One App to Test Them All - Opportunities and Challenges of Implementing a Remote Sampling System in Anti-Doping Work

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Abstract

Triggered by the Covid-19 pandemic and driven by the need to save financial and environmental resources when conducting in-person anti-doping tests, a remote sampling system (RSS) was developed that may foster the digital transformation of anti-doping work. Since research on factors affecting RSS implementation is limited, we apply the Extended Valence Framework (EVF) with decomposed core constructs as the theoretical lens to qualitatively examine perceived benefits, risks, and trust perceptions associated with RSS implementation from multiple organizational perspectives. Interviews with twelve C-level representatives of anti-doping organizations indicate support for RSS implementation, as interviewees perceive a positive net balance of benefits and risks. However, the regulatory authority expressed skepticism due to perceived risks and limited trust perception. Our results contribute to IS research by providing a contextualized EVF for future qualitative and quantitative research. Moreover, we offer practical proposals to address perceived risks and promote reciprocal trust when implementing an RSS.

Keywords: IT Implementation, Anti-Doping, Remote Testing, Extended Valence Framework.

Introduction

Anti-doping testing, the central mechanism in global anti-doping work, represents a safeguard for fair competition in sports and an embodiment of ethical principles that resonate in societies worldwide. To preserve the authenticity of sports and "protect the athletes' fundamental right to participate in doping-free sport and thus promote health, fairness and equality" (WADA, 2021a, p. 9), anti-doping organizations (ADOs) allocate more than USD 300 million annually (Butler, 2017) to conducting anti-doping tests. Of this sum, out-of-competition tests conducted by Doping Control Officers (DCOs) visiting athletes to be tested at their whereabouts and monitoring the provision of an anti-doping sample (WADA, 2022a) are the most significant cost drivers, demonstrating their pivotal role in ensuring the fairness of sports competitions a vast audience engages with. Amidst the upheaval brought by the Covid-19 pandemic, the number of in-person out-of-competition tests in 2020 dropped abruptly by over 46% due to imposed contact restrictions and lockdowns, unveiling the fragility of the existing testing system and its vulnerability to external disruptions (WADA, 2021b), with potentially drastic consequences for the integrity of global sports.

Consequently, several ADOs, in cooperation with technology partners, fostered digital transformation by launching pilot projects for remote anti-doping sample collection, enabling out-of-competition testing compliant with imposed contact restrictions and continuance of anti-doping testing during lockdowns (Doping Autoriteit, 2020; Fedoruk, 2020; NADA, 2020; USADA, 2022). As in other areas of society (e.g.,

working from home, telemedicine), the use of information and communication technology in anti-doping work resulted in concurrent vast cost and carbon emission savings by reducing the need for travel (e.g., Alipour et al., 2021; Hashiguchi, 2020; Waizenegger et al., 2020), aligning with modern technological shifts and acting as a resonant step to a more sustainable society. For example, in a five-month project conducted by the German Anti-Doping Agency (NADA) in cooperation with Sportradar AG, 288 out-of-competition tests taken remotely by seven DCOs from 24 athletes from twelve sports resulted in 20,000 kilometers less travel, and a reduction of the carbon footprint from 3.25 to 0.02 tons of CO2e (Sportradar, 2023).

The anti-doping system is characterized by unique circumstances. Following positive doping controls, athletes face a reversal burden of proof and must prove their innocence. Otherwise, penalties include bans from competition of up to four years, with lifelong bans for repeated offenses. (WADA, 2021a) or criminal prosecution (Sumner, 2017). Athletes' careers rely on proper testing, governed by World Anti-Doping Agency (WADA) regulations ensuring rigorous process integrity (WADA, 2021b). Still, manipulation attempts persist, such as intentional sample contaminations or sample swapping (Thevis et al., 2012). Thus, remote sampling is allowed only in exceptional cases when in-person collection is restricted (WADA, 2023a). Due to these unique circumstances, the applicability of findings from related social science research on the digitalization of monitoring processes is limited (e.g., see Scott Kruse et al., 2018 for a systematic review regarding telemedicine implementation).

Given the high savings potential in financial and environmental resources, coupled with the unique requirements for integrity in remote sampling, ADOs must balance, on regulatory, strategic, and operational levels, the benefits and risks associated with the implementation of a remote sampling system (RSS) while acknowledging trust perceptions among the parties involved. In information systems research, the extended valence framework (EVF) is suitable for systematically gauging benefits, risks, and trust perceptions associated with technology implementation (Kim et al., 2009). Considering the lack of behavioral science evidence on RSS implementation in anti-doping work, this study aims to systematically assess the perceptions of C-level ADO representatives from the regulatory, strategy, and operational levels assigned to making the decision to implement an RSS in anti-doping work from multiple organizational perspectives. The underlying research question is:

Which benefits, risks, and dimensions of trust perception are perceived by representatives of anti-doping organizations regarding the implementation of a remote sampling system in anti-doping work?

To address this research question, we first describe the anti-doping system and compare the processes of in-person and remote doping sample collection to provide a comprehensive understanding of (remote) anti-doping sampling and technological solutions. We then introduce the EVF (Kim et al., 2009) and, drawing on the guidelines for context-specific theorizing by Hong et al. (2014) and established IS literature, decompose its core constructs into dimensions contextual to the implementation of technologies requiring high process- and transaction-integrity. Applying the decomposed EVF as a theoretical lens, we analyze twelve semi-structured interviews with cross-cultural C-level ADO representatives through qualitative content analysis from multiple organizational perspectives (Mayring, 2014). The results reveal that ADO representatives perceive different benefits, risks, and dimensions of trust perceptions. While the regulatory level views RSS implementation ambivalently, the ADO representatives at the strategic and operational levels support its implementation. The study's qualitative findings enhance the theoretical understanding of IT implementation in anti-doping work and contextualize the EVF. By employing the EVF and its decomposed dimensions as a theoretical lens, factors related to RSS implementation in anti-doping work are explored, showcasing the applicability of the quantitatively oriented EVF as a theoretical lens for qualitative exploration. The contextualized EVF derived offers insights for future research on technology implementations involving sensitive data that potentially impact the users' financial or healthcare situation.

Understanding Remote Sampling and RSS Development in Anti-Doping Work

To understand how the implementation of an RSS affects out-of-competition anti-doping testing, the actors involved in the anti-doping system, the analytical characteristics of doping control samples, and the process associated with conducting anti-doping tests need to be clarified. The actors involved in anti-doping testing can be assigned to three different functional levels within the anti-doping system. (1) Regulation, represented by WADA. As the central regulator, WADA develops and coordinates globally applicable anti-

doping rules, e.g., the list of prohibited substances and methods in sports (WADA, 2023b). (2) Strategy, primarily represented by national and regional Anti-Doping Organizations (National ADOs and Regional ADOs) that apply the anti-doping rules established by WADA and, based on these rules, strategically develop their doping test regimes. And (3) Operation, covering two essential steps of doping testing: First, the collection of doping control samples from athletes according to the doping test regimes developed by National ADOs and Regional ADOs, and second, the analysis of the collected sample for prohibited substances and methods, conducted by anti-doping laboratories.

Regarding the analytical characteristics of doping control samples collected, ADOs on the strategic level must decide on the time, frequency, and type of doping control sample collection from an athlete. Urine samples and full blood samples are the most-collected doping control samples approved by WADA to conduct a wide spectrum of analytical testing (WADA, 2021b). A variety of alternative sample types are gaining relevance: First, so-called 'Dried-Blood-Spot' samples, where athletes provide a couple of blood drops dried up into a secure sample pod (Koulman et al., 2022; Thomas et al., 2011); and second, exhaled breath of athletes, in which exhaled aerosol particles are captured in a micro-particle filter, which is then analyzed for signals indicating the use of prohibited substances or methods (Beck et al., 2013).

In executing anti-doping test regimes, it is common practice to instruct DCOs to travel to an athlete's whereabouts and collect the required doping control sample in person (Sportradar, 2023). Here, the DCO must be of the same gender as the athlete to enable direct observation of the delivery of a urine sample (WADA, 2023a). However, during the Covid-19 pandemic, health restrictions widely permitted in-person sample collection, leading several ADOs to pilot remote sampling approaches as interim solutions (Doping Autoriteit, 2020; Fedoruk, 2020; NADA, 2020; USADA, 2022). Conditional to providing the required sample-collection equipment to the athlete beforehand, using video conferencing tools (e.g., FaceTime or Zoom) to supervise the athlete during the sample-collection process remotely enabled doping control sample collection compliant with imposed health restrictions. Consequently, the physical presence of a DCO to conduct traditional in-person sample collection was not necessary anymore in the piloted remote sampling approaches. To advance the variety of interim IT solutions, a beta version of a dedicated RSS was developed by NADA in collaboration with software development experts (NADA, 2021; Sportradar, 2023).

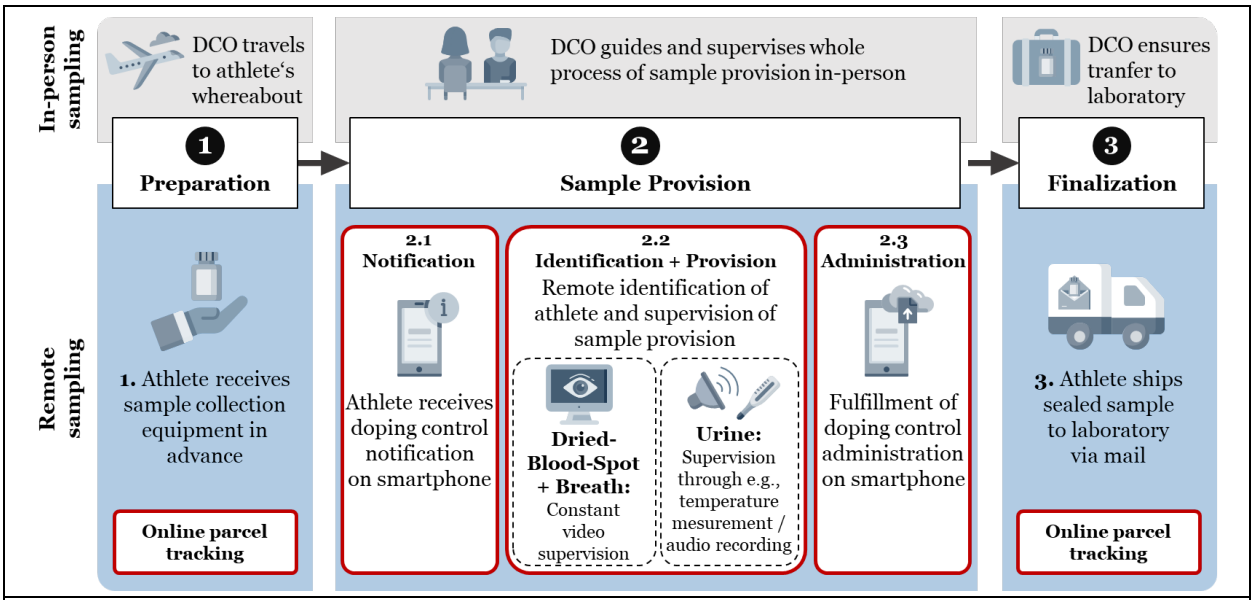

Figure 1. Comparison of in-person sample collection and remote sampling processes. Own depiction based on Martin and Nekrashevich (2020) and Sportradar (2023)

Figure 1 illustrates the differences between the conventional in-person doping control sample collection process and the remote sample collection process facilitated by the RSS. The RSS covers key steps of the doping control sample-collection process: From notifying the athlete about doping control through guiding and supervision solutions during sample provision to online administration fulfillment and parcel tracking options to comply with the 'chain of custody' mandatory in anti-doping tests (Sportradar, 2023; WADA, 2023a). Because full blood samples must be collected in person by trained medical professionals (WADA,

2023a), remote sampling utilizing an RSS can currently be conducted only to collect urine samples, Dried-Blood-Spot samples, or exhaled breath samples. Sample- and process-integrity during the sampling procedure are essential requirements to comply with the chain of custody. To supervise the collection of the abovementioned doping control samples in step 2.2 and to ensure the integrity of the sample collection process, video supervision is established for monitoring Dried-Blood-Spot and exhaled breath sample collection. To supervise urine sample provision, audio recordings of the urine sample collection procedure and temperature measurements of the collected urine sample are used (Doping Autoriteit, 2020; Martin & Nekrashevich, 2020). In order to ensure the integrity and assignability of the collected sample material, it is collected and shipped in tamper-evident, sealed, and numbered safety containers (e.g., BEREG-Kit for urine samples (Berlinger Special, 2022) or TASSO-M20 device for Dried-Blood-Spot samples (Tasso, 2023)) and matched to the athlete and sampling session in the doping control administration (step 2.3). This ensures that the sample cannot be manipulated or swapped during the shipment of collected samples to anti-doping laboratories (step 3). Furthermore, the currently available RSS features a variety of data protection precautions to ensure remote sample collection in a secure manner. This includes multifactor authentication to access the RSS securely, as well as blockchain technology and a server cluster to ensure tamper-proof exchange and storage of sensitive data collected (Sportradar, 2023).

Some ADOs have already piloted remote sampling in cooperation with athletes, DCOs, and software developers. However, developing and deploying a dominant RSS for global anti-doping work is still in progress (Doping Autoriteit, 2020; Fedoruk, 2020; NADA, 2021; Sportradar, 2023; USADA, 2022). Generally, developing and implementing an RSS in anti-doping work involves four constituents: (1) ADOs, regulating, developing, and executing doping test regimes on the previously mentioned functional levels of anti-doping work. (2) Software developer, developing and operating the software system for remote sampling. (3) Athletes following the prompts during remote sampling via the mobile app. (4) Technology, represented by the RSS (i.e., an operating platform for DCOs and mobile app for athletes; Sportradar, 2021). Figure 2 shows the user interfaces of the RSS beta version (Sportradar, 2023). In Figure 2, Picture 1 displays both the desktop application used by DCOs to conduct remote sampling and the mobile application used by athletes on their smartphones. Picture 2 gives a more detailed overview of the mobile app interface, providing an overview of anti-doping tests conducted for athletes. Picture 3 displays the interface allowing the provision of parcel tracking information to finalize the remote sampling process.

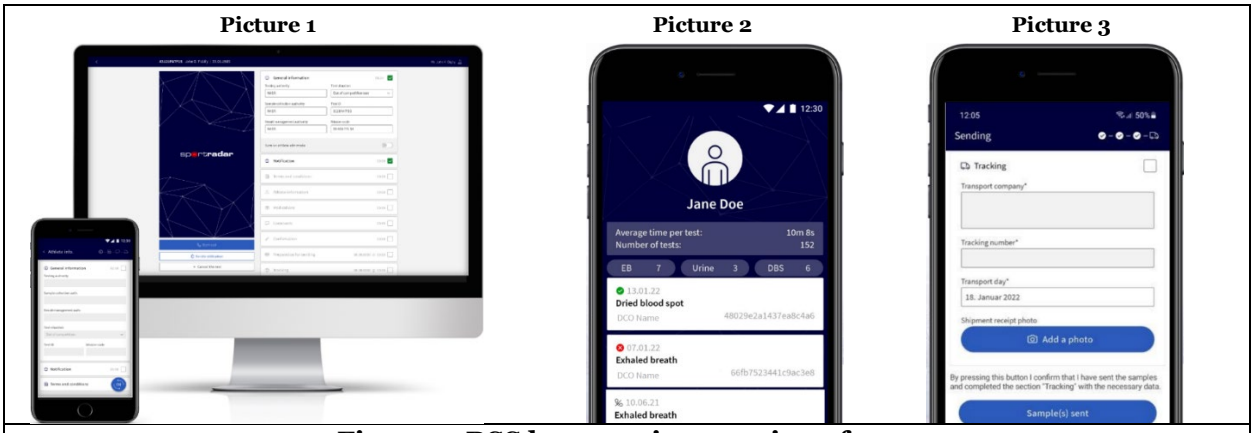

Figure 2. RSS beta version user interfaces.
Source: Sportradar (2023)

Related Research

In research, remote anti-doping testing, especially remote sampling, has received little attention. Arguably, this is because, just recently, the need for alternative testing capabilities increased in the wake of the Covid-19 pandemic (Fedoruk, 2020). From a doping analysis perspective, research mainly focuses on the potential of remote testing using the example of frequent Dried-Blood-Spot sample collection, highlighting that associated advantages can be further leveraged by an RSS to effectively organize frequent Dried-Blood-Spot sampling (Thevis et al., 2021; Yuan et al., 2021). Taking organizational perspectives and examining the view of the decision-makers in anti-doping work on implementing an RSS systematically can illuminate the

prerequisites for successful RSS implementation and thus also contribute to related IS research. However, research has not yet considered the implementation of an RSS from a behavioral science perspective aiming to understand key factors influencing the behavioral intention to implement an RSS in anti-doping work. In this regard, the intention to implement an RSS in anti-doping work depends on the degree to which the technology can accomplish the specific requirements on process- and transaction-integrity of out-of-competition in-person testing (Fedoruk, 2020; Koulman et al., 2022; Thevis et al., 2021; Yuan et al., 2021).

These requirements are based mainly on (1) medical data privacy considerations (Fedoruk, 2020), as well as (2) potential financial consequences for athletes in case of positive doping test results. As research has not yet considered RSS implementation from a behavioral science perspective, the general approach and the necessity of our analysis are inspired by related research on the implementation of technologies with comparable integrity requirements in the following way (Fedoruk, 2020): Viewed from (1) the medical data privacy perspective, technology implementation in telehealth services (e.g., Gong et al., 2019; Hashiguchi, 2020; Koulman et al., 2022; Mou et al., 2016) is highly comparable to RSS implementation in anti-doping work. This is because both systems handle sensitive medical data. Doping control samples collected from athletes contain a considerable amount of information exploitable for inquiries unrelated to anti-doping testing, e.g., to access the athletes' general health condition maliciously. Analytical material and results of anti-doping tests present athletes' sensitive medical data that must be treated confidentially, leading to high demand on process- and transaction-integrity during doping control sample collection via an RSS (WADA, 2021c; Fedoruk, 2020). Viewed from (2) the financial perspective, the requirements of mobile technologies such as mobile banking (e.g., Lin et al., 2014), mobile payment (e.g., Chin et al., 2022; Gao & Waechter, 2017; Lu et al., 2011; Pal et al., 2021; Yang et al., 2012), or mobile FinTech services (e.g., Abdul-Rahim et al., 2022; Hassan et al., 2022) are also closely related to their users' financials and therefore comparable to the requirements of an RSS implemented in anti-doping work. This is because positive doping tests can significantly affect the career path and, consequently, the financial situation of athletes (Strelan & Boeckmann, 2003; Westmattelmann et al., 2020). Integrating both (1) medical data privacy and (2) financial perspectives, integrity-ensuring mechanisms like user authentication (Kim & Ogbanufe, 2015) are particularly important in RSS implementation.

The studies mentioned above identified *perceived risks* and *perceived benefits* that influence the *behavioral intention* to implement the respective technology (e.g., Abdul-Rahim et al., 2022; Gao & Waechter, 2017; Lu et al., 2011). Moreover, research suggests that *trust perceptions* are a further central dimension influencing the implementation of technologies with the abovementioned requirements (e.g., Gong et al., 2019; Hassan et al., 2022; Lin et al., 2014).

To combine *perceived benefits* and *risks*, studies from the domain of IT implementation rely on the valence framework (Goodwin, 1996; Peter & Tarpey, 1975), and the extended valence framework (EVF), which extends the valence framework by including *trust* (Kim et al., 2008; Kim et al., 2009). Several reasons underline the suitability of the EVF as a theoretical lens for this study. First, the EVF arranges *perceived benefits*, *risks*, and *trust* as core constructs preceding the decision to implement technology (Peter & Tarpey, 1975; Kim et al., 2009). Second, in comparison to other established technology acceptance models (e.g., UTAUT; Venkatesh et al., 2016), the EVF does not focus on performance gains or subjective norms, but on comprehensive insights about *trust* and the influence of *perceived benefits* and *risks* that seem to be highly important (Bedué & Fritzsche, 2022). Third, given the EVF's broader scope and its characteristic as an easily understandable and established theory in the domain of IT implementation (Kim et al., 2009), the EVF can be applied to diverse contexts, and multiple disparate technology attributes can be organized well when using the EVF as a theoretical lens (Bedué & Fritzsche, 2022; Pal et al., 2021). Consequently, the EVF allows for further decomposition and contextualization of its core constructs to make it applicable across investigations in the context of various technologies (Hong et al., 2014). Such decompositions of the EVF's core constructs promote the examination of relevant implementation determinants and have already been done to various extents for IS research in related contexts (Bedué & Fritzsche, 2022; Gong et al., 2019; Hassan et al., 2022; Lin et al., 2014; Mou et al., 2016; Pal et al., 2021). In the following, we elaborate on the EVF and decompose its core constructs based on context-related literature (Hong et al., 2014).

Theoretical Lens: Extended Valence Framework

The valence framework originates from economic and psychological theories in behavioral research (see Figure 3; Goodwin, 1996; Kim et al., 2009). In essence, it is about a person balancing a product or service's

positive and negative attributes – the so-called 'net valences' – which is the difference between *perceived benefits* and *perceived risks* (Peter & Tarpey, 1975). Thus, the *behavioral intention* to adopt a technology is strengthened by its *benefits* and reduced by its *risks*. The valence framework considers both positive and negative attributes of a technology simultaneously, so it performs well in understanding an individual's behavior regarding a technology (Lin et al., 2014). Benefit-risk evaluations are typically intended for decision-makers (i.e., ADO C-level representatives) when making effective management decisions (Gong et al., 2019; Verhagen et al., 2012). *Trust perceptions* also take on a central role in an environment characterized by uncertainty and risk (McKnight et al., 2011). Kim et al. (2009) highlight the importance of *trust perceptions* in the technology context and extend the valence framework by including *trust* as an antecedent of *perceived risks* and *benefits*. In the EVF, *trust* directly and indirectly influences *behavioral intention* by enhancing *benefits* and inhibiting *risks* (Kim et al., 2009).

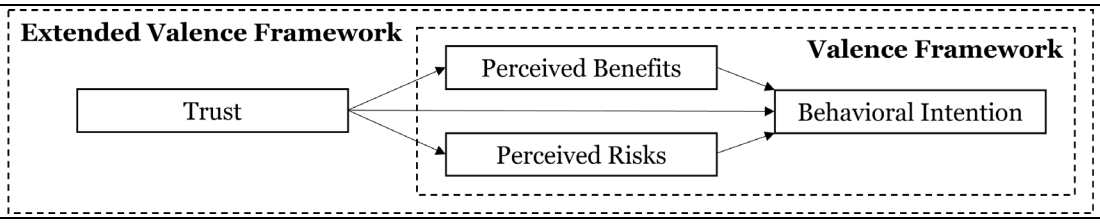

Figure 3. Extended valence framework. Arrows represent potential relations. Own depiction based on Kim et al. (2009)

The EVF is well established in research from individual perspectives in both commercial (e.g., Kim et al., 2009) and non-commercial settings (Mou et al., 2016). In accordance with Bedué and Fritzsche (2022), we adopt the EVF as a theoretical lens for examining the implementation of an RSS in anti-doping work from multiple organizational perspectives.

Perceived Benefits and Risks

Perceived benefits characterize the motivation of users to maximize, or at least increase, the positive utility (*perceived benefit*) of a technology (Kim et al., 2009). Therefore, we define *perceived benefits* as the extent to which a person is convinced that the organization she or he is part of will benefit by implementing a technology. In the domain of technology implementation, context-specific *perceived benefits* are often conceptualized based on the perception of the limited resources, time, and effort related to using a technology (Berry et al., 2002; Pal et al., 2021). For example, Pal et al. (2021) identified information access as a *perceived benefit* when examining the use intention of mobile payment technologies at an individual level. It can be argued that information access through various services by mobile payment applications offers additional *benefits* in terms of time and effort savings to the users (Pal et al., 2021).

Perceived risks characterize the motivation of users to minimize, or at least reduce, the expected negative utility (*perceived risk*) of a technology (Kim et al., 2009). Therefore, we define *perceived risks* as the extent to which a person is convinced that the organization she or he is part of faces *risks* by implementing a technology. We draw on the established risk facets proposed by Featherman and Pavlou (2003), as previous research successfully decomposed the dimension of *perceived risks* within the EVF by means of these risk facets (e.g., Mou et al., 2016; Pal et al., 2021) perceived on an individual level. The EVF's decomposed dimension of *perceived risks* and the corresponding risk facets are illustrated in Table 1.

Risk facet	Definition
Performance risk	The possibility of the technology malfunctioning and not performing as it was designed and advertised to do, therefore failing to deliver the desired benefits.
Financial risk	The potential monetary outlay that is associated with the initial purchase price as well as the subsequent maintenance cost of the technology.
Time risk	The potential time loss that a user expects when she or he learns how to use the technology.
Psychological risk	The risk that the technology's selection or performance will negatively affect the user's peace of mind or self-perception (e.g., due to information overload).

Social risk	The potential loss of status in one's social group as a result of adopting the technology, e.g., looking foolish or untrendy.
Privacy risk	The potential loss of control of one's personal data through the use of the technology.
Overall risk	A general measure of perceived risk when all criteria are evaluated together.

Table 1. Definitions of risk facets according to Featherman and Pavlou (2003, p. 455), Grewal et al. (1994), and Mitchell (1992)

Trust Perceptions

Trust is essential when knowledge and previous experience with innovative technology are lacking and uncertainty is high (Bedué & Fritzsche, 2022; Nienaber & Schewe, 2014). From a social science perspective, *trust* is understood as the willingness of a trustor to make herself or himself vulnerable to a party (the trustee) with the expectation that this trustee will perform a specific action that is significant for the trustor. This willingness is independent of the possibility of control or monitoring (Mayer et al., 1995). Thus, *trust* is a socio-psychological construct based on the perception of specific characteristics of the trustee (Rousseau et al., 1998).

When applying the EVF in the domain of IT implementation, researchers have frequently studied the effect of different *trust perceptions* on the *behavioral intention* to use technologies such as mobile banking apps or mobile FinTech services on the individual (e.g., Gong et al., 2019; Hassan et al., 2022; Lin et al., 2014) and organizational level (see Bedué & Fritzsche, 2022). To analyze multidimensional *trust perceptions* in the technology context, we decompose the EVF's dimension of *trust* and distinguish between *trust in people* and *trust in organizations*, as well as *trust in technologies* (see Table 2; McKnight et al., 2011). These *trust perceptions* differ in the fact that in the case of interpersonal *trust*, not only the characteristics but also the positive intentions of a person or an organization – the so-called trustworthiness – are considered antecedents of *trust* (Mayer et al., 1995). One cannot, however, assume a technology has intentions, so trusting beliefs are crucial in terms of *trust in technologies*. Derived from the social science perspective, we distinguish three trusting beliefs in technology comprising *functionality*, *helpfulness*, and *reliability* (see Table 2; McKnight et al., 2011).

Trust perception		Definition
Trust in people		The belief that people are performing their obligations in accordance with the trusting party.
Trust in organizations		The belief that an organization is performing its obligations in accordance with the trusting party.
Trust in technology		The belief that a specific technology has the attributes necessary to perform as expected in a given situation in which negative consequences are possible.
	Functionality	The belief that a specific technology has the capability, functionality, or features to do for one what one needs to be done.
	Helpfulness	The belief that a specific technology provides adequate and responsive help for users.
	Reliability	The belief that a specific technology will consistently operate properly.

Table 2. Definitions of trust perceptions according to Mayer et al. (1995) and McKnight et al. (2011, p. 7)

Behavioral Intention

Traditionally, technology acceptance research seeks to understand intentions and behaviors toward various technologies (Fishbein & Ajzen, 1975; Venkatesh et al., 2016). Also, when applying the (extended) valence framework, different dependent variables, such as *intention to use* (e.g., Lu et al., 2011; Pal et al., 2021) and *behavioral intention* (e.g., Yang et al., 2012), are used, depending on the research context. In this study, we investigate the *behavioral intention* of ADO representatives to implement an RSS in anti-doping work.

Methodology

Interview Study Design, Participant Recruiting, and Sample

To investigate the *behavioral intention* of ADO representatives to implement an RSS in anti-doping work, we chose a positivistic, interview-based approach that was guided by the philosophical assumptions of positivism and thus treated qualitative data as representative facts and common reality (Sarker et al., 2018a). Therefore, in interviews, a positivistic approach strives for responses that can be coded and categorized, turning qualitative responses into quantifiable metrics that can be analyzed and compared (Silverman, 2013). Due to this emphasis on objectivity and its suitability for both deductive theory testing and inductive theory building in the IT implementation domain (Sarker et al., 2013; Sarker et al., 2018a; Sarker et al., 2018b), the positivistic, interview-based approach was selected for this research. For the deductive part and thus considering the existing theory, we use the EVF with its decomposed dimensions as the theoretical lens (Bedué & Fritzsche, 2022; Hong et al., 2014). Also, aspects of the interview design reflect the chosen positivistic approach since the interview guideline was semi-structured along the (decomposed) dimensions of the EVF following the recommendations of Schultze and Avital (2011). In this way, we ensured comparability and the coverage of all relevant topics across all interviewees (Westmattelmann et al., 2021a). Besides this structured nature, the interview guideline enabled us to conduct explorative investigations, representing the inductive part of the qualitative research (Sarker et al., 2018a). In more detail, the questions asked were open-ended and aimed to illuminate general perceptions regarding remote testing (e.g., "What is your view on remote testing as a method to collect out-of-competition doping samples in a virtual setting?", "What are requirements for implementing an RSS?") as well as perceptions regarding the (decomposed) dimensions of the EVF (e.g., "What are the benefits you see in implementing an RSS?"). Besides these questions and to strengthen the explorative character of our investigation, the interviewers were allowed to question topics or ideas not initially considered within the interview guideline but which were raised by the interviewees during the interviews.

In anti-doping work, decisions are made on three functional levels: Regulation, Strategy, and Operation. To gather perceptions of the decision-makers regarding the implementation of an RSS (Gong et al., 2019; Verhagen et al., 2012), we contacted C-level representatives of ADOs from all three functional levels, following a stratified purposive sampling approach (Patton, 2001). In this sampling approach, participants are purposively selected who differ with respect to a specific key dimension (i.e., functional level; Patton, 2001). Thereby, this sampling strategy ensured that the collected data reflect the diverse and multi-layered nature of anti-doping work. In total, we interviewed twelve individuals (1 Regulation, 8 Strategy, and 3 Operation representatives) between June and September 2022 in person (2) or remotely (10) via online video conferencing tools (Myers & Newman, 2007). After these twelve interviews, we reached theoretical saturation, indicating that further interviews were unlikely to yield new insights (Bowen, 2008). The interviews were conducted by the authors, who are experienced interviewers in the IS field as well as anti-doping research (Patton, 2001). That experience also largely ruled out the problem of social dissonance between interviewer and respondent, as one of the interviewers was part of the anti-doping testing pool as a professional athlete (Myers & Newman, 2007). Before the interviews, we asked interviewees to speak from their professional perspective (i.e., in their role as C-level ADO representatives) to ensure that the organizational perspective came to light. With the consent of the interviewees, we audio-recorded the conversations and verbatim transcribed them afterward (Myers & Newman, 2007; Sarker et al., 2013). The interviewees (10 male and 2 female) are, on average, 49 years old (min = 40 years, max = 65 years), work in ten different ADOs on three different continents (i.e., 7 Europe, 3 Asia, 2 North America), and are responsible for more than USD 100 million of the global annual anti-doping budget. The sample includes, for example, Chief Executive Officers and Chief Science Officers. Furthermore, the sample contains representatives of four ADOs with initial remote sampling experience.

Interview Analysis

To account for the chosen positivist interview-based approach with an exploratory character, we decided to perform a qualitative content analysis according to Mayring (2014), which is well established in IS research (see Schlicker et al., 2021 and Westmattelmann et al., 2021a). Moreover, the choice of the procedure proposed by Mayring (2014) instead of, e.g., deductive pattern-matching (Pearse, 2019), was motivated by the following reasons. First, qualitative content analysis allows for deductive coding on the decomposed

dimensions of the EVF and inductive coding to summarize the interview material that could not be structured deductively (Mayring, 2014; Sarker et al., 2018a; Sarker et al., 2018b). Second, the systematic nature of qualitative content analysis, with its explicit rules for coding, offers a high level of replicability (Mayring, 2014). Third, qualitative content analysis is suitable when a detailed analysis is required, such as when investigating the decomposed dimensions of the EVF (Mayring, 2014) in a specific context.

Using the software MAXQDA, two authors performed the entire coding process to ensure coding objectivity (Coder A and B). Coder A first coded all interviews deductively using the decomposed dimensions of the EVF. When coding *trust perceptions*, Coder A made sure to consider only statements about the existence of *trust in people*, *organizations*, or *technology*, according to the definitions of Mayer et al. (1995) and McKnight et al. (2011, p. 7). In a second run, Coder A summarized the remaining interview material inductively and formed new inductive categories (Mayring, 2014), if necessary, at a lower level of deductive categories. Coder A derived definitions for each inductive category and coding rules for each category, which he discussed with Coder B when he handed over the entire category system to him. Coder B then repeated the process using the whole category system without knowing what Coder A had previously coded. We refer to Cohen (1960) to test the reliability of the coding on the text segment level. One major advantage of this conservative measure for coder reliability is the consideration of randomly matched coding between the two Coders (Cohen, 1960). Our coding resulted in a Cohen's Kappa value of 0.86, which is above the threshold of 0.7 for exploratory studies (Brennan & Prediger, 1981; Lombard et al., 2002) and comparable to former interview studies in the IS context (e.g., Schlicker et al., 2021; Westmattelmann et al., 2021b).

Results and Discussion

Perceived Benefits and Risks

We identified and defined six *perceived benefits* in the context of RSS implementation in anti-doping work (see Table 3; Berry et al., 2002; Pal et al., 2021).

Perceived benefits	Contextual definition	ADO		
		R	S	O
Sample collection in times of a pandemic	*The implementation of an RSS allows non-contact doping sample collection during a pandemic, thus avoiding the installation of expensive and time-consuming hygiene concepts.*	*1*	*7*	*3*
Less travel	*The implementation of an RSS reduces the time and financial effort required for DCOs to travel to and from doping sampling.*	*1*	*6*	*2*
Less bureaucracy	*The implementation of an RSS reduces the bureaucratic effort for doping sampling and thus reduces the time and financial effort.*	-	*2*	*2*
Convenience	*The convenient use of an RSS reduces the time and financial effort required for doping sampling.*	-	*1*	*1*
Deterrent effect	*The implementation of an RSS increases the deterrent effect of doping tests and thus leads to less time and financial effort in the long run.*	-	*2*	-
Gender issue	*The implementation of an RSS reduces the need for DCOs of all genders to be available, resulting in less time and financial effort.*	-	*1*	-
Note. Numbers represent the number of interviewees who mentioned a category at least once. R, Regulation (n=1); S, Strategy (n=8); O, Operation (n=3). Inductive categories are in italics.				

Table 3. Contextualized definitions and mentions of perceived benefits

Each of these *perceived benefits* illustrates the potential to (1) reduce the financial and environmental resources needed for out-of-competition anti-doping testing and (2) enable more investment of the anti-doping budget into other anti-doping measures (Butler, 2017; WADA, 2023a). Eleven interviewees articulated that with the assistance of an RSS, doping control *sample collection can be continued in times of a pandemic* without the need for expensive hygiene concepts ("[…] there was half a dozen of National ADOs that implemented [an RSS] during COVID" Regulation 1). This aligns with studies demonstrating that information systems are particularly useful in enabling collaboration in sports during pandemics

(Westmattelmann et al., 2021a). Nine representatives at all functional levels of anti-doping work perceive the advantage of *less time- and money-consuming travel* for sample collection ("[RSS] gives some flexibility to us, taking into account the size of the country" Strategy 1). Since traveling causes a considerable amount of carbon emissions (Wicker, 2019), *less travel* by using an RSS could also affect environmental sustainability, as this promotes the continued maintenance of ecosystems and their functions (Dietz et al., 2022; iNADO, 2021; Schoormann & Kutzner, 2020). Four interviewees also perceive that the *bureaucratic workload* decreases with the implementation of an RSS in anti-doping work and thus reduces the time and financial effort for sample collection ("[…] and that is an enormous benefit, that the […] paperwork can also be done online" S2). Furthermore, it is perceived by two ADO representatives that using an RSS in anti-doping work increases *convenience*. This aligns with the idea that services offer different types of *convenience*, such as transaction *convenience*, in general (Berry et al., 2002). It was also argued by two C-level representatives on the strategy level that an increase in testing frequency due to the introduction of an RSS increases the *deterrent effect* of the anti-doping measure 'testing', aiming to divert potential dopers (Overbye, 2017; Thevis et al., 2021; WADA, 2021a). The increased *deterrence effect* may be explained by athletes perceiving a higher out-of-competition testing frequency as an effective anti-doping measure (e.g., Westmattelmann et al., 2018). Finally, one interviewee mentioned that an RSS eliminates the "issues with gender" (S3) since the need for in-person visual observations during sampling, and therefore gender-conforming DCOs, is no longer relevant (WADA, 2023a).

Besides the *perceived benefits*, we identified multi-faceted *performance risks* based on statements from all twelve interviewees, for which we created context-specific, inductive subcategories and provided contextualized definitions (*legal risk, provision risk, shipment risk,* and *technological risk*; see Table 4).

Perceived risk facets	Contextual definition	ADO		
		R	S	O
Performance risk	The possibility of an RSS malfunctioning and not performing as designed and therefore failing to deliver the desired benefits.	1	8	3
Legal risk	*The sample taken using an RSS cannot be used in legal proceedings due to uncertainties in the regulations for remotely-taken samples.*	*1*	*6*	*3*
Provision risk	*The chain of custody is disrupted during the provision of an anti-doping sample using an RSS, thereby compromising the integrity of the collected sample.*	*1*	*6*	*3*
Shipment risk	*The chain of custody is disrupted during a doping test using an RSS due to issues during the shipment of the testing equipment or the collected sample.*	*1*	*5*	-
Technology risk	*An RSS does not work as expected due to technological limitations.*	-	*4*	*1*
Time risk	The potential time loss that a user expects when she or he learns how to use an RSS.	-	1	-

Note. Numbers represent the number of interviewees who mentioned a category at least once. R, Regulation (n=1); S, Strategy (n=8); O, Operation (n=3). Inductive categories are in italics.

Table 4. Contextualized definitions and mentions of perceived risks according to Featherman and Pavlou (2003, p. 455), Grewal et al. (1994), and Mitchell (1992)

Legal risk relates primarily to the admissibility of the samples taken ("And going to court with this kind of cases will be pretty tricky." Operation 1) because the ADOs are dependent on a mandatory sample collection process for effective anti-doping work (WADA, 2021a). Two *risks* along the chain of custody are perceived ADO representatives. First, during the actual sample provision (see step 2 in Figure 1; "you need to [make] sure that there is no way to tamper or manipulate samples during the sample-collection process." S3). And second, during the shipment of the testing equipment to the athletes or the collected samples to the laboratories (see steps 1 and 3 in Figure 1; "with packaging, shipping and stuff like that, I think it's critical" S2). This demonstrates that the absence of an in-person sample provision causes weaknesses in the sampling process. In this study, *technology risks* address possible technical limitations of an RSS, referred to as general *performance risks* in other studies from the domain of IT implementation (e.g., Pal et al., 2021) that do not subdivide this risk facet. *Technology risk* is perceived by a total of five ADOs at the strategy and operation level ("And [regarding] the app that is there now, the important thing is that there is a stable video system." S2). Besides the multi-faceted *performance risks*, *time risk* was perceived by one strategy-

level ADO and related to the time required to train users that apply an RSS. This risk could be related to other *perceived risks* and *trust in RSS* since *risks* could be mitigated, and *trust perceptions* could be developed during learning (Yang et al., 2015). In addition to these perceived risk facets, the content analysis indicates that, from the interviewees' perspective, the *financial*, *psychological*, *social,* and *privacy* risk facets are not important when introducing an RSS in anti-doping work. Regarding the absence of *financial risk*, remote sampling could be perceived as more cost-effective in the long run than in-person sampling (Butler, 2017). Furthermore, *psychological* and *privacy risk* may pose *risks* perceived from an athlete's perspective and, therefore do not directly relate to the organizational perspective, which is examined in this study. Finally, alignment with modernization when implementing an RSS could be a reason why ADO representatives do not perceive *social risks*, since being modern could make the ADOs look more "up-to-date" rather than inefficient in their operations (e.g., NADA, 2020, 2021).

Trust Perceptions

In the interviews, we identified statements about *trust perceptions* contextual to RSS implementation in anti-doping work (see Table 5). It is noticeable that at the regulatory level, only trust in the *software developer* is expressed, but not in the RSS itself or the athletes. At the functional levels of strategy and operation, ten respondents expressed their *trust* in an RSS (*trust in technology*). Accordingly, the respondents believe that the technology will perform adequately in terms of *functionality* and *reliability* ("I can also say that [the RSS] is going very well. That you can also guarantee the assignability and integrity of the samples. I see [the RSS] as a great opportunity for the future." O2). However, this *trust in technology* contrasts with the fact that also *technology risks* are perceived. The technology trusting belief *helpfulness* was not mentioned by ADOs, indicating that this trusting belief is not relevant in the context of an RSS, as a DCO is involved throughout the remote out-of-competition sampling process and can provide support whenever problems occur. This result is in line with other studies on the role of *trust in technology* in implementing information security systems (e.g., Jalali et al., 2020). The interviews also indicate that seven interviewees *trust athletes* to perform their obligations in accordance with ADOs' expectations ("But I think the athletes will take care of [the legal obligation of an RSS]" S2). *Trust in athletes* is essential for ADOs since athletes are at the center of effective anti-doping work (Dreiskämper et al., 2016). Furthermore, six representatives from all functional levels perceived that the software developer of an RSS will perform according to his obligations and can, therefore, be trusted.

Trust perceptions	Contextual definition	ADO		
		R	S	O
Trust in an RSS (technology)	The belief that an RSS has the attributes necessary to perform as expected in a given situation in which negative consequences are possible.	-	8	2
Functionality	The belief that an RSS has the capability, functionality, or features to do for one what one needs to be done.	-	8	2
Reliability	The belief that an RSS will consistently operate properly.	-	3	2
Trust in athletes (people)	The belief that athletes are performing their obligations in accordance with the ADOs.	-	5	2
Trust in software developer (organization)	The belief that the software developer is performing its obligations in accordance with the ADOs.	1	4	1

Note. Numbers represent the number of interviewees who mentioned a category at least once. R, Regulation (n=1); S, Strategy (n=8); O, Operation (n=3).

Table 5. Contextualized definitions and mentions of dimensions of trust perceptions according to Mayer et al. (1995) and McKnight et al. (2011, p. 7)

Behavioral Intention

All C-level representatives expressed support for the implementation of an RSS in their respective ADO area at least once. This indicates that the interviewed ADO representatives perceive a positive net balance of *benefits* and *risks* regarding RSS implementation and its impact on anti-doping work (see Table 6; e.g., "[…] we will join to the […] world movement of remote sampling." S1; Kim et al., 2009). However, merely

on the functional level of regulation, besides advocacy, doubts were expressed regarding the implementation of an RSS beyond the Covid-19 pandemic ("[…] the use would be only in a pandemic." R1). These doubts regarding the implementation of an RSS in anti-doping work, combined with the limited *trust perceptions* (see Table 5) and the *perceived risks* (see Table 4) on the functional level of regulation are in line with the fact that WADA has not yet officially introduced remote sampling as a valid method beyond the *times of a pandemic* (WADA, 2022b; "[…] it's not in the international standards that [remote sampling] can be conducted." R1). This reasoning is supported by the assumption that *trust perceptions* can reduce *perceived risks* and positively influence the implementation of a technology (Kim et al., 2009).

Behavioral intention	ADO		
	R	S	O
Support for the introduction of an RSS in anti-doping work	1	8	3
No support for the introduction of an RSS in anti-doping work	1	-	-
Note. Numbers represent the number of interviewees who mentioned a category at least once. R, Regulation (n=1); S, Strategy (n=8); O, Operation (n=3).			

Table 6. Mentions of behavioral intention

Contributions and Implications

Contributions to IS Research

First, this study's qualitative results contextualize the EVF and augment the understanding of the multi-faceted nature of RSS implementation in anti-doping work. Drawing on the EVF and its decomposed dimensions as a theoretical lens, a comprehensive qualitative investigation of relevant factors regarding the implementation of an RSS in anti-doping work was carried out. In doing so, the methodological approach of this study demonstrates the applicability of the quantitatively oriented EVF as a theoretical lens for qualitative investigations. This was enabled by following the guidelines of context-specific theorizing by Hong et al. (2014), based on which a decomposition of the EVF's dimensions of *perceived risks* into theoretically established *risk* facets (see Featherman & Pavlou, 2003) and *trust* into theoretically sound *trust perceptions* (see Mayer et al., 1995; McKnight et al., 2011) was performed. As a result, this study provides a contextualized EVF that can be used as a basis for future IS research aiming to identify relevant factors regarding the implementation of technologies that process sensitive user data that impact users' financial or healthcare situation.

Second, while previous research related to the adoption of innovative technologies applied the EVF from individual perspectives in particular (e.g., Chin et al., 2022; Gong et al., 2019), this study demonstrates its potential to be utilized from multiple organizational perspectives.

Third, we created a multidimensional understanding of *perceived benefits*, *perceived risks*, and *trust perceptions* regarding the *behavioral intention* to implement an emerging technology in an organizational setting. Specifically, we identified various *perceived benefits* relevant in the RSS implementation context due to their time and monetary savings. Furthermore, considering the *perceived risks* of implementing an RSS in anti-doping work, we subdivided the risk facet *performance risk* into further contextual risk factors and promoted the general understanding of that risk facet in the technology context (Featherman & Pavlou, 2003). This contribution to risk research and the EVF helps to provide a more comprehensive understanding of the multi-faceted nature of risk perceptions and their influence on the adoption of new technologies. Regarding the dimensions of *trust perceptions*, this study illuminates the importance of *trust in technology* as a relevant factor (esp. the technology trusting beliefs *functionality* and *reliability*) when implementing a novel technology with high user support, while other dimensions like *trust in people* or *trust in organizations* should also not be neglected (Mayer et al., 1995; McKnight et al., 2011). Studies in other areas demonstrated that *trust* transfer effects between *trust* referents exist and that *trust* referents relate differently to the intention to implement a technology (e.g., Stewart, 2003).

Fourth, and highlighting the role of an RSS as information technology, we systematically compared the out-of-competition in-person sample collection process and the remote sampling process in the context of anti-doping work (Martin & Nekrashevich, 2020). Thereby, we created a better understanding of the *functionality* of an RSS and illuminated aspects that differ from in-person sample collection and that need

consideration in technology development and implementation. Comparisons like this are valuable for IS research, as researchers frequently explore antecedents and implications of process digitalization (e.g., Han et al., 2022; Lu et al., 2011). To summarize, our findings demonstrate that the (extended) valence framework applied as a theoretical lens is suitable for organizing factors, such as *benefits, risks*, and *trust perceptions*, which need to be considered when organizations decide to implement a technology (Kim et al., 2009; Peter & Tarpey, 1975).

Practical Implications

This study also provides practical implications for all three functional levels of anti-doping work, for software developers of an RSS and athletes. At the regulatory level, our findings create awareness about the technology-related *risks* (e.g., *time risk*) that need to be considered when formally authorizing an RSS for doping control sample collection in anti-doping work. With the goal of official approval of an RSS for anti-doping work purposes, the regulator could also foster its *trust in athletes* by collaborating with them during the corresponding guidelines and standards development process. At the strategy level, the results of this study can be used when deciding to what extent an RSS should substitute or complement out-of-competition in-person anti-doping testing. In doing so, the *benefits* and *risks* of traditional anti-doping testing can be compared with the *benefits* and *risks* of technology-assisted anti-doping testing identified in this study. It is also crucial for strategy-level ADOs to work on extending their *trust in an RSS* itself by involving athletes and software developers in pilot projects. When realizing the perceived time and monetary-related *benefits* by implementing an RSS, more effective anti-doping work for strategy-level ADOs is feasible since the resources released can be invested in other anti-doping measures, such as education or long-term storage of anti-doping samples (WADA, 2023a). Accordingly, ADOs can improve the integrity of sports and the athletes' health by using this study's results for strategy development. At the operational level and for software developers, the results of this study create an understanding of what needs to be addressed when designing and applying an RSS for anti-doping work (e.g., legal admissibility of the samples taken). These parties should provide training and workshops for the stakeholders involved (e.g., athletes or DCOs) to address *perceived risks* and promote reciprocal *trust*. In case of a successful implementation of an RSS in anti-doping work based on the results of our study, the environmental sustainability of anti-doping work due to *less travel* and carbon emissions by DCOs will increase. The same applies to the continuity of effective anti-doping work in times of a pandemic.

Limitations and Further Research

First, while we tailored the sample size to the unique nature of the niche population (i.e., C-level ADO representatives are very rare), we ensured theoretical saturation (Bowen, 2008) and considered cultural validity (i.e., interviewees originate from three continents; Patton, 2001). However, this exclusive sample does not quite conform to the size suggested by Marshall et al. (2013) and lacks a gender balance, limiting the transferability and generalisability of our results (Patton, 2001). Accordingly, further studies should aim to enrich our results by considering larger-scale samples and subject triangulation (Patton, 2001).

Second, while responsible ADO authorities make the decision to implement an RSS in anti-doping work, the perspectives of the actual RSS users (i.e., athletes and DCOs) should be explored in future studies to extend our findings, for instance, regarding *psychological* and *privacy risk* (Featherman & Pavlou, 2003). Athletes are the key stakeholder group in anti-doping work from the ADO perspective (WADA, 2021a) since ADOs' ultimate goal is to "protect the athletes' fundamental right to participate in doping-free sport" (WADA, 2021a, p. 9). Involving athletes affected by this digitalization process in the decision to implement an RSS can help ensure that anti-doping testing is perceived positively rather than negatively.

Third, based on our qualitative investigation, which is important for studying emerging phenomena and understanding contextual factors, quantitative studies should be conducted to substantiate our findings by providing insights into the magnitude and direction of the relationships among the factors discussed.

Fourth, RSS implementation has as yet been limited to pilot projects. The true extent of time and financial savings originating from a large-scale introduction of an RSS remains to be quantified more precisely (e.g., its economic viability when both an in-person testing system and an RSS are operated in parallel). In this regard, it could be beneficial for future research to focus on concurrently deploying remote and in-person out-of-competition anti-doping sampling and considering a more advanced RSS version.

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