An Analysis of Vehicular Telematics and Geo-Location Data to Maximize Road Safety

Policy and Integration of Different Technological Enhancement Gear in Sports

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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

In response to the spread of COVID-19, the Center for Disease Control and Prevention initially recommended the usage of masks. Later after discussion in each state government, state by state started to mandate them, eventually leading to masks being mandated federally. This policy aimed to "curb community transmission and mitigate the spread of the virus." (Huang, 2022). Such policies play a crucial role in structuring our society and the world that we live in. Influencing our behavior and structure, they provide a guideline for us humans and the organizations we exist in.

Society and the world today are built and maintained by such policies. Policies give people rules and different ways to structure themselves. However, for each policy given, there is always an instigator or a reason why certain policies are put in place. (Jones, 2022). Through both my STS project and the technical project, I will explore how different technologies like vehicles on the UVA campus and the technological gear advancements in sports, influence the development of the policies of their two respective worlds: UVA traffic and sports.

First, my prospectus will look at methods for identifying safety hotspots at UVA and how that can lead to the University's policy development. UVA students commonly claim that "the city of Charlottesville has the worst drivers," often expressing this assertion through word of mouth or social media channels like YikYak and Reddit. The hazards of the roads in Charlottesville are also a primary concern for the UVA Facilities Management, who are in charge of maintaining the different on-grounds facilities. As a result, our team was tasked to identify various safety hotspots on grounds using vehicular telematics data. By answering the overall research question, "Which spots on campus are most prone and most at risk to accidents?" we

aim to assist UVA Facilities Management and enhance the safety of drivers who drive through grounds.

Secondly, my prospectus will answer the question of how new technological enhancement gear influences the formulation of rules and guidelines in sports. In the world of sports, new technologies in gear have arisen that have allowed for increases in comfortability and protection. However, the most controversial change that these technological gear advancements have introduced is the enhancement of the performance of its users. These changes in performance prompted the integration of numerous policies in various sports to permit and establish guidelines for future technological gear enhancements. In the topic description, I will provide an analysis of a specific performance-enhancing gear, then will outline a timeline of planned research and identify the relevant STS framework.

Technical Topic

Although there have been many complaints in the Charlottesville area about its drivers, there have not been many accidents to support this claim. When looking at driving behavior, many studies in the past have avoided incorporating crash data as a way to measure risky driving behavior due to its limitations and unavailability. Instead, different surrogate measures, such as harsh braking, proximity to each car, and speeding, have been opted to be used. (Winlaw, 2019).

My capstone project group, led by Professor Brian Park and consisting of two other System Engineer students and four Computer Science students at Virginia State University, has adopted this same methodology in our efforts to accomplish UVA FM's task of identifying safety hotspots on grounds. Two hundred seventy of UVA FM's vehicles are equipped with an onboard device called GeoTab, which reports various vehicular statistics like harsh acceleration, harsh braking, and speeding, along with their geolocation, onto the Geotab website. (Hansen, 2019).

However, limitations exist in the Geotab data and system. For one, Geotab is currently pinged to every fifteen seconds, meaning that it will not record and miss events like a second harsh brake within that interval. Secondly, Geotab has a capacity in the data that it can store. (Hansen, 2019). To address these limitations, we plan to incorporate the Internet of Things Network, which is connected to different LoRaWAN gateways currently installed on UVA grounds. Through these gateways, we can better capture the geolocation of the events like the second harsh brake in the example above.

Using the geolocation data from Geotab and the Lora Gateway, our capstone team plans to map out all the instances of harsh acceleration, harsh braking, harsh cornering, and speeding within a specific time frame onto a Google Maps API. We will then compare this with the historical crash data from the same time frame for verification. Based on the map results, we will establish the threshold number of instances of violations an area must exceed for it to be deemed as a safety hotspot.

By identifying these safety hotspots through telematics data, we then wish to provide recommendations on reducing the likelihood of accidents in these hot areas. Variables like the zone's environment (stop signs, foot traffic, stop lights) and the time when most violations occur in those zones will be analyzed. Our team hopes that by pinpointing these safety hotspots and providing recommendations, UVA FM will create the appropriate policies to minimize the risk of accidents for both the safety of UVA FM vehicles and UVA drivers.

STS Topic

In 2019, Nike released the Nike Vaporflys. This revolutionary running shoe featured advanced technologies, including the ZoomX foam on the sole that was crafted from a flexible yet rigid Pebax thermoplastic polymer. This foam boasted an 85% energy return, a significant

improvement from the previous model's 60%. The sole also incorporated a spanning carbon fiber plate for more optimal support at the runner's foot-ground contact point, minimizing weight to approximately 200 grams. On top of all of this, a new water-resistant lightweight plastic on the upper part of the shoe is incorporated to keep the weight of the shoe down. Nike boasts that the Vaporflys can increase a runner's speed by up to 4 to 5 percent. (The Interline, 2020).

The immediate impact of the Vaporflys on performance became evident when Kenyan long-distance runner Eliud Kipchoge, wearing the previous Vaporfly version, broke the world marathon record in the 2018 Berlin Marathon. After the release of the newer prototype versions of the Vaporflys, Eliud Kipchoge broke his record by seventy-eight seconds the following year. In addition, in all of the different 2019 major marathons that were hosted, thirty-one out of thirty-six runners who held podium positions wore the Vaporflys. (Dennehy, 2020).

After recognizing the significant competitive advantage these shoes provided, the World Athletics, a sports governing body that oversees the different running sports, had to intervene. In 2020, they introduced regulations banning shoes with soles thicker than 40 millimeters or containing more than one plate, the features present in the Vaporflys. In addition to this, the new regulations state that shoes worn by runners "must have been available for purchase on the retail market for a period of four months," thereby banning the prototype versions Kipchoge wore during his sub-two-hour marathon. (Dennehy, 2020). The Vaporflys gives us an example of a technological gear advancement that was not accepted by the sport. While it was not accepted, it still had a massive impact on running policy, as new guidelines were made on the eligibility of the shoes that could be worn.

As highlighted earlier, the policy adjustments made by World Athletics in response to Nike Vaporflys underscore the critical need for further research on the interaction between

technological gear enhancements and policy. There are many other examples of performance-boosting gear causing policy shifts that exist beyond running. This fact prompts my plan for my initial course of research to be exploring such cases to comprehend their impact on sports policies. In fact, I am interested in looking deeper into Speedo's LZR Racer, which was banned following its role in generating record-breaking swimming performances at the 2008 Olympics. (Betuel, 2020). Through the research of the LZR Racer, I can better understand why certain gear causes drastic changes to policy.

Subsequently, I plan on researching gear enhancers that are viewed differently from gear like the Vaporflys. Few examples exist of new technological gear that boosts performance without facing significant criticism or prompting major policy changes by sports governing bodies. For example, the tennis racquet has evolved with minimal restrictions throughout the history of tennis, being developed for more "power, control, and maneuverability." (Sanchez, 2023). The customization of tennis racquets to match the user's play style has caused professional tennis players like Roger Federer to increase their performance (Goodall, 2010). This prompts another sub-research question: "What are the qualities of new technological gear enhancers that cause them to be less controversial than others?" Both new customizable tennis racquets and the Nike Vaporflys are enhancing the performance of their users, but why is the tennis racquet met with fewer restrictions? By researching and exploring these questions, I will be able to have a firmer grasp of the intricate relationship between technological gear enhancements and policy.

For my STS Framework in my research, I plan on utilizing the Social Construction of Technology (SCOT). The SCOT framework delves into the "technical change in society as a result of technology" and also "the relationship between society and technology." (Bijker, 1987).

By incorporating this framework, I aim to examine how performance gear enhancements interact with their respective sports and influence associated policies. In addition to this, I can investigate the impact of these new technological gear advancements not only for professional athletes but also for amateur or novice-level athletes. Ethical considerations, such as the integration of such technology at the youth level and the potential disadvantages for certain athlete groups, can also be explored using this framework.

In summary, by researching various examples of technological gear enhancements and their interaction with policy, I can see in what cases performance gear enhancers are accepted and rejected in sports. However, the implications of this research extend beyond the world of sports. By understanding the interplay between technological advancements in gear and the formulation of policies, people can gain insight into how emerging technologies influence our society and our decisions and can guide us in effecting necessary changes to accommodate these innovations.

Key Texts

Bijker, W. E., Hughes, T. P., Pinch, T. J., & Douglas, D. G. (1987). In *The Social Construction of Technological Systems New Directions in the sociology and history of technology*. Essay, MIT Press.

In this essay, Pinch and Bijker talk about the importance of understanding the context of technological artifacts and how they are socially constructed. In addition, Pinch and Bijker argue about how different social actors and institutions also interact with the artifacts. This is the basis of the STS framework SCOT or the Social Construction of Technology. This essay is relevant to my prospectus because my STS project incorporates SCOT, and I base the SCOT definition in my prospectus on this paper.

Betuel, E. (2020, August 5). Olympics flashbacks: *How a NASA-designed Swimsuit rocked the 2008 games*. Inverse. https://www.inverse.com/innovation/olympic-glory-week-lzr-swimsuits

In this article, Betuel explores the impacts and technical aspects of the Speedo LZR Racer swimsuit, which took the 2008 Beijing Olympics by storm. By analyzing this technological gear performance enhancer, Beteul argues that there has been a strong profound influence of technological advancements in swimsuit design and that governing bodies must adapt quickly. This paper is relevant to my prospectus because I stated that I wanted to learn more about this technology, and it gives a sneak peek of details about it.

Dennehy, C. (2020, January 31). *Nike Vaporfly shoes avoid complete ban by World Athletics* - Runner's World. Runner's World. https://www.runnersworld.com/news/a30721631/nike-vaporfly-ban/

"Nike Vaporfly Shoes Avoid Complete Ban by World Athletics" explores the policy changes that the Nike Vaporfly forced World Athletics to make. It argues how different guidelines need to be made for the type of shoes allowed in competitions. This article is relevant to my prospectus and, more specifically, the section on the impact technological sports gear enhancements have on policy. It gives an example of technological gear forcing a change in the former policy of World Athletics and how it changed the policy. In addition to this, it gives the STS topic a reference for the technical and engineering aspects of the Nike Vaporfly.

Goodall, J. (2010, November 22). *The Controversial Evolution of Rackets*. The Wall Street Journal. http://www.wsj.com/articles/SB10001424052748703805704575594390443262092

The Controversy Evolution of Rackets argues against the evolution and different developments of the tennis racquet. Providing different historical examples of the tennis racquet and where it is now gives insight into the criticism of implementing this type of technology into the sport. This paper is relevant to my prospectus as it gives an example of how the customization of tennis racquets increases performance. In addition to this, while I did not explore this in my prospectus, this paper will prove helpful in my STS project, as it gives another opinion on the less controversial integration of different types of tennis racquets into the sports world.

Hansen, S. (2019, April 26). *Dev update: Geotab result and rate limits*. Geotab. https://www.geotab.com/blog/result-and-rate-limits/#:~:text=It%20can%20be%20used%20in,provide%20a%20GetFeed%20equivalent%20method.

In this blog, Hansen explains the new update of geotab. Hansen explains that in the new update, there will be reasonable results and rate limits to its API, along with existing

features. In addition, Hansen talks about the GetFeed requests from Geotab, which allows the vehicle's statistics to be posted on the website and then onto a Google Maps API. This blog is relevant to my prospectus as it gives information about the functionalities of Geotab and the limitations of the data it can store. Both of these are explained in my prospectus, and this blog gives evidence for my explanations.

Huang, J., Fisher, B. T., & Tam, V. (2022, February 16). *The Effectiveness of Government Masking Mandates on COVID-19 County-Level Case Incidence Across The United States, 2020*. Heath Affairs. https://www.healthaffairs.org/doi/10.1377/hlthaff.2021.01072

This study assesses the impact of county-level public masking mandates on the spread of COVID-19 during the early stages of the pandemic. In the paper, Huang argues that there is strong evidence that these county-level masking mandates contributed to reducing the number of cases within a community. This source is relevant to my prospectus because it gives an example of a policy that was enacted to help out a community. In addition, it shows the importance of policy on society, supporting my claim in the introduction of my prospectus about how it does.

The Interline. (2020, April 23). *Technical innovation in sportswear: The controversy*. https://www.theinterline.com/02/2020/the-controversial-technical-advancements-in-sports wear/.

Technical Innovation in Sportswear: The Controversy argues against the different technological gear enhancements made by different companies. The writer does this by exploring two different examples of gear enhancements, including the LZR racer swimsuit and the Nike Vaporflys. This article relates to my STS project as it provides an example of two pieces of technological gear advancements that were met with a lot of controversy in

the world of sports. In addition, the article provides much information on the engineering of the Vaporfly and LZR racer swimsuit and the different impacts and policy changes that were forced to be made because of it.

Jones, H. (2022, July 14). *What are policies and why they are important*. Collaboris. https://www.collaboris.com/what-are-policies/#:~:text=They%20are%20created%20to%20ensure,should%20behave%20in%20certain%20situations.

Collaboris, through this article, explains what exactly policies are and why they are essential, specifically in an organization. Collaboris claims that policies within an organization guide its employees, customers, and suppliers and also protect the organization from different issues and liabilities. This article is relevant to my prospectus because it highlights the importance of policy on society, or in this case, an organization.

Sanchez, A. (2023, July 3). *The evolution of Tennis Racquets - Past & Present*. Racquet Point. https://www.racquetpoint.com/blogs/racquet-point-blog/the-evolution-of-tennis-racquets-from-wood-to-modern-technology

"The Evolution of Tennis Racquets - Past & Present." explores the history and evolution of the tennis racquet and what different advancements were made concerning them. It gives an argument as to what type of tennis racquets were better for different purposes. In my STS paper, I want to include an example of a technological gear advancement that was met with little to no resistance by the sport implementing them. Tennis racquets meet this description. This paper gives a plethora of different ways that tennis racquets can be designed, given the basic guidelines that the sport has for it.

Winlaw, M., Steiner, S. H., Mackay, R. J., & Hilal, A. R. (2019, June 25). *Using telematics data to find risky driver behaviour*. Science Direct. https://www.sciencedirect.com/science/article/pii/S0001457519304956

This paper explores a method of finding risky driver behaviour using telematics data. The authors claim that because crash data is limited, they use different surrogate measures, such as speeding, from the telematics data. The researchers found that out of all the surrogate measures, speeding was the only significant driver behavior variable linked with crashes. The research is relevant to my prospectus because it gives an example of a past study incorporating the same methodology as our capstone group. In addition, it gives evidence to the fact that telematics data can be used to identify risky driving behaviour or, in our capstone's case, identify safety hotspots.