From Rural Exposure to Urban Conflict: Citizen Hazard Reporting for Municipal Road-Safety Policy

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Abstract. Citizen hazard reporting platforms promise to complement crash statistics, yet it remains unclear how they can support preventive municipal road-safety governance in rural regions. We examine "gefahrenstellen.de" as a platform of community-led problem articulation for infrastructural change and compare rural and non-rural articulations of risk. Using a comparative convergent mixed-methods design, we analyze 10,375 hazard reports (2018–2026) and 4,910 comments available within the reports. Quantitative patterns indicate that rural reporting is more strongly associated with motor-traffic exposure and visibility or geometry conditions, whereas non-rural reporting is more strongly associated with cycling and intersection or violation dynamics. A thematic analysis identifies two dominant place-based logics of hazard articulation: rural hazards are more often framed as exposure, while non-rural hazards are more often framed as conflict. These logics translate into distinct policy-facing strategies of change: baseline protection versus choreography and ordering packages, which we develop into policy implications for municipal road-safety action, including prioritization of baseline thresholds in rural regions and interaction-order interventions in non-rural networks.

Keywords. Rural HCI, hazard reporting, road safety governance, participatory sensing, municipal governance

1 Introduction

Across Europe, rural regions are simultaneously framed as spaces of structural vulnerability and laboratories of digitalization-driven "revitalization". Policy agendas such as the European Commission's Long-Term Vision for Rural Areas explicitly highlight challenges around service accessibility, connectivity, demographic change, and resilience, while also promoting new forms of participation and place-based action (European Commission, 2021; Kastrop et al., 2019). At the same time, empirical work on rural digitalization and "smart villages" shows that innovation in rural contexts often unfolds as procedural, locally negotiated social innovation rather

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than as startup-driven product development, shaped by local actors, institutional interfaces, and uneven capacities for sustained engagement (Sept, 2020; Zerrer et al., 2022).

Road safety offers a particularly concrete lens onto these dynamics. Historically, municipal road safety practice has relied on police-reported crash data and black-spot logics. However, a long research tradition in traffic safety argues that crash records alone are limited for proactive governance, as crashes are comparatively rare events, underreporting and missing behavioral context can be substantial, and long observation windows can create a "wait for harm" dilemma. This has motivated approaches that treat surrogate safety indicators and near-miss evidence as complementary inputs to identify latent risk before severe incidents accumulate (Arun et al., 2021). In parallel, HCI and GIS-adjacent work on participatory sensing and volunteered geographic information has argued that citizens can contribute place-based observations that augment conventional datasets, while raising questions of credibility, representativeness, and the translation of local knowledge into institutional action (Burke et al., 2006; Goodchild, 2007).

In Germany, "gefahrenstellen.de"[1] is an instructive case of this development. The platform explicitly mobilizes public participation to collect hazard reports, combine them with additional sources (e.g., crash data and sensor-based data of critical maneuvers), and provide processed outputs to authorities, municipalities, and research, framing hazard reporting as a proactive road-safety infrastructure rather than a mere complaint channel (Deutscher Verkehrssicherheitsrat e. V. (DVR); Ehlers et al., 2022; Initiative für sichere Straßen GmbH, 2026). Yet, despite growing interest in citizen-derived safety data, a key gap remains, as we still know too little about how rural and non-rural communities differ in their perception of mobility risks and what these differences imply for policy-relevant prioritization and intervention. This gap is consequential because both traffic-safety and civic-data research caution against treating participatory reports as a uniform proxy of "need" and rural contexts remain underexplored in surrogate or near-miss safety analyses, while volunteered and resident-reported data are often spatially biased in ways that can distort inference and resource allocation if used uncritically for governance (Kontokosta and Hong, 2021; Leschik et al., 2024; Zhang and Zhu, 2018). Furthermore, it matters because rurality is not simply "less urban". Rural HCI research has argued that the urban default of the field can obscure rural contexts as epistemic objects in their own right, leading to "urban hand-me-down solutions" that miss rural constraints and practices (Hardy et al., 2018, 2019a,b; Robinson et al., 2021; Shove, 2022; Su et al., 2021).

This paper addresses this gap by analyzing hazard reporting as a form of community-led problem articulation for infrastructural change. Rather than treating reports as neutral indicators of objective need, we understand them as articulations of perceived safety needs through which residents make hazards visible, explainable, and potentially actionable. Infrastructuring (Pipek and Wulf, 2009) is used within this paper in an upstream sense and, thus, not as direct observation of implementation work, but as the distributed civic work through which hazards are made visible, identified, causally explained, and bundled into interventionally meaningful claims that can be translated into maintenance, enforcement, or planning measures under enabling governance conditions. In this sense, hazard

[1] www.gefahrenstellen.de

reports mark early "points of infrastructure" or "points of infrastructuring" as moments in which otherwise backgrounded or normalized mobility conditions become noticeable as breakdowns, frictions, or unmet expectations and are articulated as requiring repair, redesign, enforcement, or institutional attention. This interpretation draws on CSCW and STS accounts that treat infrastructures as ongoing accomplishments that recede into the background during routine use, become visible through breakdown, and require alignment across heterogeneous actors, as well as on "infrastructuring" as a stance toward supporting that long-term alignment work (Hardy et al., 2018; Ludwig et al., 2018; Pipek and Wulf, 2009; Star and Ruhleder, 1994, 1996).

Our research question is policy-facing by design: "How do rural and non-rural communities differ in the articulation and framing of mobility hazards through citizen reporting and what does this imply for municipal road-safety action?" Concretely, we examine how the event ecology of reporting differs across place types, how comments articulate hazards as place-based problem logics, and how these articulations can be analytically condensed into policy-facing strategies of change for municipal road-safety governance.

Empirically, we study community hazard reports from "gefahrenstellen.de" using the full report metadata available (N = 10,375 reports) and the comment texts available in the dataset (N = 4,910 comments) between 2018 and 2026. Rurality is operationalized via RegioStaR 5, a German official settlement-structure typology to support mobility and transport research and infrastructure planning by grouping municipalities into comparable "municipality types" (rural = 55, non-rural $\in \{51, 52, 53, 54\}$) (BMVI, 2021). Building on a comparative convergent mixed-methods design, we combine report-level comparisons (risk recipients, road context, triggers, participation intensity) with a codebook-based thematic analysis of comments to reconstruct place-based patterns of risk articulation (Braun and Clarke, 2006; Guest et al., 2011).

Our findings show that the analysis yields two dominant place-based logics of risk articulation. In rural contexts, hazards are more often framed as exposure, as risk is constructed through bundles of speed, limited visibility or geometry, and missing baseline protections, frequently anchored in routine care mobilities such as school routes. In non-rural contexts, hazards are more often framed as conflict by recurring coordination breakdowns in dense co-presence. These logics matter because they carry different policy-facing strategies of change: baseline protection versus choreography and ordering packages, and therefore point to different policy levers.

Therefore, our work leads to three contributions: (1) Empirically, a longitudinal, place-based analysis of hazard reporting that triangulates report metadata and comment framings to show how rural and non-rural publics make risk legible in systematically different ways. (2) Conceptually, an account of exposure versus conflict as place-based logics of hazard articulation, linking rurality to epistemic conditions of risk-making rather than deficit framings (Hardy et al., 2019a; Pipek and Wulf, 2009; Star and Ruhleder, 1994). (3) Actionable implications for municipal road-safety governance as a policy contribution, including how citizen hazard data can support prioritization of baseline thresholds in rural regions and interaction-order interventions in non-rural networks (Kastrop et al., 2019).

In this way, we align with calls for reconsidering what counts as innovation in rural regions. Here, innovation is not primarily entrepreneurial novelty, but the situated,

community-led work of surfacing infrastructural deficits, articulating safety needs, and bundling feasible interventions within often constrained local governance ecologies (European Commission, 2021; Sept, 2020; Zerrer et al., 2022).

2 Related Work

2.1 Beyond Crash-Only Evidence: Near Misses, Surrogate Safety and Subjective Risk

Road safety practice and research have long relied on police-reported crash records and black-spot analysis approaches. Yet, a substantial body of traffic-safety research argues that crash data alone are structurally limited for preventive governance, as crashes are relatively rare, underreporting can be substantial, and crucial interaction processes leading to hazards are often not captured. This has motivated surrogate safety and traffic conflict approaches that aim to diagnose risk conditions earlier than severe outcomes (e.g., video-based conflict techniques, probabilistic surrogate measures) (Arun et al., 2021; Laureshyn et al., 2017).

In parallel, research on near misses highlights that non-injury incidents are frequent and meaningful, especially for vulnerable road users, and that perceived danger can shape mobility choices even in the absence of recorded crashes. For cycling, near-miss work shows how self-reported incidents capture experiential risk that would otherwise remain invisible in formal datasets (Aldred and Goodman, 2018).

A complementary line of work in risk research helps explain why citizen reports are not merely opinions but structured forms of evidence. Slovic (2016) conceptualizes risk perception as socially consequential and policy-relevant, while also distinguishing "risk as analysis" from "risk as feelings", emphasizing that experiential appraisal is a robust cognitive mode that shapes action and acceptance of interventions (Slovic et al., 2013). This legitimizes analyzing citizen hazard comments as a window into how risk becomes narratable and actionable, without claiming that comments directly measure objective crash probability.

Beyond the move from crash-only evidence to preventive indicators, contemporary policy increasingly frames severe injuries and deaths as unacceptable outcomes that must be reduced through system-level design and institutional responsibility rather than individual perfection. The Safe System approach emphasizes a holistic bundle of levers like safe roads, safe speeds, safe vehicles, effective laws and enforcement, and post-crash care, while explicitly promoting walking and cycling as desirable modes that require protective system design (World Health Organization, 2021). This policy turn is closely related to Vision Zero, which is often discussed as an enabling ethical and institutional paradigm for this shift, re-framing road deaths and serious injuries as preventable system failures and progressively redistributing responsibility toward system designers and governance actors (Belin et al., 2012; Johansson, 2009; Tingvall et al., 1999).

Implementation-oriented synthesis work further stresses that Safe System interventions are highly context-dependent and require robust institutional governance and cross-actor coordination, conditions under which citizen hazard reporting can function as upstream evidence and agenda-setting input rather than merely a complaint channel (International Transport Forum, 2022).

2.2 Citizen Reporting, Participatory Sensing and Civic Data in Municipal Governance

Citizen-generated reports have been theorized as a form of distributed sensing and volunteered geographic information, highlighting how mobile and web infrastructures can collect local observations at scale, while "citizens as sensors" serve as a systematic knowledge resource with distinct strengths and biases (Karakaya et al., 2020; Slovic, 2016).

However, the critical question for policy is not whether citizen data exists, but how they become actionable within public-sector workflows. Work on civic reporting platforms shows both the promise of routable maintenance intelligence and the risks of participation inequality and socio-spatial bias (Kontokosta and Hong, 2021; Matthews et al., 2023). For example, studies of FixMyStreet and related citizen sensor approaches document systematic differences in who reports what and warn that data-driven allocation can reproduce inequities if self-reports are treated as a neutral proxy of need (Matthews et al., 2018; Pak et al., 2017; Rae and Nyanzu, 2021).

A complementary policy-relevant insight from public administration research is that citizen participation and co-production are not cost-free add-ons to municipal work, but organizationally demanding practices that can fail or even undermine public value if institutional conditions are weak. Irvin and Stansbury (2004) caution that participation may be costly and ineffective under certain conditions and therefore requires an informed choice of process design rather than an a priori assumption of benefit. More recent research develops this critique by theorizing "dark sides" of co-production, describing how co-production can produce public value failures and "co-contamination" dynamics that public managers must anticipate and govern (Williams et al., 2016). Complementing this, studies of municipal management show that administrators' support for participation depends on perceived contributions and perceived costs, and that institutional factors shape these cost perceptions (Liao and Schachter, 2018). From the perspective of public professionals, co-production also creates cross-pressures in day-to-day work, requiring facilitation skills, organizational support, and co-production-friendly practices (Agger and Tortzen, 2023). Together, this implies that hazard reporting becomes policy-relevant not simply by collecting more data, but by institutionalizing routable responsibility, feedback, and risk-aware decision routines within municipalities, which is framed by HCI work on civic engagement technologies in public infrastructure maintenance, similarly as a trust- and workflow problem across citizens and authorities (Harding et al., 2015).

This governance challenge is not limited to municipal maintenance. In emergency response, public-private collaborations illustrate how crowdsourced incident reports can complement institutional channels, while also raising questions of validation, accountability, and operational integration (Gizikis et al., 2018). In the German road-safety context, the project FeGiS+ explicitly operationalized this integration logic as crash data, citizen hazard reports, and safety-critical maneuver and sensor data were combined and processed into smart data outputs intended for prevention and planning (Deutscher Verkehrssicherheitsrat e. V. (DVR); Ehlers et al., 2022). This provides a policy-relevant precedent, as citizen reporting is not only a participatory format but also part of an emerging evidence pipeline for preventive road-safety

governance.

2.3 Rural HCI and Place-Based Publics

Rural HCI has challenged HCI's recurring "urban default" by arguing that rurality should not be treated as a deficit framing or smaller city, but as a distinct socio-technical condition shaping infrastructures, publics, and technology practices. Hardy et al. (2019a) call for a design coming from the rural to avoid exporting "urban hand-me-down solutions", foregrounding rural regions as sites of innovation and knowledge rather than mere targets of technological catch-up (Hardy et al., 2018; Su et al., 2021).

Conceptual precision is therefore a central contribution of Rural HCI, showing that rurality is often under-specified in prior HCI work and deriving typologies of how rural is defined and which characteristics of rurality matter methodologically and analytically (Hardy et al., 2019b). This matters directly for comparative designs because it motivates treating rurality not as a simple binary but as an epistemic and infrastructural context that conditions what becomes visible, reportable, and actionable through digital participation.

Rural HCI also emphasizes that rural publics are not simply "thinner" versions of urban publics. Therefore, Robinson et al. (2021) propose "rural islandness" as an analytical lens and foreground publics and rural pluralities, showing how participation conditions, separateness, and local resource constraints shape technology appropriation and collective action. Related work on rural-urban divides in peer production further supports the claim that digital knowledge infrastructures systematically under-serve rural places. E.g., in Wikipedia and OpenStreetMap, rural content tends to be lower quality and more bot-produced, highlighting structural challenges in characterizing rural phenomena through participatory data alone (Johnson et al., 2016).

A further stance of Rural HCI research interrogates how rural users are constructed in design discourse and how systems embed assumptions that can marginalize rural experiences. Hardy and Lindtner (2017) show how rurality becomes a design object through discourse and platform imaginaries, which is relevant for hazard reporting platforms, similarly encoding what kinds of problems can be articulated and what kinds of evidence are legible.

Finally, Rural HCI connects strongly to rural innovation studies that frame digitally supported rural innovation as processual, locally negotiated, and entangled with civic participation, rather than as purely technological adoption. Sept (2020) and subsequent rural work describe how digitalization and social innovation co-evolve in rural settings and how civic participation is a key, yet uneven, dimension of smart village imaginaries (Salemink et al., 2017; Stein et al., 2022; Zerrer et al., 2022). This grounds our idea that hazard reporting can be analyzed as a place-based participation practice through which rural publics articulate safety needs and intervention pathways under infrastructural constraints.

3 Methodology

As the prior research highlights, there are strong accounts for proactive safety evidence beyond crash records, civic reporting as a governance data source with known participation biases, and Rural HCI arguments for treating rurality as an epistemic context with distinct communities and infrastructural conditions. Nevertheless, it remains unclear how rural and non-rural communities differ in the articulation of road-safety hazards through the same reporting infrastructure and how these differences can be translated into policy-relevant action categories for municipal road-safety governance.

Therefore, we conducted a comparative convergent mixed-methods study of citizen hazard reporting on "gefahrenstellen.de" to understand how mobility risk is articulated across place types and how these articulations can be translated into policy-relevant intervention pathways for municipal road-safety governance. The design is convergent because the quantitative and qualitative strands analyze complementary aspects of the same reporting infrastructure and are integrated during interpretation (Fetters et al., 2013; Gamage, 2025; Pregoner, 2024). The research design distinguishes two analytically complementary layers: an event layer derived from structured report metadata (what hazards are reported, under which road and traffic contexts, and for whom) and an interpretive layer derived from free-text comments (how hazards are explained, attributed, and connected to feasible remedies).

For the place-type comparison, we use RegioStaR 5 (R5), a regional statistical spatial typology developed for German mobility and transportation research (BMVI, 2021; Schoo and Schüssler, 2025). R5 distinguishes five spatial categories: metropolitan areas (R5 = 51), regiopolitan and large city areas (R5 = 52), urban-region surrounding areas (R5 = 53), cities and urban areas in rural regions (R5 = 54), and small-town and village-type areas in rural regions (R5 = 55). We use R5 because it provides a suitable level of aggregation for our mixed-methods comparison, preserving the distinction between rural small-town and village-type regions and more urbanized spatial contexts without fragmenting the dataset into overly fine-grained categories (BMVI, 2021). At the same time, and in line with Rural HCI's critique of under-specified rurality and urban-default assumptions, we use "rural" and "non-rural" as context-specific analytical categories rather than as universal descriptions of rural and urban life (Hardy et al., 2019b).

This separation is important for a rural/non-rural place-type comparison because report submission and comment participation are not evenly distributed across place types. In this regard, we treat report-level patterns and comment-level framings as distinct empirical objects and triangulate them in our discussion.

Figure 1 summarizes the comparative convergent mixed-methods design.

3.1 Data Source, Scope and Units of Analysis

The dataset is an export from "gefahrenstellen.de" containing 10,375 hazard reports. Each report includes a URL identifier, a UNIX timestamp, geographic and administrative fields, and multiple multi-select platform taxonomies capturing the hazard profile (e.g., who is at risk, risk types, road situation, triggers). We report a window from 2018 to 2026 to reflect the intended longitudinal framing of the

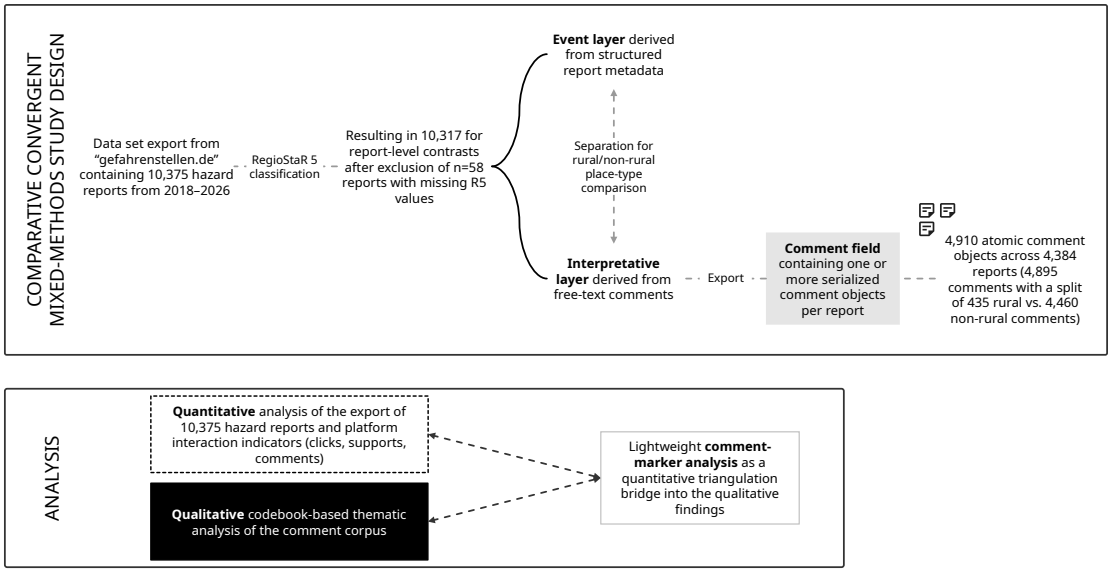

Figure 1. Overview of the comparative convergent mixed-methods research design

project and the platform's reporting horizon.

For the interpretive layer, the export provides a comment field that contains one or more serialized comment objects per report, yielding 4,910 atomic comment objects across 4,384 reports with at least one comment. No comments were removed as empty or non-linguistic. The primary unit of qualitative analysis is the individual comment, not the report, because comments are the position of framing, attribution, and intervention proposals.

To operationalize rurality and implement a transport- and planning-relevant rural/non-rural place-type contrast, we use RegioStaR 5 (R5) place types (BMVI, 2021). We classify R5 $= 55$ as rural and R5 $\in \{51, 52, 53, 54\}$ as non-rural. Reports with missing R5 values (n $= 58$) are excluded, leaving 10,317 for report-level contrasts. In our data, this yields 1,556 reports in rural and 8,761 reports in non-rural regions. At the comment level, 15 comments on reports with missing R5 were excluded from group comparisons, leaving 4,895 comments with a split of 435 rural vs. 4,460 non-rural comments. This operationalization supports interpretability for municipal governance and aligns with established settlement typologies used in German mobility and spatial analyses (BMVI, 2021; Ehlers et al., 2022). It also defines the rural group as places that are both located in rural regions and characterized by small-town or village-like settlement structures.

For reporting and quotation, we treat the corpus as public user-generated content but apply privacy safeguards by systematically anonymizing anchor excerpts (e.g., [PLACE], [STREET]). Furthermore, we avoid reproducing combinations of text and location that could facilitate re-identification. Quantitative outputs are reported as aggregate distributions, effect sizes, and modal parameters.

3.2 Quantitative Analysis

Our quantitative analysis aims to describe how hazard reporting differs across place types in structured categories that are directly legible for municipal road-safety work

and provide an interpretable backbone for triangulating qualitative framings.

First, we analyze participation intensity as a socio-technical feature of the platform, using counts and means of comment count, click count, and support count, and the probability that a report receives any comment. These participation indicators are reported per R5 group and are later treated as a constraint on interpretive inference, because comment availability is uneven.

Second, we compare report-level categorical distributions between rural and non-rural groups across key platform taxonomies (e.g., "who is at risk", "risk type", "road situation", "risk triggers"). Because these fields are multi-label, we treat each category as a binary indicator (selected or not selected) and report prevalence by group. Group differences are assessed via Pearson's chi-square tests, reporting odds ratios and 95% confidence intervals as effect sizes (Agresti, 2013; Agresti and Kateri, 2025; Bland and Altman, 2000; McHugh, 2013). Where appropriate for synthesis, we estimate logistic regression models predicting rural membership (R5 = 55) from selected category indicators, to identify which report configurations most strongly distinguish place types (Hosmer Jr et al., 2013).

Finally, we perform a lightweight comment-marker analysis as a quantitative triangulation bridge into the qualitative findings. Therefore, we use dictionary-style indicators (e.g., speed-related or visibility terms) to compare prevalence in rural and non-rural comments. This step is not used as a substitute for qualitative interpretation but provides a check that the qualitative frames are reflected in systematic textual patterns.

3.3 Qualitative Analysis

To understand how citizens articulate, explain, and translate road-safety hazards into intervention claims, we conducted a codebook-based thematic analysis of the comment corpus. Thematic analysis is suitable for identifying and interpreting patterned meanings in qualitative data, while a codebook-based procedure makes the coding logic more transparent and supports systematic comparison across a larger corpus (Braun and Clarke, 2006; Guest et al., 2011; Roberts et al., 2019).

The analysis followed a hybrid inductive-deductive procedure. The initial codes were informed by road-safety governance, rurality, infrastructure conditions, vulnerable road users, risk mechanisms, and intervention claims. These codes were then refined through close reading of comments from both rural and non-rural subsets to capture locally specific forms of hazard articulation. The resulting codebook specified code names, definitions, coding rules, and anchor examples. Since comments often combined multiple mechanisms and claims, they were coded using multiple coding, whereby a single comment could be assigned multiple codes.

Coding was conducted by two authors using the codebook. Both authors first coded and discussed a subset of rural and non-rural comments to align their understanding of the codes, clarify ambiguous cases, and refine code boundaries and anchor examples. The revised codebook was then applied to the full comment corpus. During coding, ambiguous cases were documented through analytic memoing and resolved through discussion between the two coding authors. After coding, codes were consolidated into higher-order thematic bundles and collaboratively discussed within the author team to develop a shared interpretation of recurring articulation patterns across the corpus.

Table 1 presents a condensed version of our codebook, including the main analytical dimensions, code families, coding logic, and anchor examples. The quotations used in the results section were anonymized by replacing potentially identifiable street names, place names, and numbers with placeholders. As the comments were written in German, we translated the participants' quotes in this document to reproduce them as accurately as possible.

Dimension	**Code families**	**Coding rule**	**Anchor example**
Affected groups	Children/school route, pedestrians, cyclists, accessibility	Comment identifies who is affected.	"On their way to the school bus, the children have to [...] cross the street [...]."
Risk mechanisms	Speed regime, visibility/lighting, geometry/curve/slope, right-of-way/priority, heavy-vehicle asymmetry	Comment explains how danger is produced through speed, sightlines, geometry, priority rules, or vehicle asymmetries.	"Drivers often don't see pedestrians crossing the street until it's too late, often because they're going much too fast around the curve."
Infrastructure conditions	Missing sidewalk, missing crossing, missing lighting, discontinuous path, absent separation	Comment refers to missing, insufficient, or discontinuous protective infrastructure.	"There is no safe access [...] to public transportation [...] and no lighting."
Interactional conditions	Signal phase, junction ambiguity, modal space conflict, parking encroachment, cycling discontinuity, forced merging	Comment describes recurring coordination problems between road users or unclear spatial/traffic arrangements.	"The bicycle traffic light is [...] easy to miss [...] which leads to dangerous conflicts with drivers turning right [...]."
Intervention claims	Crossing intervention, lighting/visibility intervention, speed management, enforcement, signal timing, junction redesign, parking management, cycling continuity, maintenance/repair	Comment explicitly or implicitly proposes a remedy or identifies an actionable change.	"A marking on the [STREET] would indicate that [...] cyclists [...] must yield to pedestrians."
Higher-order analytical bundles	Exposure-related bundle, conflict-related bundle, hybrid cascade	Comment links mechanisms, affected groups, infrastructural conditions, and intervention claims into a recurring problem configuration.	"Since there is [...] no sidewalk, schoolchildren have to walk along the side of the road [...] Drivers cannot see pedestrians, and especially children, in time."
Policy grammars	Baseline threshold, interaction order, enforcement hotspot, maintenance/defect, planning/redesign	Comment implies a broader action logic (e.g., establishing minimum protection).	"Changes to the traffic infrastructure are necessary: 30 km/h speed limit, one-way streets, parking on one side only [...]."

Table 1. Codebook with representative anchor examples

Integration of the quantitative and qualitative layers was conducted during interpretation by comparing report-level category patterns with comment-level code prevalences and qualitative anchor examples. This enabled us to assess whether structured reporting patterns and comment-based articulations converged, complemented, or qualified one another (Fetters et al., 2013).

4 Results

4.1 Quantitative

We analyzed the export of 10,375 hazard reports and platform interaction indicators (clicks, supports, comments). For the rural/non-rural place-type comparison, we use RegioStaR 5 (rural = 55, non-rural $\in \{51, 52, 53, 54\}$), whereas $n = 58$ reports were excluded from group contrasts due to a missing R5 categorization. Report categories are multi-select and correspond to the reporting interface of "gefahrenstellen.de" (e.g., "risk for", "risk type", "street type", "risk triggers") (Initiative für sichere Straßen GmbH, 2026).

Platform interaction differs by place type. According to Table 2, non-rural reports are nearly twice as likely to receive at least one comment (45.6% vs. 24.2%, χ^2 $p <$ .001). Mean clicks and supports are also higher in non-rural reports. This motivates treating the interpretive layer of comments as a selective window into articulation rather than a complete reflection of reporting across contexts.

Group	Reports	Reports with ≥ 1 comment	Share w/ comment	Mean comments	Mean clicks	Mean support
Non-rural	8,761	3,992	45.6%	0.51	12.54	1.01
Rural	1,556	377	24.2%	0.28	8.90	0.36

Table 2. Participation indicators by place type (reports)

Table 3 summarizes the risks for specific victims of hazards. The strongest structural contrast is cyclist salience, where 62.9% of non-rural reports but only 40.7% of rural reports are marked (OR = 0.41). Rural reports more often foreground cars, trucks, buses, and motorcycles as at-risk groups.

Risk for	Rural (%)	Non-rural (%)	OR	95% CI	p
Cyclists	40.7	62.9	0.41	[0.36, 0.45]	< .001
Car	52.1	35.1	2.01	[1.80, 2.24]	< .001
Truck	31.4	18.7	1.99	[1.76, 2.24]	< .001
Motorcycle/Moped	36.0	23.7	1.81	[1.61, 2.03]	< .001
Bus	26.5	15.5	1.96	[1.73, 2.23]	< .001
Pedestrians	41.6	48.0	0.77	[0.69, 0.86]	< .001
Other	10.5	6.4	1.73	[1.44, 2.07]	< .001

Table 3. Overview of hazard reports by victims (risk for ...)

Regarding risk types, Table 4 shows that misbehavior by drivers is substantially more prevalent in non-rural reporting (49.2% vs. 35.7%, OR = 0.57). In contrast, rural reporting more frequently encodes hazards as defects or deficiencies, and to a smaller extent, weather conditions.

We analyzed the road context by capturing street type and general circumstances. Table 5 shows that rural reports are significantly more likely to reference platform-based categories like curves and intersection contexts, while non-rural reports more often reference cycle paths. Regarding general circumstances, rural reporting includes a stronger darkness and a slightly higher gradient value.

Looking at risk triggers, a more process-oriented description of what produces a hazard is provided. Table 6 differentiates several risk triggers by place types in

Risk type	Rural (%)	Non-rural (%)	OR	95% CI	p
Driver misbehavior	35.7	49.2	0.57	[0.51, 0.64]	< .001
Defect/deficit	34.3	25.0	1.56	[1.39, 1.75]	< .001
Limited visibility spot	37.1	42.2	0.81	[0.72, 0.90]	< .001
Weather conditions	5.3	3.2	1.69	[1.31, 2.18]	< .001
Pedestrian misbehavior	6.8	8.8	0.76	[0.62, 0.94]	.013
Poor road conditions	19.7	20.6	0.95	[0.83, 1.08]	.434
Other	0.64	0.45	1.45	[0.72, 2.90]	.399

Table 4. Overview of hazard reports by risk types

Road context	Rural (%)	Non-Rural (%)	OR	95% CI	p
Curve	7.3	3.5	2.16	[1.73, 2.70]	< .001
Intersection	3.1	1.6	2.02	[1.45, 2.81]	< .001
Cycle path	1.16	3.45	0.33	[0.20, 0.53]	< .001
Darkness	6.30	4.01	1.61	[1.28, 2.03]	< .001
Gradient	3.53	2.25	1.59	[1.18, 2.16]	.003
Crosswalk	2.70	3.74	0.71	[0.51, 0.99]	.049

Table 5. Overview of hazard reports by road context

policy-relevant ways. Rural reports more frequently mark right-of-way violations and missing lighting, and show a strong signal for objects/obstacles on the roadway. Non-rural reports are more likely to mark sight restriction/obstacles and defective signs/lights/lighting.

Risk trigger	Rural (%)	Non-rural (%)	OR	95% CI	p
Obstacle on roadway	8.55	4.21	2.13	[1.73, 2.61]	< .001
Right-of-way violation	17.29	11.80	1.56	[1.35, 1.81]	< .001
Missing lighting	18.70	15.90	1.22	[1.06, 1.40]	.007
Insufficient distance	2.06	0.71	2.95	[1.92, 4.53]	< .001
Ice/snow	1.80	0.67	2.70	[1.72, 4.25]	< .001
Sight restriction	2.70	6.84	0.38	[0.28, 0.52]	< .001
Defective sign/light	1.48	3.17	0.46	[0.30, 0.70]	< .001

Table 6. Overview of hazard reports by risk triggers

To avoid over-interpreting bivariate contrasts, we estimated a logistic regression model predicting rural membership (R5 = 55) from a small set of theoretically central indicators. The model (AUC $\approx$ 0.691, McFadden's Pseudo-R^2 $\approx$ 0.07) highlights a coherent configuration as rural reporting is independently associated with right-of-way violations, curves, and darkness, and negatively associated with cyclist risk recipients, cycle-path contexts, and driver misbehavior risk-type labeling as shown in Table 7.

Taken together, these quantitative patterns describe distinct reporting ecologies across place types. Rural reports more often cluster around motor-traffic exposure and visibility or geometry constraints (curves, darkness, lighting), while non-rural reports are more cyclist-salient and include stronger signals of sight restriction and interaction contexts. This provides the empirical foundation for the subsequent qualitative analysis of how hazards are framed and bundled into intervention

Predictor	OR	95% CI	p
Risk trigger: Right-of-way violation	2.82	[2.34, 3.39]	< .001
Road context: Curve	1.89	[1.50, 2.39]	< .001
Road context: Darkness	1.53	[1.20, 1.96]	< .001
Victim: Car	1.66	[1.49, 1.86]	< .001
Victim: Cyclist	0.48	[0.43, 0.54]	< .001
Road context: Cycle path	0.55	[0.34, 0.89]	.016
Risk type: Driver misbehavior	0.48	[0.42, 0.55]	< .001
Risk trigger: Sight restriction	0.44	[0.32, 0.61]	< .001

Table 7. Logistic regression model predicting rural reporting (rural = 1, odds ratios, N=10,317)

pathways.

4.2 Qualitative

4.2.1 Two Place-Based Logics of Hazard Articulation: Exposure and Conflict

Across the comment corpus, hazard reporting is rarely limited to a factual description ("what is there"). Instead, commentators routinely *compose* a hazard by linking (1) a mechanism (how danger is produced), (2) a situated vulnerability (for whom and in which everyday routines), and (3) an implicit theory of change (what would need to be altered for the place to become safe). When read comparatively, two recurring logics of articulation become visible. They are not mutually exclusive categories, but dominant *narrative configurations* that concentrate differently in rural and non-rural regions.

We labeled these configurations *exposure* and *conflict*. On the one hand, exposure narratives frame risk as being left unprotected under conditions of speed, limited visibility, and missing baseline infrastructure (e.g., sidewalks, crossings, lighting). On the other hand, conflict representations pose risks because they disrupt interaction in dense coexistence situations where multiple road users and actors must coordinate (often at intersections or along context-specific bike lanes), and repeated rule violations, misperceptions, or spatial violations lead to near misses.

In the rural subset (R5= 55), exposure bundles occur notably more often than in non-rural comments, whereas conflict bundles concentrate more strongly in non-rural comments. We treat these prevalence tendencies as triangulation cues rather than standalone measurements, because the interpretive layer is shaped by uneven participation and commenting intensity across place types (Table 2). Accordingly, the qualitative analysis below foregrounds how these logics are performed in comments and how they translate into intervention bundles, while the quantitative layer provides the comparative background for event ecology and participation conditions.

Exposure: Risk as Being Left without Minimum Protection In rural contexts, risk is frequently articulated through a structural exposure chain. Commentators describe how everyday mobility becomes precarious because of baseline protective elements that are missing or discontinuous, while the road ecology (speed regime, geometry, sightlines) makes "careful behavior" an insufficient remedy. This logic becomes particularly visible when hazards are tied to routine care

infrastructures (school routes, bus stops, walking with children), which function as moral anchors and practical evidence that the hazard is not a fringe issue but part of daily life.

A typical exposure articulation combines speed, geometry, visibility, and vulnerability in one closely linked account. For instance, one rural comment explicitly enumerates the ingredients of exposure and translates them into an intervention that would establish a minimum threshold of safety:

> "Attention! Pedestrians should be extra careful here, as drivers often come around the curve at excessive speeds ([STREET] for elementary school students, on the way to [STREET]). At the very least, a crosswalk would be a good idea here! (Intersection, curve, bus stop, excessive speed)." – [R5=55, Rep#9296/Com#1]

This comment does not merely label a location as dangerous. It specifies a mechanism ("speed around a curve"), identifies a routine vulnerability ("primary school children, path to school"), and proposes a baseline intervention ("at least a zebra crossing") as a minimal protective affordance that would reduce exposure.

Exposure narratives also frequently mobilize visibility constraints as risk multipliers that make speed intolerable. Therefore, a rural comment constructs risk via the interaction of a confusing, unclear curve, a high-speed crossing, and mutual invisibility:

> "Bicycles and [STREET] cross paths with [STREET] (70 km/h) at a blind spot just past a curve. Cars approach at high speed and are neither visible nor able to see other road users." – [R5=55, Rep#6629/Com#1]

Here, the hazard is framed as systemically produced by infrastructure and geometry. The point is not simply that drivers behave badly, but that the place is configured such that neither actor can see the other in time. This characteristic of exposure describes risk as predictable under normal conditions, not exceptional.

A third pattern in rural exposure articulation is the emphasis on missing baseline infrastructure (lighting, sidewalks) as the core reason why ordinary activities become hazardous. The absence is presented as a categorical safety deficit rather than a convenience issue:

> "Very dangerous for schoolchildren as drivers are speeding down the [STREET], [and there is] no lighting [on the sidewalk]." – [R5=55, Rep#6230/Com#1]

The brevity of this comment is analytically telling. The comment assumes that the combination of children, speed, and darkness is self-evidently unacceptable, again treating the hazard as structural exposure rather than an isolated conflict.

Finally, rural exposure narratives often anchor vulnerability in micro-geographies of everyday mobility (e.g., a bus stop across the road), where a single missing protective element turns routine movement into an unsafe crossing:

> "Sharp curve, bus stop on the other side of the street. It is not safe to get to the bus stop." – [R5=55, Rep#9276/Com#1]

A recurring care infrastructure pattern emerges as a key finding. Rural comments often formulate location-specific minimum requirements for protection, precisely in places where everyday functionality would otherwise no longer be guaranteed (e.g., at schools, bus stops, and on routes for basic procurements). The concept of innovation embedded in the discussion about risk, therefore, often revolves around the establishment of basic safety thresholds like crossings, sidewalks, lighting, restoration of visibility, and speed reduction measures that do not rely on perfect compliance.

Conflict: Risk as Interactional Breakdown in Dense Co-Presence Especially in non-rural contexts, hazard articulation more often takes the form of conflict narratives where risk emerges from repeated coordination failures among multiple road users and from design and governance arrangements that make the interaction order hard to read or hard to sustain. The recurring object of concern is less "missing baseline infrastructure" and more contested space, especially along cycling infrastructure and at intersections where turning movements, signals, and priority claims must align.

A particularly clear conflict articulation is the description of signal choreography producing systematic misrecognition, with a concrete, designable fix:

> "At the intersection of [STREET] and [STREET], the pedestrian signal turns red while the bicycle signal, which is synchronized with the car signal, is still green. On several occasions, trucks have cut me off (as a cyclist) because they look at the pedestrian signal and assume that I also have a red light. The bicycle signal should be synchronized with the pedestrian signal." – [R5=51, Rep#6209/Com#1]

The hazard is explicitly interactional as a mismatch in signaling creates a recurring interpretation error ("they look at the pedestrian light"). The proposed intervention is not merely enforcement, but re-ordering the interaction system (synchronizing signals). This is archetypal conflict logic as the hazard is a repeated breakdown of coordination and legibility.

Conflict logic also appears when infrastructure intended for specific uses becomes contested in practice. E.g., a restricted crossing used illegally by cars, producing recurrent conflicts with pedestrians and cyclists:

> "The [STREET]/[STREET] crossing is intended for public transportation, emergency services, and, to my knowledge, taxis as well. Its (prohibited) use by regular drivers and trucks repeatedly leads to conflicts with pedestrians crossing the street [...] in violation of the current traffic light signals [...]." – [R5=52, Rep#5967/Com#1]

Here, the platform comment functions as a governance claim as it asserts an intended rule regime ("for public transport, emergency services"), diagnoses repeated rule transgression, and frames the hazard as systematic conflict between legitimate and illegitimate uses of space.

A third non-rural pattern combines parking violations, infrastructural discontinuity, and forced negotiation by articulating how vulnerable users are pushed into conflict because the protected space collapses:

> "Extremely narrow sections [...] Students [...] have to squeeze past cars parked illegally. [...] For cyclists, the [STREET] ends abruptly, forcing them to navigate through heavy traffic. [...] [There are also] dangerous passing maneuvers by trucks [...]." – [R5=53, Rep#2482/Com#1]

This comment is instructive because it shows conflict logic is not only about explicit violations, but about how micro-violations and infrastructure breaks generate predictable negotiations. Pedestrians push their way between cars, cyclists are forced into the traffic stream, and overtaking becomes a repeated near-miss scenario. The hazard is produced through the interaction order by who yields, who pushes, and who "has to" take risk, rather than through a simple absence of infrastructure.

Finally, conflict logic is also articulated as a strategic misuse of cycling infrastructure by motorized vehicles to gain advantage under congestion, bringing them dangerously close to schoolchildren waiting at signals:

> "[...] [Cars] therefore use the bike lane on [STREET] as a passing lane to overtake [vehicles turning left], coming dangerously close to the schoolchildren waiting at the traffic light [...]." – [R5=52, Rep#4252/Com#1]

Again, the comment describes a recurring interactive pattern ("use cycleway as passing lane"), highlights the institutional status of the space ("mandatory cycleway"), and ties it to a vulnerable group (schoolchildren). The implied interventions are governance and design combined with rule enforcement, physical and organizational measures that prevent this appropriation.

4.3 From Articulation to Intervention Packages: Baseline Protection versus Choreography and Ordering

Although the previous results established two dominant logics of hazard articulation within the report comments, the rural/non-rural place-type comparison becomes especially meaningful when following how commentators translate articulation into actionability. Across the corpus, comments frequently contain more than a complaint, as they sketch what would need to be changed to make the place safe. These proposals are rarely random, and they appear as relatively stable intervention packages as bundles of measures that correspond to the underlying articulation logic and to local socio-technical conditions. Therefore, the platform operates as a forum where communities not only identify hazards but also develop place-based "micro-design briefings".

We can observe two main bundles with different weights across rural versus non-rural contexts. Baseline protection packages appear more typically in rural exposure comments as well as choreography and ordering packages, which are more typical in non-rural conflict comments. Importantly, both bundles may combine material infrastructure with governance (controls, enforcement), illustrating that community-led innovation imaginaries are inherently socio-technical.

4.3.1 Baseline Protection Packages in Rural Areas

Baseline protection packages are characterized by the idea that a minimum set of protective affordances is missing, such that everyday mobility requires risky

improvisation. The implied goal is to establish threshold conditions under which walking (often with children) becomes feasible without "constant luck". The most common elements are (1) safe crossings, (2) sidewalks or separation, (3) lighting and visibility restoration, and (4) speed reduction as a system property.

"At Least a Safe Crossing" as a Minimal Threshold A recurring form is the explicit request for a zebra crossing or equivalent protected crossing, often framed as the minimum acceptable intervention. The rhetoric (e.g., "at least") is analytically telling as it signals a threshold logic rather than a wish.

> "A crosswalk is missing. Cars often drive too fast, and it's impossible to cross the street safely with children." – [R5=55, Rep#5295/Com#1]

> "[...]. At the very least, a crosswalk would be a good idea here!" – [R5=55, Rep#9296/Com#1]

In these accounts, crossings are not requested as a convenience but as protective infrastructure enabling basic routines (e.g., shopping, school, bus stop).

Sidewalks as a Separated Space as Baseline Infrastructure Another recurring component is the explicit naming of absent sidewalks as the core cause of exposure. Here, commentators often describe that pedestrians are forced into the roadway, producing a structural vulnerability independent of driver intent.

> "There is no sidewalk here [...]." – [R5=55, Rep#6875/Com#1]

> "Since there is no sidewalk on [STREET], schoolchildren in particular must walk on [PLACE] [...]." – [R5=55, Rep#5291/Com#1]

Visibility and Lighting Restoration as Protective Enabling Conditions Baseline protection packages frequently include lighting and visibility interventions (vegetation cutting, mirrors, warnings) that make crossing and co-presence legible.

> "Installing mirrors or trimming the trees could help improve visibility [...]." – [R5=55, Rep#4873/Com#1]

These suggestions show that residents articulate not only where but also why and propose concrete, often low-cost measures consistent with rural maintenance and repair practices.

Speed Reduction as System Property: Calming, Cues and Enforcement Where speed is central, rural intervention packages often treat it as a regime requiring structural reduction, sometimes explicitly coupling cues and enforcement. Enforcement appears, but typically as a complement to missing baseline protections rather than as a stand-alone solution.

> "Speed cameras, a traffic island at the entrance to town, and signs reading "Caution: Children" [...] would be useful [...] illuminated signs [...]." – [R5=55, Rep#9451/Com#1]

> "A sign [...] but only if inspections are actually conducted there." – [R5=55, Rep#3554/Com#1]

This coupling is analytically important as commentators construct an implicit theory of compliance ("signs alone don't work") and propose a socio-technical bundle (signage with enforcement and physical measures).

4.3.2 Choreography and Ordering Packages in Urbanized and Non-Rural Contexts

Choreography and ordering intervention packages are anchored in the idea that risk is produced by recurring coordination failures in dense co-presence where multiple actors and modes are present, rules are contested, and small design decisions (phasing, marking, visibility triangles, parking regimes) generate systematic conflicts. The implied goal is not merely to add infrastructure but to stabilize the interaction order by making priority legible and compliance likely.

Signal and Junction Re-Ordering to "Fix the Choreography" Non-rural comments frequently propose interventions that modify the timing, legibility, or geometry of intersections to prevent systematic misrecognition.

> "The bicycle traffic light should be synchronized with the pedestrian traffic light." – [R5=51, Rep#6209/Com#1]

The specificity here matters as commentators do not only ask for more safety, but identify a designable coordination bug as *"they [drivers] look at the wrong signal" – [R5=51, Rep#6209/Com#1]*.

Protecting and Enforcing Modal Space A second intervention package for mainly non-rural contexts concerns cycling infrastructure as contested space for ensuring continuity, preventing car invasions, and reducing forced merges into traffic.

> "For cyclists, [STREET] ends [...], forcing them to [ride] into heavy traffic [...]." – [R5=53, Rep#2482/Com#1]

These comments propose interventions that are both design and governance as physical measures (separation, barriers) and enforcement to prevent appropriation.

Parking and Standing as a Governance Object for Visibility Triangles and Sidewalk Access Non-rural comments also target parking as a recurring conflict generator. Suggested remedies typically include enforcement against illegal parking, reallocation of space, or physical deterrents, often tied to accessibility for pedestrian safety, e.g., for wheelchairs.

> "[...] because of [...] parked cars, [wheelchair users in particular] are not visible until it is too late." – [R5=51, Rep#233/Com#1]

4.3.3 Boundary Cases, Intersecting Patterns and Limits of Place-Based Claims

A comparative rural/non-rural interpretation carries the risk of reducing rurality and urbanity to fixed stereotypes (rural as exposure, urbanized as conflict). To avoid such oversimplification, we systematically examined boundary cases by comments that contradict the prevailing pattern as rural conflict and non-rural exposure narratives, as well as comments that combine both logics. These comments illustrate what exactly is location-specific in the corpus as not a deterministic assignment, but a shift in narrative repertoires shaped by infrastructure, mobility composition, and participation dynamics.

Dense Co-Presence and Governance Conflicts Appearing in Rural Narratives Although rural comments often emphasize missing baseline protections, commentators in rural contexts do articulate classic interactional conflicts. These cases typically arise when (1) cycling infrastructure exists but is contested, (2) heavy vehicles interact with vulnerable road users under constrained space, or (3) junction choreography becomes the central mechanism of risk. Importantly, these rural conflict narratives frequently retain a rural inflection as conflict is framed through asymmetries of mass and speed (e.g., trucks overtaking cyclists) and through low-redundancy corridors where alternatives are limited.

A recurring pattern is the articulation of conflict around cycling infrastructure obligations and turn-taking:

> "This is a [STREET] where cyclists are required to use the road, but turning toward [PLACE] is not safe for cyclists. [...] Many trucks drive [...] and pass cyclists [...]." – [R5=55, Rep#3554/Com#1]

This is structurally a conflict narrative as it centers on the interaction between cyclists and heavy vehicles and on how infrastructure rules (mandatory facility use) play out under real traffic. Yet, it also carries exposure elements (low protection against heavy vehicle overtaking), showing that boundary cases often hybridize rather than flip cleanly.

Another rural intersection occurs when road users are forced to negotiate space because of directional constraints or ambiguous infrastructure use:

> "Cyclists are forced here [...] to ride on the road [...] in both directions [...]." – [R5=55, Rep#4089/Com#1]

Even without full contextual detail in the short excerpt, the structure signals conflict over how space is allocated and how users must coordinate.

When Baseline Protection is Missing in Non-Rural Exposure Narratives Conversely, non-rural municipalities are not uniformly characterized by well-provisioned baseline infrastructure. A subset of non-rural comments clearly reproduces the rural exposure chain through absent sidewalks, unlit segments, and speed on corridor-like roads. These cases often appear at urban fringes, arterial roads, or transitional segments where the street functions like a high-speed corridor despite being embedded in an urban administrative unit.

For example, a non-rural comment frames risk via the absence of a sidewalk, reproducing exposure under a persistent speed regime:

> "There is no sidewalk [...] Drivers are going full speed [...]." – [R5=51, Rep#770/Com#1]

Hybrid Narratives When Exposure and Conflict are Co-Articulated Beyond exceptions, some comments combine elements of both exposure and conflict logics. These hybrids often articulate how a baseline deficit (e.g., a missing sidewalk or discontinuous cycling facility) forces users into interactional conflict.

A clear example is a non-rural comment, where illegal parking constricts pedestrian space and simultaneously pushes cyclists into dense traffic, creating a cascade of conflicts and exposure.

> "Students [...] have to squeeze past [...] parked cars [...] For cyclists, [STREET] comes to an abrupt end [and they are] forced to ride into heavy traffic [...] where there is dangerous passing by trucks [...]." – [R5=53, Rep#2482/Com#1]

Here, the narrative is simultaneously about ordering failure (parking violation), infrastructural discontinuity (cycling facility ends), forced negotiation (merge into traffic), and asymmetry exposure (truck overtaking). Such hybrids are analytically productive as they show that exposure and conflict are not separate worlds but can form causal cascades and multi-layered socio-technical risk production.

5 Discussion

5.1 Hazard Reporting as a Rural Road Safety Innovation Infrastructure

Our findings show that a platform for road safety like "gefahrenstellen.de" is best understood as a community-led infrastructuring forum. The infrastructuring contribution of hazard reporting lies first in making problems visible. Road-safety infrastructures often remain in the background of everyday mobility until they fail to support ordinary movement. A missing crossing becomes visible when children cannot safely reach a bus stop or a curve becomes infrastructurally relevant when limited sightlines and speed make safe crossing impossible. In this sense, reports mark "points of infrastructuring" as moments in which residents recognize that the existing arrangement no longer works adequately and articulate it as requiring maintenance, redesign, enforcement, or planning attention (Ludwig et al., 2018; Pipek and Wulf, 2009; Star and Ruhleder, 1996). The platform therefore does not simply collect opinions, it provides a socio-technical format through which latent infrastructural frictions are transformed into documented and potentially resolvable public issues.

Comments frequently operate as more than narrative add-ons, as they function as micro-briefings that connect a location to an explanatory mechanism (e.g., speed under limited sightlines), specify who is exposed (e.g., children on school routes), and articulate what kind of intervention would count as improvement (e.g., a crossing, lighting, enforcement). This matches the broader participatory sensing and volunteered geographic information logic. Citizens act as contributors of situational, place-based observations that can augment conventional sources, while simultaneously surfacing the interpretive and normative dimensions of those observations (what is risky, why, and what should change) (Burke et al., 2006; Goodchild, 2007). In our dataset, these micro-briefings routinely take the form of intervention packages as rural comments translate exposure into baseline protection bundles (safe crossings, sidewalks, lighting, speed reduction as a regime), whereas non-rural comments translate conflict into choreography and ordering bundles (signal synchronization, intersection legibility, reducing parking violations or protecting cycling continuity). Citizens do not propose isolated "fixes", but they articulate bundles as material reconfigurations including governance and compliance assumptions, which is consistent with accounts of articulation work in complex socio-technical arrangements (Schmidt and Bannon, 1992).

The platform can further support infrastructuring by enabling users to turn situated safety concerns and place-based knowledge into shared reference objects. Hazard reports and comment threads link a location, a perceived hazard, an explanatory account, and often a proposed remedy. In this sense, they can be understood as boundary-object-like articulation forms, being flexible enough to accommodate situated civic accounts, yet structured enough to remain identifiable and actionable across contexts (Star and Griesemer, 1989). Their analytic relevance lies not simply in representing local complaints, but in formatting everyday experiences of danger into objects that can be discussed, compared, aggregated, and potentially routed. This makes hazard reports important mediating artifacts in the early stages of infrastructuring, where local problems are made legible as matters for maintenance, enforcement, redesign, or planning attention. This is precisely the socio-technical shaping of innovation emphasized in rural digitalization and rural social innovation literature, where locally initiated problem solutions must navigate institutional interfaces and capacities (Sept, 2020; Stein et al., 2022; Zerrer et al., 2022).

Finally, the platform's infrastructuring role must be understood together with its participation ecology, which is itself place-sensitive. Quantitatively, the rural subset ($R5 = 55$) shows substantially lower interaction intensity, as fewer reports receive comments. Rather than treating this exclusively as a limitation, we interpret it as evidence that the platform constitutes different kinds of publics across place types. Rural hazard reporting appears more often as a "thin" participation mode with shorter, more threshold-oriented articulation, whereas non-rural contexts more frequently use the platform as a deliberative forum. This interpretation aligns with research on participation inequality and "lurking" in online communities (Nonnecke and Preece, 2000; Preece et al., 2004) and with rural digitalization research noting that the interaction between digital tools and civic participation is context-dependent and uneven (Stein et al., 2022).

Taken together, hazard reporting can become a community-led infrastructuring practice that produces situated safety knowledge beyond crash-only indicators, bundles local theories of change into actionable intervention packages, functions as a boundary object between civic articulation and administrative admissibility, and exhibits place-sensitive participation ecologies that must be treated as part of the phenomenon rather than a mere artifact.

For municipal road-safety governance, this means that hazard reporting functions as an upstream prioritization resource as it surfaces where baseline protection is missing, where interaction order repeatedly breaks down, and which intervention bundles residents consider feasible and legitimate. In Safe System terms, these articulations can be treated as early signals of latent risk that justify preventive site checks and low-regret interventions before severe outcomes accumulate. Seen through Safe System or Vision Zero, hazard reporting becomes a preventive governance resource rather than a post hoc black-spot instrument as exposure bundles specify where "safe speeds" and "forgiving roads" are missing in routine mobility, while conflict bundles specify where interaction order breaks down because priorities and boundaries are not legible or enforceable. This connects the comment-level intervention packages to Safe System levers (safe roads, safe speeds, enforcement, and governance capacity), and clarifies why citizen reporting can support preventive municipal prioritization even where crash-only evidence is sparse

or slow to accumulate (Belin et al., 2012; International Transport Forum, 2022; World Health Organization, 2021).

5.2 Place-Based Logics of Risk Articulation

Rurality should not be treated as a "smaller city", but as a distinct epistemic context in which mobility risk becomes observable, narratable, and actionable through community reporting. This aligns with Rural HCI's long-standing critique that HCI tends to reproduce an urban default and then "export" urban solutions to rural contexts, rather than developing concepts and design implications from rural conditions (Hardy et al., 2019a; Robinson et al., 2021). In our data, the distinction between exposure and conflict is best understood as a pair of place-based logics of risk articulation, making hazard meaningful through two recurrent ways, stabilizing differently across rural and non-rural reporting publics.

Report-level pattern	**Comment-level codes**	**Qualitative reading**	**Policy interpretation**
Rural reports more often mark motorized and heavy-vehicle risk recipients (cars, trucks, buses, motorcycles).	Rural comments more often include speed regime (25.3% vs. 14.6%) and children/school route codes (17.9% vs. 12.8%).	Risk is articulated as exposure to fast and heavy traffic in everyday mobility routines.	Prioritize baseline protection near care mobility infrastructures, such as school routes and bus stops.
Rural reports more often reference curves, darkness, and missing lighting.	Rural comments more often include geometry/curve/slope (17.5% vs. 8.2%) and missing sidewalk codes (3.7% vs. 0.7%).	Hazards are framed as structurally produced by limited sightlines, road geometry, and missing protective affordances.	Treat visibility, lighting, sidewalks, and crossings as minimum safety thresholds rather than optional improvements.
Non-rural reports are more cyclist-salient and more strongly associated with cycle-path contexts.	Non-rural comments more often include cyclist codes (33.6% vs. 15.6%) and cycling discontinuity or modal-space conflict codes.	Risk is articulated as contested multimodal co-presence, especially around cycling infrastructure.	Focus on protected continuity, modal separation, and prevention of forced merging.
Non-rural reports show stronger interaction and violation dynamics.	Non-rural comments more often include signal-phase choreography (13.2% vs. 4.8%), parking encroachment (16.8% vs. 9.2%), and right-of-way/priority codes (26.1% vs. 18.6%).	Hazards are framed as recurring breakdowns of interaction order and legibility.	Prioritize signal timing, junction redesign, parking management, and enforcement routines.

Table 8. Triangulating report-level patterns, comment-level codes, and policy interpretations

Table 8 shows that the quantitative and qualitative layers do not simply duplicate each other. Rather, they provide complementary evidence for the same place-based articulation logics. The report-level categories identify broader reporting ecologies, such as motor-traffic exposure, visibility constraints, cycling salience, and interaction or violation contexts. The comment-level codes specify how these ecologies are

made meaningful by residents as rural comments more often connect speed, geometry, missing infrastructure, and care mobility into exposure-oriented claims, whereas non-rural comments more often connect cycling, signal phases, parking encroachment, and priority conflicts into interaction-order claims. This triangulation supports our interpretation of exposure and conflict as recurrent articulation bundles rather than isolated keywords or merely statistical category differences.

Exposure Is Stabilized by a Motor-Traffic Dominant Event Ecology and Baseline Deficit Problem Definitions The exposure frame is supported by convergence between the report-level event layer and the comment-level coding. Report-level metadata show that rural reports are more likely to flag hazards for motorized and heavy vehicles and less likely to flag hazards for cyclists than non-rural reports (Table 3). This matters analytically because it points to a different dominant mobility assemblage in which everyday vulnerability is frequently described as exposure to fast, heavy flows rather than as negotiation of dense multimodal co-presence. The road ecology signal is reinforced by report-level contexts, referencing curves and darkness more often in rural areas (Table 5), features that are repeatedly mobilized in comments as mechanistic explanations for why careful behavior is insufficient (e.g., limited sightlines, stopping distance arguments). At the comment level, this pattern is mirrored by the higher salience of speed regime, geometry/curve/slope, children or school route, and missing-sidewalk codes in rural comments. Together, these patterns suggest that exposure is not merely a qualitative reading of selected quotations, but a recurring articulation bundle visible across both structured report metadata and comment-level coding. In this configuration, the exposure narrative operates like a baseline safety diagnosis as commentators treat sidewalks, safe crossings, lighting, and speed reduction as minimum thresholds required for ordinary routines (school routes, bus stops, daily procurements) to remain feasible, which can be observed in the baseline protection packages.

Theoretically, this pattern resonates with risk-perception work showing that risk is often grasped through an experiential system which is fast, contextual, and affectively grounded, rather than through formal probabilistic reasoning (Slovic, 2016; Slovic et al., 2013). Many rural exposure comments can be read as experiential risk reasoning as they combine concrete cues (curve, darkness, missing sidewalk) with embodied vulnerability (children, walking alone the carriageway) and then infer what kind of intervention would plausibly reduce exposure (crossing, lighting, speed regime changes). The argument is not “people feel differently”, but that the conditions of everyday mobility invite and legitimate a particular evidentiary style, like causal chains that connect infrastructure absence to exposure under speed and limited sight (Table 6).

Conflict is Stabilized by Cycling Salience, Intersection Choreography, and Violation Politics Conversely, the conflict frame is supported by convergence between non-rural report-level cyclist salience and comment-level codes related to cyclists, signal-phase choreography, parking encroachment, and right-of-way or priority. Non-rural reports much more often highlight hazards for cyclists and pedestrians than rural reports (Table 3), indicating a setting where multimodal co-presence and cycling infrastructure are more central objects of safety concern. In addition, report-level trigger patterns and road-situation categories point

toward an ecology where intersections, signals, and spatial violation (e.g., parking-related obstruction/visibility triangles) are frequent and salient (Table 6 and 5). At the comment level, this pattern is mirrored by the higher salience of cyclists, signal-phase choreography, parking encroachment, and right-of-way or priority codes in non-rural comments. Together, these patterns suggest that conflict is not reducible to individual complaints about misconduct but reflects a broader articulation pattern in which residents describe safety as a problem of interaction order, modal space, and enforceability. The qualitative comments translate this ecology into conflict narratives as hazards are constructed as recurring breakdowns of interaction order, e.g., misrecognition at signal phases, priority disputes at junctions, appropriation of cycling space, and the micro-politics of "who yields" and "who is seen".

This non-rural style also aligns with infrastructural accounts of safety as a product of coordination and governance, not simply physical deficits. In conflict narratives, the "solution" is often not only more infrastructure, but re-ordering and stabilizing the socio-technical choreography (signal synchronization, protected continuity, enforcement against violation), a pattern consistent with how digitally supported social innovations in rural and peripheral settings and village apps are described as processual and governance-embedded rather than purely technological (Stein et al., 2022; Zerrer et al., 2022). In this way, conflict articulation does not merely complain about behavior, but it performs a civic diagnosis of how infrastructure, rules, and enforcement co-produce predictable near-miss situations.

Right-of-way issues illustrate how the "same" hazard type is made governable through different causal stories: in rural comments, it is frequently folded into exposure chains under speed and limited sight, whereas in non-rural comments, it is frequently articulated as choreography and legibility failure at nodes (Table 6).

Boundary Cases as Scope Conditions A major analytical risk in comparative work is essentializing the groups. Therefore, the boundary case analysis allows a more defensible claim as rurality and urbanity do not deterministically produce frames but shift the probability distribution of available repertoires. Exposure framings appear in non-rural settings where corridor-like road ecologies and baseline deficits are present (e.g., missing sidewalks on arterial segments), and conflict framings appear in rural settings where cycling or turning interactions and heavy-vehicle asymmetries become salient. This is exactly why the strongest unit of inference in this paper is the bundle configuration (mechanism x vulnerability x intervention imaginary) rather than isolated keywords.

This repertoire view is also where Rural HCI theory helps interpret the participation ecology without rehashing limitations. The concept of rural "publics and rural pluralities" highlights that rural contexts are not simply less connected, but differently organized in terms of public life and participation conditions (Robinson et al., 2021). Our participation-layer differences (Table 2) are thus not only methodological precautions, as they are part of the socio-technical explanation for why rural hazard articulation can appear more threshold-oriented and less thread-deliberative. The platform may function as a thin infrastructuring public in rural contexts, oriented toward establishing baseline deficits as actionable claims. In contrast, in non-rural contexts, it more often becomes a forum for negotiating contested mobility orders.

Implications for Rural HCI Putting together, the distinction between exposure and conflict is not a stylistic dichotomy. It is a triangulated account that connects (1) report-level risk recipients and contexts, (2) comment-level interpretive frames, and (3) the broader rural digitalization literature's emphasis on context-dependent participation and social innovation processes (Hardy et al., 2019a; Manzini, 2015; Stein et al., 2022; Zerrer et al., 2022). This offers a concrete way to reframe innovation in rural regions by rural hazard reporting becoming a site where rural publics enact maintenance-oriented innovation by specifying baseline safety thresholds under exposure conditions, while non-rural publics enact governance-oriented innovation by negotiating choreography, violation, and compliance in dense co-presence.

5.3 Policy-Facing Strategies of Change and Implications: Translating Community Articulation into Actionable Rural Road-Safety Infrastructuring

Building on the place-based articulation logics and the empirically observed intervention claims, we analytically condense recurring comment patterns into policy-facing strategies of change. We use this term to describe reconstructed patterns in how commenters connect a perceived hazard with assumptions about what would need to change for a reported place to become safer. These are not formal municipal strategies or fully articulated policy programs by commenters, but analytically derived patterns of civic problem articulation that can be translated into policy-facing intervention packages. This matters because it reframes innovation away from novel products toward situated pathways of repair, maintenance, enforcement, and governance adaptation. For municipal road-safety governance, these reconstructed strategies can support preventive prioritization and scoping under constrained local capacities (Tables 2–7). While implications for platform/interface design exist, we foreground policy implications and treat interface or pipeline considerations as institutionalization requirements for making community articulation resolvable (Pipek and Wulf, 2009; Star and Ruhleder, 1994; Toots et al., 2017; Torfing et al., 2019).

Rural Policy-Facing Strategy of Change: Reducing Exposure by Establishing Minimum Protective Thresholds In the rural comments subset, recurring intervention claims can be condensed into a policy-facing strategy of change centered on baseline protection: safe crossing opportunities, continuous pedestrian space (sidewalks), lighting and visibility restoration, and speed reduction as a regime rather than a one-off warning. Quantitative event-layer patterns support why these proposals are locally plausible. Rural reports often mark hazards in motor-traffic-dominated ecologies and show stronger signals for road geometry and low visibility (curves, darkness), while triggers emphasize maneuvers and priority-related hazards that become acute under speed and limited sight. In this regard, rural proposals are not merely preferences as they respond to an event ecology in which everyday mobility is frequently framed as exposure to fast, heavy flows under constrained visibility. This is also consistent with proactive safety paradigms that argue for going beyond crash records to identify risk conditions earlier, including near-miss and surrogate-safety approaches (Aldred and Goodman,

2018; Ehlers et al., 2022).

For municipalities, this reconstructed strategy of change translates into a prioritization logic centered on minimum safety thresholds that reduce exposure independent of perfect compliance: protected crossings at routine care infrastructures (schools, bus stops), continuous pedestrian space where walking occurs along corridor segments, visibility/lighting restoration in curved or dark road sections, and speed-regime interventions that treat speed as an ambient risk condition rather than an episodic violation. Importantly, these baseline-threshold packages can be read as repair- and maintenance-near innovation as they foreground incremental "keep-it-working" interventions (e.g., restoring lighting/visibility, closing sidewalk discontinuities, maintaining safe crossings) rather than transformational redesign, aligning with infrastructure research that treats maintenance and repair as central, yet often undervalued, modes of socio-technical change (Graham and Thrift, 2007; Jackson, 2014). In practice, this implies that rural road-safety action should be evaluated not only by whether a "hotspot" exists in crash data, but by whether baseline protective affordances are missing at predictable exposure locations surfaced through reporting (International Transport Forum, 2022; World Health Organization, 2021).

However, this does not mean that rural baseline protection is politically or organizationally uncontested. The distinction between exposure and conflict refers to how hazards are articulated in comments, not to the absence of conflict in implementation. Once translated into municipal action, baseline protection measures may redistribute space, speed, priority, and responsibility: a new crossing can slow traffic, a sidewalk can reallocate road space, lighting or visibility measures can trigger maintenance obligations, and speed reduction can challenge locally normalized car-oriented mobility practices. Thus, rural exposure-oriented claims may become conflictual when they enter municipal decision-making, especially where local power relations, resource constraints, or dominant automobility interests shape what is considered feasible or legitimate. Reporting can make such problems visible and potentially routable, but it does not by itself resolve the political and organizational work required to implement change (Agger and Tortzen, 2023; Irvin and Stansbury, 2004; Liao and Schachter, 2018; Williams et al., 2016).

A main implication is therefore not primarily about adding more free-text capacity, but about ensuring that exposure bundles can be rendered into administratively actionable units while remaining attentive to the conflicts and trade-offs that implementation may generate. Concretely, municipal triage and scoping should privilege structured recognition of (1) baseline deficits, (2) visibility constraints, (3) speed regime, and (4) routine vulnerability context, because these are the elements that compose exposure in rural articulation. This does not require reducing citizen articulation to checkboxes. Rather, it means using the platform's structured metadata (see Tables 3–6) as inputs and using comment bundles to justify preventive site checks and "low-regret" interventions under capacity constraints. Such bundle-first capture does not replace free text, but it makes community reasoning translatable into actionable maintenance tasks and prioritization criteria. This aligns with infrastructuring, which supports the ongoing work of making systems usable and improvable across stakeholder boundaries, rather than treating reporting as an isolated front-end feature (Pipek and Wulf, 2009; Toots et al., 2017).

Non-Rural Policy-Facing Strategy of Change: Reducing Conflict by Stabilizing Interaction Order in Dense Co-Presence In non-rural contexts, recurring intervention claims can be condensed into a policy-facing strategy of change centered on choreography and ordering: signal synchronization, intersection legibility, protection of cycling continuity, and governance against violations such as parking encroachment. This aligns tightly with the event layer, where non-rural reports are noticeably more cyclist-salient and where intersection and violation dynamics appear more prominent. The reconstructed strategic logic is that safety improves when the system becomes more legible and compliance becomes more likely, e.g., through stable choreography (signals) and enforceable boundaries. This interpretation resonates with a broader body of crowd- and sensor-supported mobility safety work that uses user reports to diagnose systematic near-miss patterns and translate them into planning knowledge, for instance, in smartphone-based crowdsourcing of cycling near misses and related near-miss research traditions (Aldred and Goodman, 2018; Karakaya et al., 2020).

For municipalities, the non-rural theory of change translates into a prioritization logic centered on stabilizing interaction order at recurrent breakdown points as signal-phase and junction choreography (where misrecognition is systematic), protected continuity through nodes (to avoid forced merges), and parking governance where encroachment repeatedly produces occlusion and compelled negotiation. In this framing, "conflict" is not reduced to interpersonal blame, it is treated as a governance and design problem of making priorities legible and enforceable under density.

A secondary implication concerns the translation of evidence into traffic-engineering forms. Conflict narratives often hinge on repeated interpretive breakdowns (e.g., "drivers look at the wrong signal", "priority is systematically misrecognized"), which are actionable only if they can be rendered into the common informational forms used by traffic engineering and enforcement. Thus, municipalities benefit when reporting outputs support auditable descriptions of conflict types (turning conflicts, priority ambiguity, encroachment/violation) and the situational parameters that make breakdowns recurrent (time-of-day peaks, direction of travel, phase mismatch). Supporting this translation remains a problem of articulation work as systems must not eliminate coordination work, but they must support it (Schmidt and Bannon, 1992; Torfing et al., 2019).

From Proposals to Implementation: Designing the Reporting Platform as a Co-Production Pipeline Public administration research cautions that co-production is not cost-free and can produce public-value failures if institutional conditions are weak. Municipal actors may perceive participation as costly or risky unless responsibility, capacity, and feedback routines are stabilized (Agger and Tortzen, 2023; Irvin and Stansbury, 2004; Liao and Schachter, 2018; Williams et al., 2016). This complements HCI accounts that civic maintenance technologies succeed when they function as trust- and workflow infrastructures across citizens and authorities rather than mere reporting interfaces (Harding et al., 2015).

Both policy-facing strategies of change depend on whether citizen articulation can be converted into public value creation rather than accumulating as unprocessed complaint text. This conversion is not a neutral technical step. Making a hazard visible can also make competing interests visible: between through-traffic and

pedestrian protection, parking convenience and cycling continuity, local habits and formal safety goals, or short-term municipal capacity and long-term prevention. The platform can support articulation and routing, but it cannot by itself settle these conflicts. Municipal uptake therefore requires governance arrangements that can negotiate competing claims, justify prioritization decisions, and communicate why some reported issues are acted upon while others are delayed, reframed, or rejected. Here, research on co-creation and co-production in public-sector innovation is directly applicable as it highlights that citizen contributions create value only under enabling institutional conditions (clear roles, feedback loops, capacity, and leadership) and that the outcomes of co-production are often under-measured relative to the emphasis on participation itself (Toots et al., 2017; Torfing et al., 2019; Voorberg et al., 2015). In our case, the policy relevance of hazard reporting hinges on whether exposure and conflict bundles can be routed into municipal workstreams (maintenance, enforcement, planning) with clear responsibility and closure.

Practically, this suggests treating hazard reporting as a pipeline with three designable stages of (1) structured articulation that enables comparability and prioritization across municipalities, (2) routable responsibility that acknowledges that the same report may require multi-actor coordination, and (3) feedback and closure, which is essential for sustaining community-led infrastructuring rather than episodic reporting. Importantly, the participation ecology differs by place type (see Table 2) as rural reports show substantially lower interaction intensity, so volume-based attention can unintentionally under-prioritize low-reporting areas. Because rural reports generate thinner interaction traces (Table 2), volume-based prioritization risks reproducing a visibility bias where low-reporting areas are structurally deprioritized, contradicting Safe Systems' preventive and equity-oriented intent (International Transport Forum, 2022; Kontokosta and Hong, 2021). Policy implementation therefore requires bias-aware governance routines (e.g., combining report signals with routine vulnerability contexts such as school routes) rather than treating reporting volume as a neutral proxy of need.

Evidence from civic reporting systems in adjacent domains underscores why feedback loops matter. FixMyStreet, for instance, is explicitly built around routing citizen reports to authorities and enabling citizens to track outcomes, yet research also cautions that citizen-initiated reporting exhibits strong spatial inequalities (e.g., more affluent areas reporting more), which can inadvertently maintain attention if not counterbalanced (Matthews et al., 2018; Pak et al., 2017; Rae and Nyanzu, 2021).

Hybridizing Citizen Reports with Other Safety Data: Toward Preventive Rural Safety Governance A further implication, particularly relevant for rural areas where formal sensing and inspection capacity may be limited, is to treat citizen hazard reports as one layer in a hybrid safety evidence stack. The German FeGiS+ project provides a concrete precedent as it explicitly combined police crash data, hazard reports, and safety-critical maneuver data to identify hazards early and provide smart data outputs for prevention (Ehlers et al., 2022). Internationally, collaborations around crowdsourced incident reporting illustrate that real-time community reports can be operationally useful when integrated with institutional workflows, while also raising questions of validation, false positives, and

responsibility allocation (Gizikis et al., 2018).

According to our findings, the key point should not be to advocate a single technical integration, but to argue that community-led infrastructuring becomes more effective when reporting systems are designed for hybrid evidencing. For municipal policy, "hybrid evidencing" means that citizen articulation becomes decision-relevant when it can be triangulated against other layers (where available) and when uncertainty and validation status are made transparent to avoid both overreaction and dismissal. The platform should support multiple evidentiary formats (structured bundles, narrative, media), cross-layer validation (reports enhanced by other datasets where available), and transparent uncertainty (e.g., unverified, recurrent pattern, validated by additional sources). This aligns with the broader "citizens as sensors" and participatory sensing tradition where citizen-generated observations augment authoritative datasets, while keeping the focus on socio-technical conditions under which such augmentation produces legitimate and actionable innovation (Goodchild, 2007; Karakaya et al., 2020).

5.4 Limitations and Future Work

Several limitations arise from studying hazard reporting as mediated public participation rather than as a representative measurement instrument.

Our findings describe place-based patterns of articulation within a mediated civic arena, not objective hazard prevalence. Two biases therefore matter. First, participation inequality is intrinsic to online communities as many users read but do not post, and visible deliberation reflects a small share of contributors (Nonnecke and Preece, 2000; Preece et al., 2004). Second, citizen-initiated reporting can be socio-spatially uneven, which may skew what becomes visible if reporting intensity is treated as a direct proxy of need (Kontokosta and Hong, 2021). In our dataset, this is reflected in the participation layer, where rural reports show lower interaction intensity (see Table 2). We therefore interpret the rural–non-rural contrast as differences in public articulation and "problem-making," not as direct differences in "true" hazard distributions. This matters in our dataset because rural reports show substantially lower interaction intensity (see Table 2), so the comment layer captures a "thinner" rural public and must be treated as selective evidence rather than exhaustive local discourse.

A second limitation concerns comment availability and temporal coverage. Our qualitative analysis relies on the commented subset, but the probability of being commented differs by place type, which creates selection effects for the interpretive layer. Future work should treat reporting as a longitudinal infrastructuring process, examining whether exposure or conflict bundles and intervention packages shift with policy changes or implemented measures.

Third, rurality is operationalized via RegioStaR 5 (BMVI, 2021). While appropriate for transport/planning comparisons, it compresses heterogeneity as exposure narratives also occur in non-rural corridor-like segments, and conflict narratives occur in rural hubs.

Finally, qualitative claims require reliability and outcome linkage. Content analysis research emphasizes explicit intercoder reliability reporting and cautions against overly liberal agreement measures (Lombard et al., 2002). In addition, our platform data alone does not establish whether articulated issues translate into implemented

measures or safety improvements. While we conceptualize hazard reports as boundary-object-like articulation forms, our data capture the civic reporting side rather than their downstream use by municipalities, planning departments, or political decision-making bodies. We therefore cannot assess how reported hazards are received, translated, contested, accepted, or rejected in local administrative and political arenas. Future work should trace whether and how reported hazards become embedded in institutional workflows, how conflicts around space, speed, and responsibility are negotiated, and whether reports lead to concrete maintenance, enforcement, or planning measures. This should include attention to local campaigning traditions, lobbying capacity, informal contacts with authorities, and prior road-safety service provision, as these factors may shape which hazards become visible and actionable in municipal decision-making. A promising direction is to link reporting to municipal workflows and to hybrid evidence stacks, an approach already envisioned in the platform ecosystem via multi-source "risk score" integration and projects combining crash data, citizen reports, and vehicle maneuver data (Deutscher Verkehrssicherheitsrat e. V. (DVR); Ehlers et al., 2022).

6 Conclusion

Our paper reframes citizen hazard reporting as community-led socio-technical practice for road safety as an upstream evidence for municipal road-safety action in rural regions through which residents make breakdowns visible, assemble situated causal accounts, and propose actionable interventions that resemble incremental repair and maintenance rather than startup innovation. Drawing on a mixed-methods comparison of reports and comments using RegioStaR 5, we show that the platform does not simply mirror hazards, but structures how hazards become knowable and governable in different place types.

Across quantitative event patterns and qualitative comment framings, two dominant place-based logics emerged. Rural reporting tends to stabilize articulations of exposure, where risk is constructed through bundles of speed, limited visibility, and missing baseline protections, often anchored in routine care mobilities such as school routes. Non-rural reporting more often stabilizes conflict articulations, where risk is produced through interaction order in dense co-presence (cycling, intersections, encroachment, and compliance). These logics translate into distinct policy-facing strategies of change: baseline-protection packages in rural contexts versus choreography and ordering packages in non-rural contexts. Together, they provide a basis for designing hazard reporting platforms that better support rural road-safety innovation by capturing exposure bundles as first-class objects, routing responsibilities across institutions, and strengthening feedback loops so that "thin" rural publics can still achieve actionable outcomes.

By locating hazard reporting at the intersection of Rural HCI and community-led innovation, the study contributes an empirically grounded way to conceptualize rurality as an epistemic object in its own right by not seeing it as a deficit category, but a distinct socio-technical condition shaping what risks are articulated, how they are justified, and which interventions are imagined as feasible and legitimate.

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