Addressing Social and Operational Impacts of Wearable Sensors in Sports' Response to Covid-19

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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Introduction

Wearable technology, specifically proximity sensors and fitness trackers, have long been introduced in sports, proving to have many applications. Many organizations utilize this technology to analyze load management for athletes, checking that they are not being overworked in practices and games (Buchheit, 2017). With this analysis, decision-makers are more informed on injury risk, how to improve efficiency in practices, as well as how to create more insightful individual-based training programs.

The Covid-19 pandemic creates the opportunity for novel applications of this technology. Wearable devices can be used to calculate distance between users in real time, meaning they can ensure 6 feet distance between users. Using that same logic, the technology could be instrumental in conducting contact tracing when athletes test positive for the virus. The technology would record how long players were within 6 feet distance of the infected athlete, and if that time was deemed long enough to be considered an "interaction", the player could be subject to contact tracing protocols by the league.

The National Basketball Association, or NBA, was the first to implement such protocols in its playoff "bubble" in Orlando, Florida. Players, staff, and media were restricted to only the bubble's premises for months, removing attendees from their families, homes, and lives. The league adopted Kinexon Safezone as its wearable solution, mandating all staff members and media to wear it. The device had a sharp alarm if two sensors were within 6 feet. Now, the league is requiring players and many team staffers to wear the SafeZone sensors during all team-organized activities such as travel and practices. Players are subject to fines and suspensions if the sensors are not worn (Holmes, 2020).

It is evident how influential this technology is in changing human interaction and operations within this league. Humans cannot walk within 6 feet of another or go back to their homes without financial and personal repercussions. The NBA has to alter business operations significantly, needing to create a "bubble" concept and contact tracing in order to maintain their revenue stream. This case study presents many different questions regarding business strategy, player morale, privacy, team management, and more social intricacies. These questions will be explored deeply through various STS research methods and research.

First, document analysis will investigate why different sports are implementing different technologies and stakeholders involved through actor-network theory and mediation theory. Then, I will analyze social aspects of this implementation with a local case study: the UVA women's soccer team. This research will dive into how wearables impact players' psychology, team dynamics, and practice routines through interviews with the team and staff. This analysis will help us understand the broader implications of implementing the technology and how it impacts players directly.

Literature Review

The potential of wearable technology to completely change the sports industry has been evident for years. Sensors such as load transducers, accelerometers, heart rate monitors, and multiple sensor systems are being used in order to perform load monitoring, performance enhancement, and injury prevention (Butte, 2012). These sensors help determine patterns of movement, stride lengths and frequency, and estimate speed and distance of level walking and running. Mathematical models are used to classify physical activity and help athletes learn more about their health and bodies.

One valuable use case of this technology is performance enhancement (Li, 2016). Advancements in wearables have allowed individual athletes, sports teams, and physicians to monitor functional movements, workloads, and biometric markers to maximize performance. Coaches can utilize this data to personalize training and conditioning to match the athlete's current physical status based on trends on their data. Similarly, the technology has been used to load monitor athletes in many leagues, including NCAA Women's Division 1 Basketball. Ransdell et al. analyzed this league's usage of the technology and identified metrics such as PlayerLoad, PlayerLoad per minute, high-inertial analysis, jumps, and jumps per minute (Ransdell, 2019). These metrics intend to showcase how hard an athlete is working and how this may affect their body. Coaches and training staff can then leverage this data to alter practices, ensuring their players are not being overworked. Wearables can also be applied to prevent injuries in a different way, as outlined in a rugby study (Kelly, 2012). These researchers developed an automatic detection system for collisions in rugby using an accelerometer sensor. This data was used to analyze the change in temporal acceleration during the collision and classify collisions as simply impacts, collisions, or tackles. Tackling was identified as the primary cause of injuries in rugby, so this data is crucial in helping players tackle safely and prevent injuries.

The primary concern of athletes regarding wearable technology is the privacy of their data. These devices record location, heart rate, and more specific to each athlete. Concerns have consistently been expressed by players, such as Kyle Kuzma in the NBA. Baccellieri (2020) quoted Kuzma saying the Oura Ring "looked like a tracking device". The NBA claims the data is anonymized; however, player suspicion will remain. These concerns need to be addressed in order to safely transition to the implementation of these devices. An alternative perspective was

provided by Thierer (2015) in his journal article. His argument was that while security issues need to be addressed, strict regulations to adopt the technology will only hinder its potential and beneficial uses. This argument is important to consider as we weigh the tradeoffs between saving lives and global data security.

Another important implication is how the data can be used against players with regards to contracts. Berman (2020) looks into this dilemma. Who has ownership of the data? Player unions address the concerns of players and ensure the data cannot be used in contract negotiation. The role of these unions will be crucial in order to protect the players' interests while implementing the beneficial technology. Balletta (2019) similarly analyzes the role of player unions with wearables in the MLB. Players want to ensure their privacy and be confident their organization is not tracking their sleep, movement, and diet. Given the MLB's rich antitrust history, the players distrust of the organization is logical. The negotiations between leagues and players will be detrimental in determining the impact of this technology at a global scale.

Despite progress in vaccines, Covid-19 will be around for the foreseeable future. This virus creates a new dimension in how wearable technology can be used in sports. This paper intends to address gaps in literature and these unique dimensions, such as social interactions, business operations, contact tracing protocols, player psychology, and team dynamics. This technology has become widespread across the globe and the potential for it to help leagues adapt to this virus is clear.

Research Methods

First, I intend to conduct a document analysis regarding different leagues' protocols in returning to their sports during Covid-19. This will focus predominantly on the NBA Bubble due

to its success and timing, but will also take into account other popular global sports leagues. This will give us a thorough understanding of the different mechanisms that occur in order to allow for the return of the respective league in a potentially unsafe environment.

The first STS framework that will be applied is actor-network theory. This theory is applicable to this research due to the vast network of human-nonhuman interactions in the world of sports and league protocols. Actor-network theory reconceptualizes the role of humans and non-humans in the development of science and technology. It argues these human and non-human actors play an equal role in society. This network of interactions will be analyzed through the NBA Bubble use case in the data analysis section of this paper.

Mediation theory is another strong framework to apply on the NBA Bubble system of athletes, wearable sensors, and policy. This theory thinks of technology and humans as mutual entities that shape each through their relationships. It poses that technology can be considered an active mediator in relationships with people and reality. Similarly, this theory will be explored more in the data analysis section.

Next, I intend to conduct interviews with players on the UVA women's soccer team as well as Strength & Conditioning coach Peter Alston. These interviews will try to get a more qualitative perspective on wearable technology, players' concerns, how it impacts their gameplay, their psychology, and other factors. An interview is the best way to pursue this research because it is more in depth than a survey while still understanding the qualitative aspects of the player-technology relationship. True understanding of this relationship cannot be described by participant observation, only by the players themselves. This data will then be synthesized and analyzed in order to understand how players interact with the technology and

how it impacts them. Due to the small sample size, it may be hard to scale these findings globally. To mitigate this, however, we will combine the interviews with document analysis on related topics. Understanding players' relationships with technology in other sports and globally will be crucial in order to understand the conundrum.

Data Analysis

Sports League Document Analysis

Sports leagues across the globe have adapted to the changing conditions associated with the Covid-19 pandemic. Regulations such as mandatory masks, frequent testing, limited spectators, and socially distanced events have been commonplace in sports leagues worldwide (Goodell, 2020). Some of the more prominent leagues and associations, however, have adopted wearable sensors as part of their combat against the virus. The analysis below intends to answer my research question of how leagues have used wearables in their Covid-19 protocols and policy.

The first league to restart after global sports' stoppage was the NBA with their "bubble" concept (Baccellieri, 2020). They utilized Kinexon Safezone as their wearable solution, allowing this product to emerge as the premier social distancing solution. The device was mandatory for all staff members and media, and would beep if two sensors were within six feet of each other for a substantial amount of time. Now, the league is requiring players and team staffers to wear the SafeZone sensors during all team-organized activities. Players are subject to discipline such as fines and suspensions if the sensors are not worn. The wearables record the distance and duration of in-person interactions, allowing for an effective solution to contact tracing. Interaction metrics include distance between players and time of interaction. Data is

anonymized and only shared with the league and individuals' team, not other teams, to mitigate any security issues. It is a strong effort of collaboration by the NBA, players' union, and medical officials to ensure the safety of the league.

Many other leagues have followed the NBA and adopted Kinexon Safezone as their provider of sensors and contact tracing software. The NFL made it mandatory for all players and personnel to wear the tag at club facilities, practice, and travel (Golden, 2020). The tags also attain data on how practices can be made safer and more socially distanced. Across the world in Germany, Bundesliga followed suit and mandated the technology for all players and personnel (Cohen, 2020). The technology requires no infrastructure, making it easily scalable and implemented. Similarly, the South-Eastern Conference in NCAA and the MLB enacted Kinexon Safezone once their respective leagues resumed from the virus (SEC Staff, 2020).

Years before the pandemic, athletes and teams across the world used a wearable sensor called the Catapult to improve performance, monitor health, and prevent injury. This company supports over 3000 teams globally and improved their product to monitor player's proximity data as well in response to the virus (Catapult Staff, 2020). Catapult added new wellness parameters and a detailed proximity report. This product is most popular in soccer, with English Premier League teams such as Chelsea, Tottenham, and Newcastle extensively using it to adapt their practices and utilize data (Cohen, 2020).

Some leagues are utilizing different types of sensors to combat coronavirus. These types of sensors do not contact trace, but have actually been shown to help predict a positive test. These sensors monitor health data such as heart rate and sleep patterns, which can be early predictors of the virus. One of these products, the Whoop, alerted golfer Nick Watney before a

tournament that he may have the virus, potentially saving many people (Ahmed, 2020). In response to this, the PGA, LPGA, and Premier Lacrosse League purchased 1000 of the Whoop bands to anyone who wanted one. A similar product is the Oura Ring, which helped UFC fighter Daniel Cormier learn he had the virus before an upcoming fight (Golden, 2020). This allowed him to prepare accordingly and stay safe before spreading the virus to anyone else. Soon after, Oura Ring announced a partnership with the UFC, providing an Oura Ring for all fighters who wanted one. These devices also provide performance analytics for elite athletes as they prepare for their next event.

All of these technologies together showcase how this human-nonhuman aggregated enterprise will change the world of sports moving forward. Sports are no longer solely human-human, and wearables are essential in how sports continue to develop. They have the ability to enhance performance, prevent injuries, and even combat the novel coronavirus through social distancing mechanisms and contact tracing. League operations, policies, and interactions are all becoming increasingly dependent on wearables, and this will continue well into the future.

STS Framework Analysis - NBA Bubble

Actant-network theory can be applied thoroughly to this system of athletes, league and team executives, and technology in the NBA Bubble. This is because of the multitude of human and non-human actors that are crucial to the spread of wearable technology. This theory argues that the construction of technology is through both humans and non-humans, not only by politics or social groups. Some of the human actors recruited into this network are the NBA players, league and team executives, technology developers, and player unions. The most important nonhuman actors to consider are the wearable devices, Disney World (the setting of the system) ,

the media, and policy. Players in the Bubble used the technology, and spread awareness of it to the masses through media. This helps create a larger global network involving wearable technology going forward. League executives decided that all staff and media members must wear Kinexon Safezone tags, meaning humans and technology are working together for the NBA to resume operations as safely as possible (Baccellieri, 2020). These policies must be discussed and agreed upon with Disney World as well. Before the Bubble was finalized, the National Basketball Players Association (NBPA) helped protect the interests and safety of the players before any policies were finalized. Finally, it is very important to consider the scientists and tech firms who are constantly unlocking novel applications of wearable technology in sports and developed the social distancing and contact tracing solutions for the Bubble.

There have been many instances of successful and failed processes of translation in the formation of this actant network. One strong example to consider is that between the players, the technology, and NBA executives with regards to security. Security concerns have consistently been expressed by players, as discussed in the literature review. This will always be a consideration as technology becomes more ingrained in our everyday lives, but is important to mitigate. Kinexon and the NBA assured the data is completely anonymous while league executives emphasized the importance of player safety and desire to resume playing their respective sports. This process of translation was crucial in redefining actors' interests, addressing concerns, and creating policy that all parties will agree to and will be mandated to follow. Another translation occurring in the system is between the athletes and the media. Professional athletes have media “followers” on the order of millions, and have been actively promoting safe practices while playing sports and the benefits of the technology. Through this

medium, the technology has spread to more and more sports leagues across the world, including the NFL, English Premier League, Bundesliga, and more.

Mediation theory is a strong framework to apply to this system of athletes, wearable sensors, and the policies enacted by the leagues behind sports. The sensor technology is certainly an active mediator and guides policy and consequences throughout the NBA Bubble. In this system, the users are the players, staff, and media wearing the sensor. Kinexon developed their sensors and analytics software to adapt to Covid-19 and enable proper social distancing guidelines for the NBA Bubble and sports leagues in the future. These sensors have alarms that alert users when they are within 6 feet distance for an extended period of time. This completely changes social interaction between humans as it essentially forces people to stand further away from one another and interact completely differently. This will translate to sports leagues across the world as the pandemic will certainly be a part of our lives for the foreseeable future.

This technology also impacts the NBA's policy in that if an athlete were to test positive for the virus, the sensor data would be utilized to conduct contact tracing and see which staff members or players were in close contact with the positive case given the sensor's thresholds. This threshold consequently impacts players, team, and staff greatly with their actions and consequences. Players unions have thus negotiated with the league to ensure the sensor data cannot impact their contract if any negative information is discovered. It is interesting to analyze this system's two-way interaction with the sensors as they were previously being used for performance and recovery analytics. Decisions by coaching staff and players were greatly influenced by the technology, but now it has adapted to the novel coronavirus and mediates day to day interaction greatly.

Interview Analysis

The sociological research questions of how wearable technologies affect athletes were analyzed by interviews with two members of the UVa women's soccer team, McKenna Angotti and Lauren Hinton, as well as Strength & Conditioning Coach Peter Alston who works extensively with the sensor data. Alston described his program as "data-informed, not data-driven," emphasizing his program's holistic approach while also acknowledging the importance of wearable sensor data. Alston says that the data is very practical and applied every day, however qualitative metrics such as conversations with the players are just as important for decision-making. The combination of data and prior methods creates the strongest path towards performance enhancement, states Alston. The players wear the Catapult, a wearable sensor embedded in a sports vest. This sensor has an accelerometer (to measure accelerations and force), a gyroscope (to measure rotation), and a magnetometer (to measure body orientation). All three sensors collect data in three axes, or directions, allowing sensitive 'maps' of athlete movements and actions to be created.

Angotti, Hinton, and Alston all reported UVa soccer uses the data for load monitoring. Players submit a readiness report on a scale of 1-10 before and after practices and weight training measuring how sore and tired the athlete is at that given moment. Alston utilizes the data to plan individuals' workouts, keep track of prior injuries, and schedule the fitness portions of practice. Hinton mentioned the fitness staff monitored a teammate's back injury using the Catapult, ensuring she did not favor one side of the back when recovering. Angotti and Hinton did not know what exact data the wearables collected; however, this was due to their trust in Alston's analytics and coaching, not a lack of communication.

Angotti and Hinton both contracted the virus in Fall 2020 and the Catapult's data was not used for contact tracing. This is an aspect of the technology Alston plans to implement in the near future as we continue to adapt to the virus. Angotti did mention, however, that the heart rate data was being carefully monitored once she returned to the soccer field. This data was leveraged to track her progress on returning to full stamina and tailoring workouts accordingly.

Comfort and performance interference are two very important considerations for wearables in a sports setting. Hinton and Angotti both started wearing the technology in summer 2018, and now do not even notice it. "It's just such a habit at this point, I don't really even think about it anymore. Putting on the Catapult is just like putting on my cleats or shin guards," said Angotti. Both players were firm in agreement that the wearables had no impact on their comfort or performance. The technology has been adjusted so that it is simply embedded into the clothing and is practically unnoticeable. Angotti's one recommendation was to consolidate the technology to one device, so it wouldn't take as much time preparing for practice or a game.

When asked about the social implications of the technology, the players were somewhat conflicted. After games, Alston analyzes the data and produces a "Performance Report" which informs the players how far they ran that game, how many touches on the ball, max sprint speed, and other statistics. While most athletes on the team just glance at the data and compare it to the prior game, some get competitive. Players could potentially see each other's reports, however Alston stated that it does not tend to happen. Regardless, however, players formed slight rivalries to see who worked the hardest or performed the best each game. Hinton and Angotti claimed the majority of the time the performance reports breed competition, but occasionally spark trouble in the locker room. Both, however, acknowledged these were small rivalries and not a huge distraction at all to the team and its goals. Similarly, this performance report is used

in what are called “split-squad” practices in which one group practices more intensely than the other based on their performance metrics from the report. Angotti stated that sometimes players can feel slighted by the data and believe they belong in the hard-working group. The players again insisted on the lack of the severity of the conflicts, but admitted they do exist. Overall, Hinton and Angotti agree that the benefits far outweigh the negatives, with safety, comfort, and security not being of concern at all.

Again, actor-network theory is a strong way to analyze this case study. The relationship dynamics between the soccer team, the Catapult, and the coaching staff are very interesting. The human coaching staff and non-human sensors work together to form social relationships and make decisions for the team. The Catapults are perturbing the surface of team dynamics and are essentially becoming a member of the team, given their capacity for performance enhancement and their breeding of competition. It can be argued they are as important as a member of the coaching staff and its significance in decision-making is undeniable. The team’s capabilities are constantly being improved through this network of non-human technologies and human team members and staff.

Discussion

Wearable devices have begun to change the meaning of sports and the social norms of team performance. The technology was essential in ensuring the return of sports leagues everywhere, as highlighted by the NBA Bubble case study. There are instances where the technology enforces 6 feet social distancing, completely transforming the way people interact in sports. The technology can also influence player psychology, competition, and completely change the structure of training sessions. It's essential for teams to compete at the highest level,

as its performance enhancement features, load monitoring capabilities, and injury prevention. The future of sports is one where technology continues to be leveraged more as research into sports analytics grows. This technology will fundamentally change the way we look at sports, the way leagues operate, and how they are played forever. Sports have transformed into a human and nonhuman machine as technology changes social and performance norms globally. Developments are only becoming more advanced, so it will be interesting to continue to see the cases of technology in sports.

Conclusion

Wearable technology has been paramount in sports' response to the novel coronavirus. Professional and collegiate sports teams around the world have adopted these sensors for contact tracing and social distancing, not to mention advanced analytics to help make more informed decisions. While different leagues have different regulations regarding the virus, it is clear that technology is influencing human interaction more than ever. While the vaccine may put an end to the global quarantine, technology is more prepared than ever to respond to another global tragedy. It will be important to continue this technological development, while still considering its effects on society, how people interact, and how it affects policy.

There are many social and physical dimensions of the implementation to consider, however many were deemed negligible. The wearables are seamlessly embedded in clothing, making comfort not a concern at all. Some professional athletes have raised concerns about security, but overall leagues have emphasized education on the technology so players are aware how the technology is used, what personal data is being collected, and the implications this data

has. Athletes and player unions have ensured to protect their interests and not allow technological data to influence contracts and their ability to make a wellbeing.

The case study on the UVa women's soccer team yielded similar findings, however identified other social issues. Players compete over whose data has the best "performance" and are placed into different practice groups due to the wearable data analysis. While this does create some social conflict, Angotti and Hinton emphasized that the wearables spark motivation before causing any real trouble in the locker room. The players, like the majority of the sports world, understand the value added by the wearables and the applications in load management and performance analytics. Wearable technology and sports will continue to grow together and influence one another as active mediators. It will be interesting to see what is next in scientific development and the capabilities of technology in sports.

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