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Building an End-to-End Incident Management Platform for Elite Level UCI Races

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1 Abstract

Elite-level road cycling races operate in complex, dynamic, and high-risk environments. With race convoys spanning multiple kilometers, high rider speeds, variable terrain, and dense roadside infrastructure, effective incident management is critical for long-term safety improvement. Incident data has historically been fragmented across commissaire reports, broadcast footage, team communications, and post-race medical summaries. In this research, we present the design and implementation of an end-to-end incident management platform used by UCI and SafeR officials that integrates operational, technical, medical, and public data streams into a unified system to support decision-making, safety analytics, and preventive screening for future race editions. For instance in the 2025 season, 640 incidents were recorded involving 802 distinct riders. 88% originate from uci officials vs. 12% sourced from social media. At the core of the platform is structured incident generation by UCI race commissaires operating in-race vehicles. Using Veloviewer as a geospatial interface, commissaires log incidents in real time, tagging GPS coordinates, and inferring race context (stage, sector, kilometer marker), riders or vehicles involved, and preliminary categorization (e.g., crash, obstruction, rule infringement, infrastructure hazard). The in-car workflow is optimized for speed and minimal input, recognizing that the commissaires primary concern remains race supervision. Incident records generated through Veloviewer automatically populate the incident management database, creating a location-specific tag which is

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further extended after the race. Where available, Video Assistant Referee (VAR) teams provide a second input stream. Utilizing broadcast feeds from fixed cameras, motorcycle and helicopter footage, VAR officials attach video clips to the incident entry. The integration of VAR data reduces reliance on narrative-only descriptions and enables downstream (safety) analysis through computer vision techniques. Following the race, SafeR analysts further validate and extend the information included in the incident (involved riders, causes, etc.). Their role is to reconcile discrepancies between commissaire entries, VAR footage, and social media reports (from verified accounts), or in some cases, add missed incidents. Note that most incident inputs consist of standardized taxonomies to ensure cross comparability across events and seasons. Within the UCI World Tour, team medical representatives contribute further medical data (Fallon et. al, 2026). These include anatomical injury location, and a provisional severity indicator expressed as estimated days out of competition/training. By linking medical outcomes to the original incident record, the platform supports severity-weighted risk analysis rather than relying solely on incident counts. This distinction is important: not all crashes are equal in consequence, and safety interventions should be focused and prioritized based on potential severity. As part of ongoing platform development, we are piloting the integration of AI-enabled tracking devices capable of automated crash detection. These wearable or bike-mounted devices combine sensor and GPS values with machine learning models to identify crash-like events in real time. Beyond crash detection, aggregated tracking data provide contextual variables such as rider density, relative speed differences, speed entering technical sectors, and peloton configuration at the moment of impact. While experimental, these data streams offer an evidence base to better inform regulatory interventions, including targeted speed-reduction measures and other safety-focused rules introduced by the UCI. Beyond management and post-event analysis, a key innovation of the platform is its reuse of incident data for proactive safety screening in future race editions or other races using overlapping routes. Geospatial clustering algorithms identify high-incidence zones, such as specific descents, roundabouts, road narrowings, or finish straight configurations, and generate risk flags when these segments appear in proposed race itineraries. Historical incident profiles are presented to organizers and safety delegates during pre-race screening. This allows incident data to be used in a predictive planning tool and provides a data driven way of tagging dangerous points in combination with the machine learning based video analysis output on pre race parkour recordings (traversed with a camera on a car). The implementation of this end-to-end incident management system demonstrates that improved safety insights in elite cycling is achievable through structured data, captured from multi-source integration design. By connecting in-race officiating, video review, digital public signals, expert analysis, medical outcomes, and forward-looking route screening, the platform provides a holistic view of race risk. As elite road cycling continues to evolve in speed, technology, and global reach, such integrated systems will be essential for safeguarding athletes while preserving the competitive integrity and spectacle of the sport.

Conflicts of Interest: The authors declare no conflict of interest.

References

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