of technology used for the video referee. At first, tv broadcaster's images were used for review by the video referee. Both hockey players and referees prefer the Hawk-Eye system as it significantly reduces the margin of error and therefore adds to both moral and pragmatic legitimacy. However Hawk-Eye put pressure on the FIH budget, which meant that a switch back to television images had to be made. This was a disappointment for the athletes and the referees because "Hawk-Eye shortened the lead time incredibly." However, the system using television images has not been rejected as it performs well.

Football posed a more complex case as the application of the video referee system is broader than a semi-automatic detection whether the ball is 'in' or 'out' (like tennis). It also entails interpretation of rules, which has proved to be a complex matter. Currently grey areas and clarity in general form the main point of discussion in football as is illustrated by the chairman of the supporters association, who stated that "the VAR is a great addition to the sport as it makes football way fairer, but supporters demand clarity regarding its functioning." The demand for transparency and clarity (simply 'knowing what is going on') is expressed in two ways: rule interpretation issues and deployment issues. Rule interpretation issues diminish the legitimacy of the video referee, both moral and cognitive. Moral legitimacy diminished because of the fact that various similar situations can be judged differently. Cognitive legitimacy diminished due to the fact that actor groups are not aware of the (video) referee's considerations during the decision-making process, which is "a cause for frustration and irritation." The situations the video referee should judge cannot be caught in strict regulatory frameworks, due to interpretation of rules and deliberate degrees of freedom. This is illustrated in paragraph 4.2.3, using the examples of grey areas in the game rules and the fact that the video referee can interfere in every situation in which it thinks the referee on the pitch has made a mistake. Another example of this, is the 'Woudestein' example. At 'Woudestein stadium' it is not possible to set up the so-called '16 metres camera', which is crucial for judging offside situations. "This is most likely to become an issue whenever Excelsior is promoted to Eredivisie again." The differences in i.e. camera protocols are assumed to have an effect on the uniform application of the video referee and thus moral legitimacy. The video referee as a tool is therefore not as useful as it could be, as it is prone to those interpretations of the game rules. Rule changes are made at the start of every new season by FIFA, IFAB and KNVB. These rule changes mainly consider fouls that relatively often require the interference of the video referee, i.e. hands and offside. The attended press briefing showed that KNVB is attempting to make the video referee fit in with existing game rules. However, emphasis was placed on the functioning of the video referee instead of clear agreements on interpretation of the rules which was illustrated by the more than ten almost similar video examples shown. Another issue connected to complexity of embedding, is the unlimited deployment of the video referee. The VAR checks every possible reason for interference, "thereby slowing down the match and spoiling some of the fun." Having the players or team management to call

the VAR into action with a limited frequency is no option according to KNVB, because "it might compromise match results due to already used review requests."

4.3.3 Governing power balance

The factual description of both in-game functioning and the dynamics during the technology implementation phase, offers interesting insights on governance.

In the case of *tennis* ITF holds the power throughout the technology implementation trajectory. European and national tennis associations do not have the authority for changing rules or apply Hawk-Eye in novel ways. The power being centralised, provides clear and uniform regulations all around the world which aids fairness and cognitive legitimacy. However, the athletes committee is there as a controlling organ. Decisions and actions made by FIH need approval of the athletes committee before major changes such as the introduction of Hawk-Eye can be executed.

The case of *field hockey* operates similar to the case of tennis. It is the FIH that holds the power to design, impose and change rules. On top of that, it also controls the budget regarding the video referee. This means that national associations cannot apply the video referee in different ways or intensities. However, the FIH operations are controlled by the athletes committee. Added to the single source of governance in field hockey, is the possibility for agile rule adaptation during the season or tournaments in cooperation with the athletes committee and referees. This phenomenon is closely linked to the degree of complexity of embedding as discussed in 4.3.2, as it provides a dynamic framework in which complexity can be handled. The centralised agreements make sure that there are no differences in rules (interpretations) among national competitions. Moreover, this approach provides every actor group with the information necessary due to the centralised communication, thereby increasing comprehension regarding rules and video referral functioning which enhances cognitive legitimacy through actor group involvement.

Governance in the *football* case consists of multiple organs having institutional power to a certain degree. Rule changes accompanying the introduction of the video referee have been composed by international association FIFA and the rules association IFAB. The athletes committee maintained a passive role during the entire trajectory, being informed by the associations rather than being consulted. On top of that, national associations (i.e. KNVB) have been provided a degree of freedom that allows for individualised implementation, deployment and governance of the video referee. For instance, national associations such as KNVB have the authority to alter the camera setup and make minor rule changes regarding i.e. hands with the latter also often being prone to interpretation. This means that the video referee is by regulations allowed to operate under different and even inferior circumstances, which

is caused by the degree of freedom provided by the international associations and illustrated by the earlier mentioned 'Woudestein case'.

4.3.4   Non-governing actor group involvement

Thirdly, as shown in paragraph 2.1.1, legitimacy finds its basis in a solid support base. In the case of one or more actor groups being excluded from the legitimisation process, legitimacy will be harder to achieve.

Unfortunately, there is very little information available regarding the initiation and actor group involvement in the case of *tennis*. It has become clear though that the athletes committee plays an active and vital role in assessing new technology and rules. Moreover, spectators are directly involved in the in-game decision-making processes by being able to watch the process and see the verdict on-screen. Another well involved actor group is formed by athletes. Firstly, during the initiation the players committee has been consulted. Secondly, athletes hold the power to deploy the video referee technology but on a limited scale thereby not necessarily slowing down the match. The athletes are, however, excluded from some of the information about the technology's functioning which could diminish cognitive legitimacy but possible increase the other types of legitimacy. KNLTB has not informed athletes about the considerable amount of manual operations behind Hawk-Eye as "it could cause them to become distracted and worried about Hawk-Eye's functioning." This means KNLTB has made the deliberate choice to keep information away from end users.

The *field hockey* community also consists of actively involved actor groups. From the start, the most important actor groups were the most important stakeholders which is illustrated by the athletes initiating the entire trajectory. No step was taken without considering spectators and athletes, because the game of field hockey had to be "attractive and fun for those actor groups". The athletes committee and television broadcasters were involved during the ideation stage, during which the focal theme concerned the interests of athletes and spectators. The end-user group of referees however was excluded, which resulted in a certain degree of resistance by the referees as the video referee was seen as a way to publicly correct referral mistakes and not as a supportive innovation. Referees were not consulted in the very beginning due to the concept of having the sport and the athletes central to every case. Throughout the years, by experiencing the usage of the video referee as well as significant rule changes, this attitude from the referees altered towards an attitude in which they embrace the video referee. It can be stated that legitimacy among the different actor groups was well-developed from the start, but the actor group consisting of referees fell behind. It acknowledged the functional effectiveness of the video referee, however the "fear of losing power" can be seen as an underdeveloped degree of cognitive legitimacy as its purpose had not been made clear enough, which is illustrated by that very fear. The conversation between the referees on the pitch and the video referee can be heard at the venue and on television. On

top of that, as the television broadcasters were involved from the very beginning, it is possible for all spectators to watch the exact same video images as the video referee. This transparency greatly affects the degree of cognitive legitimacy as it offers people all the information to come to the conclusion whether they agree with the referee or not. Moreover, in this case the athletes also hold the limited power to deploy the video referee and they are directly involved in solving interpretation issues.

Football started with a smaller amount of actor groups involved compared to the other cases. In fact, the only active actor group was KNVB. Referees and athletes were not being involved in the initial stage of the implementation. The biggest difference compared to the other cases is the lack of transparency. Due to broadcasting rights, spectators are not allowed to watch the VAR's video images. Also, the audio communication is shielded from the outside world. All of this is illustrated in paragraph 4.2.3. The lack of transparency and not knowing what the referees are considering when judging a situation, frustrates athletes and spectators.

In football the number and duration of available review requests is not limited. This results in "matches becoming longer and causing irritation" with spectators, team management and athletes due to the fact that no information about on-going decision-making processes is being shared. It can be stated that the lack of limits in football causes a lower degree of moral legitimacy for football compared to tennis and field hockey. Not because of the video referee making the sport unfair, but "the football community does not appreciate the continuous interference." This causes frustration with athletes, team management and spectators as some decisions can take relatively long and it is unclear what decision-making process is going on.

An overview of the technology legitimisation characteristics, summarising the findings of section 0, has been compiled in Table 15.

Table 15: Technology legitimisation events in the three cases.

Case	Complexity of embedding	Governing power balance	Non-governing actor group involvement
Tennis	Not complex. Limited interpretation of rules. Usage of video referee limited regarding requests and game situations.	Concentrated at the highest level (international associations), controlled by athletes committee. Dynamics in change unknown.	Visualisations shared with actor groups. Athletes committee plays significant role. Strategic sharing of information.
Field hockey	Complex. Often interpretation of rules. Usage of video referee limited regarding requests and game situations. Agreements made on interpretations.	Concentrated at the highest level (international associations), controlled by athletes committee. Agile in change.	Communication and video images shared with actor groups. Athletes committee plays active role. Attractiveness to spectators and athletes is key.
Football	Complex. Often interpretation of rules. Usage of video referee not limited.	Spread, delegation from international to national associations. Static in change.	Communication and video images shielded from actor groups. Athletes committee plays passive role. Seeking to provide more information.

4.4 Legitimisation by institutional actor groups

4.4.1 Tennis

Not much is known about specific strategy deployment in the case of tennis. However, interview analysis has revealed some strategic moves that were intended to increase legitimisation.

The first strategy found revolves around *framing*. This strategy has been deployed during the ideation stage of the innovation trajectory by FIH. Framing was used to paint the picture of the tennis community falling behind in innovation and thus needing an (institutional) innovation like the video referee. The angle was positive: the video referee would "fit the tennis community, because of its progressive people." The effect of this strategy is not known. It is assumed that it has not harmed the innovation trajectory as the video referee has been implemented successfully.

Secondly, *theorisation* has been applied to the innovation trajectory. However, theorisation has been applied in a particular way. It has influenced cognitive legitimacy within the tennis community not necessarily by a providing all information, but selecting and communicating the information necessary to gain legitimacy. According to a KNLTB representative, information about the manual procedures involved in the operation of the video referee has been withheld from spectators and athletes The reason for this is that the information "could have diminished trust in the system," thereby raising questions regarding its functionality and fairness. An overview of the strategies can be found in Table 16. The timeline of the tennis case can be found in Figure 4.

| Legitimisation strategy	Strategy deployment	Trigger	Effect
Framing	Persuading the community that a video referee would fit the community.	Unknown. Assumed that other sports served as example.	Unknown. Assumed not to have harmed the trajectory progress and gained overall legitimacy.
Theorisation	Shielding information that could affect trust in the system from actor groups.	Discovery of manual operations in Hawk-Eye decision-making process.	Actor groups are unaware, but cognitive legitimacy has increased.
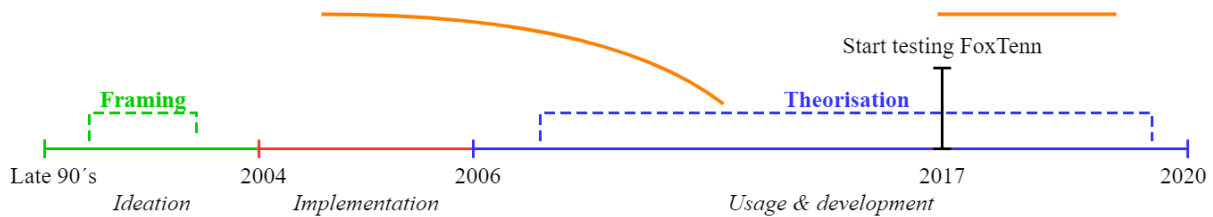
Figure 4: Innovation trajectory timeline in the tennis case.

4.4.2 Field hockey

In field hockey, *framing* took place during the ideation stage. However, the framing strategy was utilised by two actor groups.

At first the athletes committee, representing an important user actor group, framed the then current situation without video referee as inferior. This led to a request for video referee implementation at the most prominent institutional actor group: FIH. FIH gathered the task force as described in paragraph 0, convincing the actor groups involved that the question "How to make the sport better?" should be answered.

The strategy type *theorisation* has been applied by FIH.

It is a continuously deployed strategy in the form of maintaining complete transparency about the in-game decision-making processes. Spectators, at the venue and at home, are able to see the same video images as the video referee. Moreover, the live communication between the referee and the video referee is broadcasted at the venue and on television. According to a KNHB representative, this serves the purpose of involving the most important actor groups (athletes and spectators) in the process. The KNHB representative also stated that this transparency does not have the goal to convince athletes and spectators that the decision is always correct, but to let them make up their own minds based on the information the referee and video referee receive.

The final type of legitimisation strategy deployed within the field hockey community revolves around *collaboration*.

The stage of ideation also contained an element of collaborating strategy deployed by FIH. From the start it was FIH's purpose to serve the interests of athletes and spectators. It therefore immediately sought collaboration in different forms at those actor groups. Collaboration with athletes was achieved by cooperating with the athletes committee. Collaboration with spectators was achieved through involving television broadcasters at the very start of the innovation trajectory, as television broadcasters were vital to reach the vast group of spectators at home and in general to deliver the video images needed for the referees.

Further down the road, during the stage of usage and development, the field hockey community sometimes ran into video referee related issues such as the interpretation of rules. In some cases this led to searching for knowledge and solutions externally, i.e. at football association FIFA. The basis of this search was, according to a KNHB representative, the idea of "look for someone who does it better, copy it and then improve it." This exchange of knowledge shows that FIH realises that it does not have all the answers to more complex video referee relate matters. An overview of the strategies can be found in Table 17. The timeline of the field hockey case can be found in Figure 5.

Table 17: Legitimisation strategies as deployed in the field hockey case.

| Legitimisation strategy	Strategy deployment	Trigger	Effect
Framing	Statement and request for a video referee	Athletes framed the old situation as inferior	Task force development by FIH, creating general legitimacy.
Theorisation	Transparency regarding video images and communication between referee and video referee.	Unknown. Assumed that focus on athletes and spectators sparked this strategy.	Actor groups better understand the decision-making process. Cognitive legitimacy has increased.
Collaboration I	Seeking expertise, input and feedback at community actor groups.	Athletes, television broadcasters and spectators were focal and therefore crucial to FIH.	Start of making the video referee a transparent innovation. Cognitive legitimacy has increased. Exclusion of referees.
Collaboration II	Seeking expertise, input and feedback externally.	Insufficient knowledge in the case of issues related to usage.	Increase knowledge absorption from other sports communities, thereby increasing functionality.
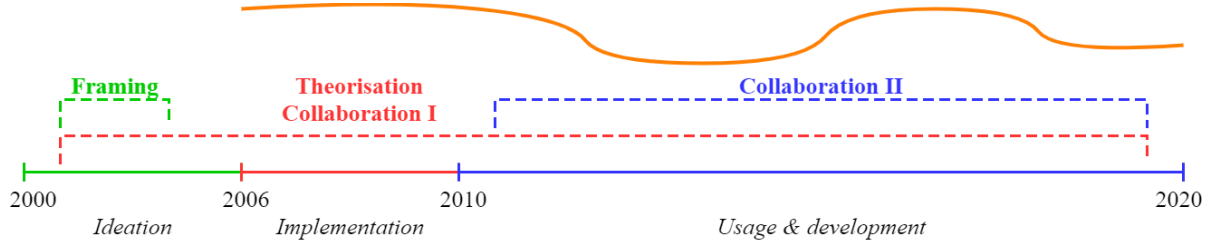
Figure 5: Innovation trajectory timeline in the field hockey case.

4.4.3 Football

The video referee system being an institutional innovation, institutional actor groups are most likely to have played an active role in the legitimisation process. KNVB has applied different legitimisation strategies over the entire implementation trajectory in order to increase the degree of legitimacy of the institutional innovation.

Framing has been applied in two different manners. During the stage of ideation, the DCR manager attempted to convince high-level FIFA officials that the then current situation in which no video referee was present, was inferior to the potential situation in which one was present. This approach was based on a strong belief in following other successful video referee implementations, but the DCR manager encountered resistance with this approach.

The second framing strategy that was applied was based on an attempt to convince spectators, via mainstream media, that the situation in which the video referee is far superior to the situation without. This strategy has been used throughout the entire trajectory, from pilots until usage today. This has been attempted by an annual presentation of video referee effectiveness figures, i.e. corrected referral mistakes and withdrawn red cards. KNVB appeared to maintain a critical approach during the presentation of these figures during the attended press briefing, by providing critical commentary with some figures and stating that "these definitely need to be improved." However, when asked, the benchmarking method remains rather unclear: "We compare with other European domestic competitions and our own track record, and all of our figures are in line with the European figures."

During the phase of usage and development, *theorisation* has been used by means of 'VAR moment of the week'. Criticism regarding the vagueness in interpretation of the rules emerged which caused KNVB to respond with a series of online video publications on social media. In the period of August 2019 till March 2020 on Twitter, a match moment during which the video referee acted was published on a weekly basis. This could either be a correct or an incorrect interference by the video referee. KNVB then provided context and explanation about the decision-making process so that actor group 'spectators' could gain insights in the process and form an opinion. This strategy was terminated in March 2020 for unknown reasons.

In terms of *collaboration*, interesting choices have been made. It is not known whether the choice was deliberate, but it became clear from the description of the ideation process that little cooperation took place at that point in time. Two user groups, athletes and referees, were mainly not actively involved in the ideation stage. Some referees were involved during the pilots and tests. It was in the stage of usage and development that both user groups were asked for feedback. The reason for not involving these two actor groups actively is unknown.

During the stage of usage and development in particular, KNVB chose intentionally not to cooperate with other sports communities whilst improving the institutional innovation. This means that knowledge

spill-overs from other sports, i.e. field hockey, were not integrated in the knowledge of KNVB. The reason for the choice of not cooperating lies within the perception of KNVB that other sports operate on a "significantly different scale." KNVB therefore assumes that solutions from other sports are not applicable to the case of football and therefore limits cooperation to exchanging information with other national competitions within the football community.

The final type of strategy that has been identified is *lobbying*. It has been applied in two ways. The first variant shows up in the ideation stage. The DCR manager attempted to persuade FIFA to start introducing the video referee in football. Questions, as described in paragraph 4.2.3, were posed however and showed hesitation and doubt in the top-level management of FIFA. The DCR manager then changed the focus of his lobby at FIFA, from an emphasis on having the video referee to an emphasis on investigating the possibilities of such an innovation in football. This attempt proved to be successful, but the obtained degree of freedom in video referee application and deployment posed issues as described in paragraph 4.3.3.

During the stage of usage and development another successful lobby at FIFA has been conducted. KNVB designed camera protocols for a correct and uniform usage of the video referee. However, at several stadiums the official setup could not be implemented at every venue at the same time by television broadcaster ESPN. KNVB attempted to solve this problem by installing its own cameras, but even so official protocols could not always be maintained. This meant that KNVB had to lobby at FIFA for dispensation to use the video referee without official camera protocol. Interview output and speech intonation suggested that this lobby was fairly easy. An overview of the strategies can be found in Table 18. The timeline of the football case can be found in Figure 6Figure 5.

Table 18: Legitimisation strategies as deployed in the football case.

| Legitimisation strategy	Strategy deployment	Trigger	Effect
Framing I	Convincing FIFA officials to consider video referee implementation.	Other sports having successfully implemented the video referee.	Reluctant FIFA officials.
Framing II	Presentation of effectiveness figures via mainstream media to spectators and media.	No specific trigger.	Effect is unknown, but video referee's functionality seems not be doubted so it is likely not to have damaged legitimacy.
Theorisation	Publication of video items on social media explaining (in)correct video referee decisions.	Criticism regarding the lack of in-game video referee transparency.	Effect is unknown, but it is assumed that this strategy has not increased legitimacy due to its sudden termination and on-going criticism regarding transparency.
Collaboration I	Not involving end user groups in the ideation stage.	No specific trigger.	Resistance from referees in particular, missing input from athletes.
Collaboration II	Not cooperating with other sports communities that already had a video referee system in place.	"Scale difference"	Direct effect is unknown, but best practice input is missing.
Lobbying I	During ideation, shifting emphasis from implementation to investigation.	Resistance by FIFA officials.	Permission to start pilots and a degree of freedom in deploying the video referee.
Lobbying II	Asking for permission at FIFA to deploy the video referee even though protocols could not be maintained.	Stadiums being unsuitable for uniform video referee deployment.	Permission granted by FIFA and thus an additional degree of freedom in video referee deployment.
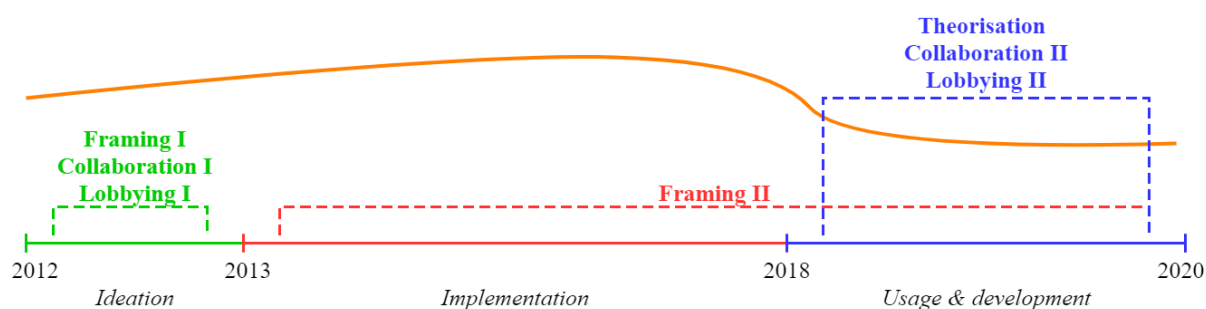
Figure 6: Innovation trajectory timeline in the football case.

5 Conclusion and discussion

5.1 Conclusion

The research question for this thesis was: *How are the different degrees of legitimacy of the video referee in different sports communities established and what is the influence of sports associations on legitimisation?*

The answer to this question has been found by conducting a mainly qualitative multiple-case study. The development of legitimacy throughout the cases has been analysed making use of sentiment analysis in mainstream media coupled to a qualitative analysis. The qualitative analysis contained a detailed description of interactions between actor groups and the innovation, both in-game and during the entire innovation trajectory. These interactions and their respective influences were linked to the respective sentiment developments in each case. Finally, legitimisation strategies deployed by associations were identified and their respective effects on legitimacy development were assessed.

It is concluded that particular types of *interactions* play a major role in legitimisation of the institutional innovation in these three cases.

Firstly, *in-game involvement of actor groups* appears to play a significant role in two ways. The analysis of in-game interactions shows that different combinations of actor type, interaction direction and effect type occur throughout the cases. From these combinations it becomes apparent that legitimacy can increase when *end user actor groups* have the power to deploy the video referee, whilst an increased power and influence of the video referee on game progress is likely to contribute to loss of (particularly moral and cognitive) legitimacy. Differences among the cases can also be assigned to the (lack of) involvement of *non-institutional actor groups*. The cases in which the video referee's decision-making process is shared with spectators, athletes and team management, have also obtained the highest degrees of legitimacy. Transparency regarding the in-game decision-making process, by making video images visible and inter-referee communication audible, appears to make the sports community aware of how decisions come into being and can thereby increase cognitive legitimacy with spectators in particular.

Secondly, *innovation trajectory involvement of user actor groups* revolves around crucial interactions in the first stage of the innovation trajectory. It has become apparent that during the stage of ideation, end-user groups can cause resistance if they are not consulted when the introduction of an innovation is being considered by the institutional actor group. This degree of resistance can be a cause for decelerated progress in legitimisation.

Several causes, besides the causes that directly link to interactions as mentioned above, can be assigned to the *differences in degrees of legitimacy* of the institutional innovations.

Legitimacy appears to increase more easily when the *embeddedness complexity* has been diminished, making it easier for the innovation to settle within the already existing regulatory and institutional frameworks. Decreasing complexity has been achieved in two of the three cases by limiting the possible applications of the video referee. This has been achieved by imposing regulations that limit the in-game usage of the video referee to end user actor groups, frequency of deployment and/or clearly defined situations in which the video referee is allowed (and not allowed) to interfere.

On the subject of governance, it becomes apparent that the cases with a higher degree of legitimacy concentrate the *governing power* at the highest, international associations. These associations govern the innovation and thereby provide consistency and clarity regarding the institutions surrounding the video referee. Contrary to this is the case with a very much balanced governing power, in which the international association provided an increased degree of freedom to the national association regarding developing and imposing regulations on national level thereby possibly deviating from other regulatory frameworks.

The last part of the research question concerns the effects of the *legitimisation strategies* as deployed by institutional actor groups. All cases have been subject to *framing* by the institutional actor groups which correlates with positive sentiments throughout the three cases, indicating that framing the then current situation as 'inferior' is a vital starting point in the legitimisation process.

Also, *collaboration* plays a role. The choice to not collaborate with actor groups within the sports community and external actor groups appears to correlate with decreased legitimacy. Cases in which collaboration was used, have maintained positive sentiments. This phenomenon also links to the earlier mentioned involvement of non-institutional actor groups. Concentrated usage of multiple strategies during a single stage of the innovation trajectory, mainly as a reaction to decreasing legitimacy, appears to be counterproductive and decrease legitimacy. A spread and apparently coordinated deployment of strategies throughout the entire innovation trajectory does not appear to diminish legitimacy.

5.2 Discussion

The outcomes of this research have provided further empirical evidence for the development of an innovation's legitimacy in sports. Moreover, further empirical evidence has been found for the actual deployment of several legitimisation strategies as defined by Pelzer et al. (2019) by governing bodies in each sports community. The synergy provided an angle from which legitimacy development has been studied based on interactions between critical actor groups and the innovation in question. This made it possible to identify the roles and importance of each actor group during the different stages of an innovation trajectory, instead of maintaining a general view on acceptance without addressing actor group involvements.

This research further contributes to innovation science literature in two ways. Firstly, Hargrave & Van de Ven (2006) address the adoption and acceptance of technology as part of the innovation and do acknowledge the role of institutional actor groups. However the role of users and producers remains underexposed, not only by Hargrave & Van de Ven (2006) but by Suchman (1995) and Markard et al. (2016). The results of this research provide more clarity about the role of the various actor groups and how their respective interactions with the innovation influence the development of legitimacy. The institutional view was enriched with a sociomaterial perspective, which made it possible to address more than a single actor group, i.e. institutional actors or users only. Thereby, the influence of interactions between the innovation in question and both institutional and non-institutional actor groups have become clear.

Secondly, development of legitimisation has been investigated by Pelzer et al. (2019) but with a specific focus on the functioning of a single institutional entrepreneur attempting to change regulations and the respective outcomes of that attempt. Although the work by Pelzer et al. (2019) is a step forward compared to earlier institutional work only acknowledging institutional context in general (Geels, 2004), the focus of Pelzer et al. (2019) does not extensively address the roles of users and producers. This research provides an expansion on this by also identifying the, mainly user and producer, actor groups at which the legitimisation strategies were aimed and analysing their respective responses. Again, this has been the consequence of enriching the institutional view with a sociomaterial angle revealing the interactions that took place.

Considering the importance of interactions with actor groups, this research also entails practical implications for innovation developers and sports associations. It has been shown that actor group involvement in the various stages of the innovation trajectory is important. It is therefore recommended that stakeholder identification and analysis is conducted when considering to implement an innovation. Stakeholder analysis will reveal the interests and demands of the various actor groups and thereby provide guidance for making the innovation congruent with the community's norms which is necessary for legitimising an innovation (Binz et al., 2016; Pelzer et al., 2019).

A second recommendation would be determining how an innovation should be deployed at the start of the innovation trajectory, which is closely linked to diminishing the complexity of embedding. Results have indicated that few and/or minor regulatory changes after implementation are acceptable but many and/or major regulatory changes with regard to i.e. video referee deployment or transparency are likely to be preceded by resistance from one or more actor groups. This implies that careful strategic planning, i.e. by means of road mapping years ahead in combination with scenario planning, could provide insights into legitimacy development and thereby provide suggestions to address complexity of embedding.

In terms of the research process, a strength of this research lies in its approach that revolves around consulting a variety of sources. As this research has been qualitative by nature, validity of the results had to be ensured by refraining from collecting data at a single source. This helped in finding and explaining differences between the cases, due to the fact that interviews with experts or informal conversations during attended events could confirm or reject findings obtained in i.e. official documentation.

Secondly, the article selection procedure has been conducted partially manually. After making use of the search queries, it still needed to be checked whether the articles found were actually about the video referee and accompanying sentiments. This enhanced the quality of the sample. The search queries themselves were well framed, so a possible bias is likely to be minor.

A first potential limit has been identified as the unequal development of implementation trajectories. All three cases had timelines of varying length. For instance, Hawk-Eye in tennis was officially implemented more than a decade earlier than football's VAR. This could mean that the football trajectory is in a less mature state compared to the tennis case. It is therefore recommended to reproduce this research in a few years from now, to create a new overview of the different timelines and their development.

The second potential limit can be appointed to the actor group focus in this research. Although it has been attempted to be objective and increase validity by means of a variety of data collection methods, the current focus of the research is mainly aimed at the perspective of the sports associations. Most interviews have been conducted with their respective representatives. This results in a potentially stronger focus on the perceptions of the sports associations and a less strong focus on the viewing points of athletes and the role mainstream media play in creating sentiments. It is therefore recommended that future research addresses this issue. A sociological approach to community and media behaviour is needed, in addition to the angle provided by innovation sciences.

Few operational improvements with regard to the research process could be made in the future. Firstly, the usage of R has been logical as it is a comprehensible piece of software and versatile in deployment due to the packages developed by other users. However, the used package 'Syuzhet' relies on a piece of basic open-source software recognising words and sentiments. An individual analysis by an expert would have been more reliable, but as the media analysis is supportive rather than leading, the currently used method suffices.

It should be mentioned that part of the findings may be partially explained by other factors that have not been investigated. New insights might be obtained by conducting the same research with other cases. A comparison between i.e. judo, not being a ball sport, and sports such as rugby could provide new angles. Another explanation for differences in legitimacy might have been the sociocultural characteristics of each sports community. Elements such as educational backgrounds, a community's natural conservativeness towards innovations and other sociological factors might explain acceptance from a different angle than innovation sciences.

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Appendix I – Official documentation: overview

Case	Document designation	Document type
Tennis	KNLTB Regulations 2020	KNLTB Game rules
	Regulations update January 2020	Game rules
Field hockey	Regulations 2017	Game rules
	Regulations 2015	Game rules
	KNVB Regulations 2018-2019	KNVB Game rules
Football	KNVB Regulations 2019-2020	KNVB Game rules
	KNVB Regulations 2020-2021	KNVB Game rules
	Seasons 18-19 in figures	KNVB effectiveness figures

Appendix II – Interview protocol

Opening

    a. Interview conductor background
-       i. Self-introduction
-       ii. Purpose of the interview
-       iii. Link to informed consent

    b. Interviewee background
-       i. What is your occupation at the organisation?
-       ii. What is the most direct relation to a/the video referee system you have?

Leading questions and themes

    c. **What parties and actors are involved with both implementation as well as usage of the video referee system?**
Themes:
-       i. Involved when implementing the video referee system
-       ii. Involved when using the video referee system
-       iii. Involved when evaluating/changing the video referee system

    d. **How would you describe the process from introduction of the video referee system up until now?**
Themes:
-       i. Consideration and initiation of technology implementation
-       ii. Implementation process itself
-       iii. Substantiated rights and wrongs during the process
-       iv. Contact with stakeholders, other sports and experts

    e. **Common positive and negative opinions from actors identified in question 2a.**
-       i. Reasons/underlying feelings behind these opinions (negative & positive)

    f. **Opinion trends/changes throughout the years**
-       i. Would you describe the video assistant referee as relevant at the moment?
-       ii. Do you expect changes in your perceived legitimacy? If so, why?
-       iii. Are there significant plans for change in usage in the future?

    g. **About the technology itself**
-       i. Can the system be used in literally every match/venue?
-       ii. Rules have obviously been developed in order to make Hawk-Eye fit in the game. Have there also been alterations to already existing rules? (i.e. changes in older rules like offside or other punishable acts)

    h. **Legitimisation strategies by association**
5 types: framing, theorisation, collaboration, lobbying, negotiation
-       i. Framing: Emphasise how bad the situation without VAR is.
-       ii. Theorisation: Paint the picture of the hypothetical implementation of VAR.
-       iii. Collaboration: Involving stakeholders and other frontrunners.
-       iv. Lobbying: Getting high-level association members on your side as well as media (political powers!)
-       v. Negotiation: trying to meet halfway with parties reluctant to have VAR.

Closure

Appendix III – Document coding scheme: In-game

Category	Code	Secondary code	Example label
Actor group designation	User	Athletes	"Players"
		Referees	"Match official"
		Spectators	"People in the stadium"
		Other officials	"AVAR"
	Producer	Manufacturer	"Hawk-Eye"
		Broadcaster	"ESPN"
Direction of interaction	One-way	Pre-match two-way	"ESPN provides the technology in advance"
		Not authorised to act	"…not allowed to request a review."
	Two-way	Consultation	"…is advised but is able to overrule."
Effect type	Direct	Influences match result	"…he may rectify the referee's mistake."
		Influences tactics	"the outcomes could influence team performance"
	Indirect	Not influencing match result	"People see the outcomes and don't understand."

Appendix IV – Document coding scheme: Innovation trajectory

Category	Code	Secondary code	Example label
Actor group designation	User	Athletes committee	"Player representatives"
		Referees	"Ref"
	Institutional	National association	"KNVB"
		International association	"IFAB"
		Spectators	"People in the grandstands"
Trajectory stage	Introduction	Ideation	"They were the ones who came up with the initiative."
		Qualification	"Effectiveness demands"
		Initial resistance	"Immediate resistance by referees"
	Implementation	Pilots & testing	"If the effectiveness figures suffice…"
		Implementation resistance	"FIFA posed questions regarding implementation…"
	Usage & development	Usage experience	"This made the entire decision-making process so much shorter."
		Criticism	"At first, they could challenge every situation. It was horrible."
		Evaluation	"Sometimes we send out a questionnaire…"

Appendix V – Interview coding scheme: Degrees of legitimacy

Category	Primary code	Secondary codes	Example label
Complexity of embedding	Pragmatic legitimacy	Formal regulations	"camera protocols"
		Effectiveness	"…video referee has corrected X% of referral errors."
	Moral legitimacy	Consensus on rule interpretation	"…bringing several parties…together to discuss interpretation…"
		Fairness regulations	"We only apply the video referee during international tournaments and national play-offs."
		Degree of pleasure	"Players could request an unlimited amount of reviews at any time, it was horrible."
	Cognitive legitimacy	Demand for clarity	"People at home want to know what is happening."
Governing power balance	Moral legitimacy	Rule ambiguity	"The grey areas cause similar situations to be judged differently every time."
		Agile governance	"If we run into problems, FIH allows for quick problem solving by rule changes."
	Cognitive legitimacy	Controlling organ	"We gather all parties involved so that they are informed from the start…"
Non-institutional actor group involvement	Pragmatic legitimacy	Perception of effectiveness	"We can all agree that the VAR functions, but…"
	Moral legitimacy	Perception of fairness	"Sometimes we send out questionnaires concerning the VAR…"
		Perception of pleasure	"…but the endless interference is annoying."
	Cognitive legitimacy	User involvement	"The athletes committee was the initiator of the trajectory…"
		Producer involvement	"We have trouble getting in touch with Hawk-Eye ourselves."
		Spectator involvement	"We cannot share the communication between the referee and the VAR…"

Appendix VI – Interview coding scheme: Legitimisation

Category	Primary code	Secondary codes	Example label
Strategy type	Framing	-	"Inferior situation"
	Theorisation	-	"VAR moment of the week"
	Collaboration	-	"Knowledge exchange with FIFA"
	Lobbying	-	"Permission to deviate from camera protocols"
Strategy deployment	Actor group deploying	Institutional actor group	"DCR manager"
		User group	"Athletes committee"
	Method	Communication	"Broadcasting communication between the referees"
		Cooperation	"We tend not to work together with other sports, we differ too much."
		Feedback inquiry	"…people could then give their opinion on Twitter."
Effect	Positive	Increased legitimacy	"People then understood what was happening."
		Increased knowledge	"We look somewhere else, copy it and then improve it."
	Negative	Decreased legitimacy	"FIFA and IFAB started posing difficult questions…"
		Plausibly decreased legitimacy	"The VAR of the week project was then terminated, but I do not know why exactly."
Trigger event	Initiative	Not reaching out	"Scale difference"
		Active involvement	"The athletes committee contacted the FIH."
	Reaction	Response to criticism	"People complained about the lack of transparency."

Appendix VII – R Studio protocol

 # Start-up

library(tm)

library(syuzhet)

library(SnowballC)

library(dplyr)

#Enable text tidying

toSpace <- content_transformer(function (x , pattern) gsub(pattern, " ", x))

#Loading & reading articles

setwd("~/R Thesis 2021/*Case name*/*Temporal scope*")

Artikel1<-readLines("*Title*.txt")

Art_1<-Corpus(VectorSource(Artikel1))

Artikel2<-readLines("*Title*.txt")

Art_2<-Corpus(VectorSource(Artikel2))

Artikel3<-readLines("*Title*.txt")

Art_3<-Corpus(VectorSource(Artikel3))

Artikel4<-readLines("*Title*.txt")

Art_4<-Corpus(VectorSource(Artikel4))

Artikel5<-readLines("*Title*.txt")

Art_5<-Corpus(VectorSource(Artikel5))

#Tidying

 # Copy these code lines for Art_2, Art_3, Art_4 and Art_5

Art_1<- tm_map(Art_1, toSpace, "/")

Art_1<- tm_map(Art_1, toSpace, "@")

Art_1<- tm_map(Art_1, toSpace, "\\|")

Art_1<- tm_map(Art_1, content_transformer(tolower))

Art_1<- tm_map(Art_1, removeNumbers)

Art_1<- tm_map(Art_1, removeWords, stopwords("dutch"))

Art_1<- tm_map(Art_1, removePunctuation)

Art_1<- tm_map(Art_1, stripWhitespace)

Art_1<- tm_map(Art_1, stemDocument)

#Analysis

 # Copy these code lines for Art_2, Art_3, Art_4 and Art_5

syuzhet_vector1 <- get_sentiment(Art_1, method="syuzhet", path_to_tagger = NULL, language = "dutch")

summary(syuzhet_vector1)

##

Appendix VIII – Informed consent form

Utrecht University **INFORMED CONSENT FORM** for participation in:

Fast Forward - Development of technological legitimacy in sports communities

To be completed by the participant:

I confirm that:
- I am satisfied with the received information about the research;
- I have been given opportunity to ask questions about the research and that any questions that have been risen have been answered satisfactorily;
- I had the opportunity to think carefully about participating in the study;
- I will give an honest answer to the questions asked.

I agree that:
- the data to be collected will be obtained and stored for scientific purposes;
- the collected, completely anonymous, research data can be shared and re-used by scientists to answer other research questions;
- video and/or audio recordings may also be used for scientific purposes.

I understand that:
- I have the right to withdraw my consent to use the data;
- I have the right to see the research report afterwards.

Name of participant: _____

Signature: _____   Date, place: ___ / ___ / ____, _____

To be completed by the investigator:

I declare that I have explained the above mentioned participant what participation means and the reasons for data collection. I guarantee the privacy of the data.

Name: _____

Date: ___ / ___ / _____ (dd/mm/yyyy)

Signature:

Appendix IX – Sentiment analysis output Tennis

2005-2007

5 out of 5 articles with positive sentiments.

```
> summary(syuzhet_vector1)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
 0.0000  0.0000  0.0000  0.5167  0.7750  1.5500
> summary(syuzhet_vector2)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
 0.0000  0.0000  0.0000  0.2167  0.3250  0.6500
> summary(syuzhet_vector3)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
0.00000 0.00000 0.00000 0.08333 0.12500 0.25000
> summary(syuzhet_vector4)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
  0.000   0.000   0.000   0.350   0.525   1.050
> summary(syuzhet_vector5)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
 0.0000  0.0000  0.0000  0.7333  1.1000  2.2000
```

2008-2010

5 out of 5 articles with positive sentiments.

```
> summary(syuzhet_vector1)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
  0.000   0.000   0.000   1.233   1.850   3.700
> summary(syuzhet_vector2)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
 0.0000  0.0000  0.0000  0.7333  1.1000  2.2000
> summary(syuzhet_vector3)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
  0.000   0.000   0.000   0.350   0.525   1.050
> summary(syuzhet_vector4)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
 0.0000  0.0000  0.0000  0.2667  0.4000  0.8000
> summary(syuzhet_vector5)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
 0.0000  0.0000  0.0000  0.2667  0.4000  0.8000
> |
```

2011-2013

2 out of 3 articles with positive sentiments.
1 out of 3 articles with negative sentiments.

```
> summary(syuzhet_vector1)
    Min.  1st Qu.   Median     Mean  3rd Qu.     Max.
-0.25000 -0.12500  0.00000 -0.08333  0.00000  0.00000
> summary(syuzhet_vector2)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
 0.0000  0.0000  0.0000  0.4667  0.7000  1.4000
> summary(syuzhet_vector3)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
 0.0000  0.0000  0.0000  0.7333  1.1000  2.2000
```

2017-2019

2 out of 2 articles with positive sentiments.

```
> summary(syuzhet_vector1)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
 0.0000  0.0000  0.0000  0.3833  0.5750  1.1500
> summary(syuzhet_vector2)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
    0.0     0.0     0.0     0.2     0.3     0.6
```

Appendix X – Sentiment analysis output Field hockey

2006-2008

5 out of 5 articles with positive sentiments.

```
> summary(syuzhet_vector1)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
 0.0000  0.0000  0.0000  0.6333  0.9500  1.9000
> summary(syuzhet_vector2)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
 0.0000  0.0000  0.0000  0.5667  0.8500  1.7000
> summary(syuzhet_vector3)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
 0.0000  0.0000  0.0000  0.4333  0.6500  1.3000
> summary(syuzhet_vector4)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
 0.0000  0.0000  0.0000  0.6833  1.0250  2.0500
> summary(syuzhet_vector5)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
 0.0000  0.0000  0.0000  0.2667  0.4000  0.8000
```

2009-2011

5 out of 5 articles with positive sentiments.

```
> summary(syuzhet_vector1)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
      0       0       0       2       3       6
> summary(syuzhet_vector2)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
    0.0     0.0     0.0     1.4     2.1     4.2
> summary(syuzhet_vector3)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
   0.00    0.00    0.00    0.70    1.05    2.10
> summary(syuzhet_vector4)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
    0.0     0.0     0.0     0.4     0.6     1.2
> summary(syuzhet_vector5)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
 0.0000  0.0000  0.0000  0.9167  1.3750  2.7500
> |
```

2012-2014

4 out of 5 articles with positive sentiments.
1 out of 5 articles with negative sentiments.

```
> summary(syuzhet_vector1)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
0.00000 0.00000 0.00000 0.01667 0.02500 0.05000
> summary(syuzhet_vector2)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
    0.0     0.0     0.0     0.6     0.9     1.8
> summary(syuzhet_vector3)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
    0.0     0.0     0.0     0.6     0.9     1.8
> summary(syuzhet_vector4)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
-0.7000 -0.3500  0.0000 -0.2333  0.0000  0.0000
> summary(syuzhet_vector5)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
 0.0000  0.0000  0.0000  0.2167  0.3250  0.6500
```

2015-2017

4 out of 4 articles with positive sentiments.

```
> summary(syuzhet_vector1)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
 0.0000  0.0000  0.0000  0.2667  0.4000  0.8000
> summary(syuzhet_vector2)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
   0.00    0.00    0.00    0.70    1.05    2.10
> summary(syuzhet_vector3)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
 0.0000  0.0000  0.0000  0.2667  0.4000  0.8000
> summary(syuzhet_vector4)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
  0.000   0.000   0.000   1.050   1.575   3.150
```

2018-2020

4 out of 5 articles with positive sentiments.
1 out of 5 articles with negative sentiments.

```
> summary(syuzhet_vector1)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
-0.8500 -0.4250  0.0000 -0.2833  0.0000  0.0000
> summary(syuzhet_vector2)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
 0.0000  0.0000  0.0000  0.5333  0.8000  1.6000
> summary(syuzhet_vector3)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
 0.0000  0.0000  0.0000  0.1833  0.2750  0.5500
> summary(syuzhet_vector4)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
  0.000   0.000   0.000   1.017   1.525   3.050
> summary(syuzhet_vector5)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
 0.0000  0.0000  0.0000  0.7833  1.1750  2.3500
```

Appendix XI – Sentiment analysis output Football

2012-2014

4 out of 5 articles with positive sentiments.
1 out of 5 articles with negative sentiments.

```
> summary(syuzhet_vector1)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
 0.0000  0.0000  0.0000  0.2667  0.4000  0.8000
> summary(syuzhet_vector2)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
 0.0000  0.0000  0.0000  0.5333  0.8000  1.6000
> summary(syuzhet_vector3)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
 -0.450  -0.225   0.000  -0.150   0.000   0.000
> summary(syuzhet_vector4)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
   0.00    0.00    0.00    0.10    0.15    0.30
> summary(syuzhet_vector5)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
 0.0000  0.0000  0.0000  0.1333  0.2000  0.4000
```

2015-2017

5 out of 5 articles with positive sentiments.

```
> summary(syuzhet_vector1)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
  0.000   0.000   0.000   0.050   0.075   0.150
> summary(syuzhet_vector2)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
 0.0000  0.0000  0.0000  0.3167  0.4750  0.9500
> summary(syuzhet_vector3)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
 0.0000  0.0000  0.0000  0.2667  0.4000  0.8000
> summary(syuzhet_vector4)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
    0.0     0.0     0.0     0.2     0.3     0.6
> summary(syuzhet_vector5)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
 0.0000  0.0000  0.0000  0.5333  0.8000  1.6000
```

2018-2020

3 out of 5 articles with positive sentiments.
2 out of 5 articles with negative sentiments.

```
> summary(syuzhet_vector1)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
  0.000   0.000   0.000   0.150   0.225   0.450
> summary(syuzhet_vector2)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
 0.0000  0.0000  0.0000  0.5333  0.8000  1.6000
> summary(syuzhet_vector3)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
 -1.050  -0.525   0.000  -0.350   0.000   0.000
> summary(syuzhet_vector4)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
  0.000   0.000   0.000   0.650   0.975   1.950
> summary(syuzhet_vector5)
    Min.  1st Qu.   Median     Mean  3rd Qu.     Max.
-0.25000 -0.12500  0.00000 -0.08333  0.00000  0.00000
> |
```