Informal Communication Signals Among Drivers: A Behavioural and Technological Assessment of Road Safety in Zimbabwe

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Abstract

This study explores the informal communication signals among drivers in Zimbabwe, focusing on their behavioural patterns and compatibility with emerging vehicle-to-vehicle (V2V) technologies. Using a mixed-methods approach, the study surveyed 400 licensed drivers and conducted 30 in-depth interviews with traffic police officers, road safety experts, and experienced drivers. Field observations were also analysed thematically. Quantitative data were processed using SPSS to test hypotheses on demographic differences, safety outcomes, and signalling patterns. Chi-square tests and logistic regression revealed significant relationships between informal signal use and near-miss incidents, particularly among younger and peri-urban drivers. Qualitative findings confirmed that stress, cultural learning, and experiential factors drive signalling practices, which are largely incompatible with automated communication systems. Results highlight a disconnect between human behaviour and technological standardisation. The study recommends an integrated strategy combining culturally sensitive driver training and adaptive AI systems. These findings contribute to behavioural transport theory and offer practical insights for policy, driver education, and smart mobility design in low- and middle-income countries.

Keywords: Informal Driver Communication, Road Safety, Mixed Methods, Zimbabwe, Non-verbal Signalling

Introduction

Background: The Global Burden of Road Safety and Human Behavioural Factors

Road safety remains a critical public health issue globally, with over 1.3 million people dying annually due to road traffic accidents (World Health Organization, 2022). In African countries like Zimbabwe, the situation is worsened by rapid motorisation, poor road infrastructure, and limited law enforcement capacity. However, while infrastructure and regulatory issues have received significant attention, less focus has been placed on the behavioural dimensions of driver communication, particularly informal signalling, which is common in everyday driving scenarios (Adedeji et al., 2024; Mohamed et al., 2024).

In contexts where formal road signs, traffic lights, and enforcement systems are either weak or inconsistently available, drivers develop and rely on informal ways to communicate. These include hand gestures, flashing headlights, short horn beeps, and subtle movements like slowing down or shifting slightly towards one side. These are intended to signal intentions, warn other road users, or request cooperation where there are no official signals (Zhou et al., 2023; Dong et al., 2024). While such types of behaviour can help drivers cope with chaotic traffic conditions, they have a tendency to be imprecise, inconsistent, and are not taught in formal driver education systems, leading to miscommunication, confusion, and accidents (Liu et al., 2023; Zhang et al., 2023).

Furthermore, informal signals will be subject to peer education, cultural beliefs, driver's experience, stress reaction, and driving record. Their interpretation will vary with drivers from different geographical locations, driving records, or age. For instance, a flash of headlights for a short period may indicate a warning in a particular city but a right-of-way indication elsewhere. This heterogeneity presents a key challenge, especially with the increasing urbanisation of Zimbabwe and the onset of vehicle-to-vehicle (V2V) and AI technologies beginning to infiltrate the transport network. Both of these technologies are dependent on interoperable communication standards and may therefore find it difficult to interact with the dynamic and context-dependent character of informal signalling (Gould & Brown, 2023; Schumann et al., 2023).

Despite the ubiquity of informal driver communication and its potential effect, it remains inadequately captured in national road statistics, under-theorised by the African academic literature, and overlooked in policy and drivers' training curricula (Chibaro & Foya, 2024; Suryana et al., 2024). As a result, current Zimbabwean road safety models fail to account for a significant behavioural dimension of road users' communication and on-the-spot decision-making. The present study, hence, aims to fill this gap.

Research Gap: Under-examined Informal Signalling in African Contexts

Informal driver communication is, in most instances, seen as an adaptation tactic to infrastructural and systemic failings (Mohamed et al., 2024). However, current researches in Zimbabwe, South Africa, and other Sub-Saharan countries recognise that such conduct, though seemingly cooperative, promotes misinterpretation and unsafe driving actions (Adedeji et al., 2024; Chibaro & Fowa, 2024). Researchers have increasingly looked into cultural norms and stressors' effects on informal driver signals as situational awareness mechanisms of possible miscommunication causes. For instance, Dong et al. (2024) emphasise that cultural variability can significantly alter

the manner in which drivers receive non-verbal signals and behave differently in response. Liu et al. (2023) demonstrate how stress-susceptible and sensation-seeking drivers have a higher probability of using ambiguous informal signs, which augments the prospects for dangerous interactions. Similarly, Zhang et al. (2023) discovered that a significant percentage of Chinese urban traffic accidents trace their origin to misinterpreted informal cues and exhibit how psychological and situational stress could distort the communicative function of such signs. The dual nature of informal signalling, protective yet potentially perilous, raises critical questions about its role in behaviour formation and accident causation.

Objectives of the study: Investigating Informal Driver Communication in Zimbabwe

Despite its ubiquity, informal signalling remains on the periphery of policy reports and driver education programs, particularly in African contexts in which formal systems fail to recognise or learn from local practices (Adedeji et al., 2024). Furthermore, the lack of harmonisation between the informal and formal signalling systems has become increasingly relevant with the introduction of vehicle-to-vehicle (V2V) communication technologies. While these technologies hold promise for improving road safety in high-income countries, they rely on standardised communication protocols that may clash with context-specific informal behaviours (Gould & Brown, 2022).
Against this background, the study seeks to investigate the nature, prevalence, and implications of informal driver communication signals in Zimbabwe, thereby addressing a critical gap in both academic literature and practical road safety interventions. The specific objectives are to:

1. Classify the dominant types of informal communication signals used by drivers in Zimbabwe.
2. Examine the relationship between informal signalling practices and road safety outcomes across different driver groups.
3. Evaluate the compatibility of informal driver communication with emerging vehicle-to-vehicle technologies.

Literature Review

The Role of Informal Communication in Road Safety

Informal communication among drivers, such as headlight flashing, horn blowing, and hand signals, plays a pivotal role in ensuring road safety, especially in contexts where formal traffic systems are underdeveloped or irregularly enforced. In South Africa, Adedeji et al. (2024) noted that 81% of road users use informal cues such as headlight flashing to signal intent, but different interpretations of such signals can lead to potential misunderstandings and conflicts on the road. Chibaro and Foya (2024) observed that in Zimbabwe, gestures and non-verbal signals are widely used to manage traffic, at times as a replacement for inadequate infrastructure and signage.
Globally, the importance of these non-formal signals is profoundly diverse. For example, flashing lights in Russia may either be a warning or of disapproval, while the same signal in Italy expresses thankfulness or a greeting (Dong et al., 2024). Moreover, the universality of their perception increases the level of accidents. Zhang et al. (2023) explored and confirmed that 15% of Chinese city accidents were caused by the misunderstanding of non-verbal communication. In African

nations where informal communication is most prevalent, the level of miscommunication is particularly risky for road usage.

Behavioural and Psychological Frameworks

Psychology theories provide an adequate explanation regarding how motorists comprehend and utilise non-formal communication while driving. Theory of Planned Behaviour (TPB) elucidates that the behaviour of an individual is driven by behavioural intentions, which are induced by attitudes, subjective norms, and perceived behavioural control of the behaviour (Ajzen, 1991). In driving, TPB assumes that the application of informal signals by a driver is an outcome of their attitude toward whether the signal is helpful, social norms, and their perceived control over effectively utilising the signals. TPB has since been elaborated further in recent research to include other psychological concepts such as risk perception and sensation seeking.

For example, Liu et al. (2023) integrated TPB with sensation-seeking theory and concluded that highly sensation-seeking drivers will be more prone to exhibit riskier driving behaviour, i.e., to utilise informal signals. Similarly, the Vulnerability-Stress-Adaptation (VSA) model (Langer et al., 2008) implies that psychologically stressed drivers will tend to adjust their communication style, and informal signals will become unpredictable and riskier. Furthermore, risk compensation theory also anticipates that drivers will behave in self-initiated ways that align with perceptions of safety. For example, drivers take greater risks as they believe their informal signals make their intentions clear and other drivers will be able to respond accordingly (Elvik & Vaa, 2004). These theoretical considerations highlight the significance of underlying psychological dynamics underpinning off-duty communication on highways, particularly in cases of poor formal regulation.

Technology and Informal Signalling: Conflict or Convergence?

The use of vehicle-to-vehicle (V2V) communication and automated car technology brings new dynamics to car communication. Autonomous technologies are based on standardised protocols to read and respond to signals, a format that can be at odds with the multi-layered and context-dependent nature of spontaneous human communication. Schumann et al. (2023) argue that most automated systems lack the cognitive flexibility to decipher causal clues in adaptive road environments. Similarly, Suryana et al. (2024) highlight the failure of autonomous cars to recognise unstandardised driver behaviour, warning that this mismatch will lead to disastrous safety malfunctions in unstructured road infrastructure. For instance, autonomous vehicles might be given a flash of a headlight by a driver as something open to more than one interpretation based on circumstances (Lee & See, 2021; Liao et al., 2023; Frerichs, 2016).

Kettle et al. (2023) maintain that machine-like communication attributes should be integrated into autonomous systems to develop situation awareness and trust. Their study illustrates how the integration of adaptive communication methods, i.e., augmented reality visualisations and driver assistance systems, has the potential to bridge the gap between the interpretability of machines and human informal cues. In addition, the incorporation of cognitive models into autonomous vehicles can improve the detection of informal signs. Schumann et al. (2023) inferred a cognitive-theory-

based model to forecast human driving behaviour and demonstrated that such models can enable automated vehicles to focus more on human drivers' informal signals.

Cultural and Regional Variations

Cultural norms and regional practices significantly shape informal road communication. In Zimbabwe, to drive in traffic, drivers employ hand signals and horn honking, and it is a common practice deeply rooted in indigenous driving culture (Chibaro & Foya, 2024). In India and the Philippines, flashing and horn honking carry culturally distinct meanings, reflecting wider variation in non-verbal communication (Zhou et al., 2023).

Cross-cultural studies highlight the importance of grasping these differences in terms of improving road safety. For example, Zhou et al. (2023) investigated country differences in implicit driving cues and reported substantial variation in the use and understanding of informal signals. The implications are that interventions for improving road safety must be contextualised within the specific cultural environment to be impactful. Also, the lack of instruction on informal communication in driving schools exacerbates the problem. In South Africa, although the K53 driver's manual is packed with information on formal communication, it lacks information on informal signs, thus inconsistencies in road behaviour (Adedeji et al., 2024).

Gaps and Hypotheses

Despite the universality of informal signalling in driving, there is a notable lack of comprehensive studies addressing the road safety implications generally and particularly in African settings. While existing researches often focus on specific fields or isolated aspects of informal signalling, there is still insufficient general knowledge on their implications for broader road safety outcomes.

To address this gap, this study proposes the following hypotheses:
H1: There are statistically significant differences in the types of informal communication signals used by drivers based on age, driving experience, and location.
H2: Increased frequency of informal signalling is positively associated with the incidence of near-miss road safety events among Zimbabwean drivers.
H3: Informal driver communication practices show low compatibility with standardised vehicle-to-vehicle communication protocols.

Methodology

The study utilised a mixed-methods approach, which combines the qualitative and the quantitative methods to gather extensive information on informal driver communication and its contribution to improving road safety in Zimbabwe. The mixed-methods design best suits the study of complex social phenomena because it facilitates data triangulation and verification of findings from multiple sources of data (Creswell & Clark, 2023). Through combining qualitative insight with quantitative information, the study sought to determine the tacit behaviour and attitudes of drivers, as well as quantitative patterns of road safety accidents. Fetters et al. (2021) emphasise the value of mixed-methods design in health and social sciences because it facilitates a more detailed exploration by integrating quantitative data with contextual information.

Study Area and Participants

The research was conducted in Zimbabwe, covering major urban centres such as Harare and Bulawayo, peri-urban and rural communities, to provide a spectrum of diverse driving environments. Roads in Zimbabwe are approximately 88,100 kilometres long and have varying infrastructural and maintenance standards (Zimbabwe National Road Administration, 2023). Urbanisation and expansion in the number of motor vehicles have led to increased concerns about road safety and driver behaviour.

The target population for this study comprises licensed drivers, traffic police officers, and road safety experts operating within Zimbabwe's major urban centres (Harare and Bulawayo), peri-urban areas, and select rural districts. According to the Zimbabwe National Road Administration (ZINARA, 2023), there are approximately 1.2 million registered drivers across the country, with an estimated 450,000 based in the study regions. The number of traffic police officers assigned to urban and peri-urban transport departments is approximately 3,500, while road safety experts and regulatory officials are drawn from institutions such as the Traffic Safety Council of Zimbabwe (TSCZ), urban transport planners, and academia.

A stratified random sampling technique was employed for the quantitative component, focusing exclusively on licensed drivers. The total sample size was 400 drivers, determined using Cochran's formula to ensure statistical representativeness. Stratification was based on age group, gender, driving experience, and geographic location (urban vs. peri-urban), allowing the analysis of informal signalling patterns across key demographic groups.

For the qualitative component, 30 purposively selected stakeholders participated in in-depth interviews. These included: - 10 traffic police officers, - 10 road safety experts (from the Traffic Safety Council of Zimbabwe and local universities), and - 10 experienced drivers selected based on their exposure to diverse traffic environments. These stakeholders were selected to provide rich, contextual insights on how informal communication signals are used, interpreted, and regulated in Zimbabwe.

Data Collection Methods

The study utilises a variety of data collection methods for robust and rigorous analysis:
Field Observations: Systematic observations at major intersections and busy areas were conducted to capture instances of informal communication, such as hand signals, flashing headlamps, and horn honking.
Surveys: Structured questionnaires were administered to collect quantitative data on the frequency, context, and perceived effectiveness of informal communication methods among drivers. The questionnaires were personally distributed at strategic transport nodes such as bus ranks, junctions, and taxi parks in Harare, Bulawayo, and the surrounding peri-urban areas. Data were gathered over the course of three weeks, and questionnaires were disseminated by trained enumerators on an intercept face-to-face basis, an approach shown to be effective in gathering valid transport behaviour data in middle- and low-income contexts (Mohamed et al., 2024; Zhou et al., 2023). All the participants were screened for eligibility before the administration of the

surveys by ensuring that they had a valid Zimbabwean driver's licence. The respondents were then told about the study purpose, assured of confidentiality, and provided with informed consent forms. Enumerators were also available to clarify survey questions and standardise responses, minimise data entry mistakes, and address comprehension challenges. This method is promoted by recent field surveys of driver attitude in Africa (Adedeji et al., 2024; Chibaro & Foya, 2024).

Questionnaire items were developed with the assistance of extant behavioural road safety research and pilot-tested on a small sample of drivers before being fully administered. The survey instrument covered four general areas: types of informal signals used, contextual conditions (e.g., congestion, overtaking), how often they were used, and how effective they were perceived to be in accident or conflict avoidance. This strategy enabled the researchers to collect both behavioural and perceptual data required to study road safety implications in a culturally embedded signalling space (Liu et al., 2023; Zhang et al., 2023).

Semi-structured interviews were conducted with a purposive sample of 30 participants comprising road safety experts, traffic police officers, and experienced drivers to gather rich qualitative data on why, how, and with what effects informal signalling is occurring in Zimbabwe. Data gathering was conducted within four weeks in 2024 and was done face-to-face in a location convenient to the informants. Interviews lasted on average between 30 and 45 minutes. Participants were sampled through purposive sampling, which is particularly strong in qualitative transport research when attempting to gather expert and experience-based opinions (Liu et al., 2023; Mohamed et al., 2024). The sample included: - 10 frontline enforcement traffic police officers, - 10 road safety officials from organizations such as the Traffic Safety Council of Zimbabwe (TSCZ), and - 10 long-distance and commuter drivers with a minimum of 10 years' driving experience.

All interviews used a semi-structured guide with uniformity between key topics (e.g., frequency, meaning, and control of informal signals), but with the scope for variation for participants to give examples from personal experience and setting (Dong et al., 2024). Interviews were conducted in English, Shona, or Ndebele, subject preference, and were tape-recorded with consent. Field notes were also gathered to capture non-verbal data and set context. Following data collection, the interview recordings were transcribed verbatim and imported into NVivo software for thematic analysis, which enabled systematic coding and identification of recurring patterns (Braun & Clarke, 2023) and was widely applied in qualitative transport behaviour studies (Zhou et al., 2023).
Accident Report Analysis: Traffic accident reports were analysed within the past five years to determine patterns and correlations between accident occurrence and informal communication behaviour. The blending of these methodologies enhances the validity of the results and yields a more sensitive understanding of the research problem (Creswell & Creswell, 2022).

Data Analysis

Quantitative data collected through surveys were analysed using statistical software tools such as SPSS (v26) and R (v4.3). Descriptive statistics, including frequency distributions and cross-tabulations, were used to summarise the types and frequency of informal communication signals. Inferential statistical techniques, including chi-square tests and binary logistic regression, were applied to examine relationships between demographic variables (e.g., age, experience) and self-

reported safety outcomes such as near-miss incidents. This is in accordance with best practice in transport behaviour analysis using large-scale driver surveys (Zhou et al., 2023; Liu et al., 2023). For qualitative data, thematic analysis was conducted using NVivo 14 software. Field observation notes and interview transcripts were first transcribed and imported into the software. Deductive and inductive coding were used to identify repetitive patterns, themes, and categories of non-formal signalling behaviour. Repetitive themes like perception of safety, cultural learning, and communication breakdowns were worked through iteratively, and cross-data sources were checked (Braun & Clarke, 2023).

Specifically, field observation reports served as independent qualitative data sources. Observation checklists and descriptive remarks, collected at intersections, roundabouts, and taxi stands, were coded independently of interview data for richness of context. Field observation reports had naturalistic descriptions of actual-time informal signalling behaviour, including spontaneous gestures, horn use, and driver-to-driver communication. Patterns found between sites were triangulated with interview responses to enhance thematic validity and confirm behaviour consistencies across different traffic conditions (Mohamed et al., 2024; Dong et al., 2024).
By integrating several qualitative and quantitative sources of data, the analysis offered an integrated technological and behavioural analysis of the role of informal signalling in road safety in Zimbabwe.

Ethical Considerations

The research received ethical clearance from the Zimbabwe Medical Research Council. There was adequate informed consent gathered from all respondents, and anonymity and confidentiality were provided. Participants were informed of their right to drop out of the study at any time without penalty. The research took the ethical guidelines for researching human participants as outlined in the Declaration of Helsinki and local regulatory bodies (Man & Schaefer, 2023; Braun & Larke, 2023).

Results
Response Rate

For the quantitative component of the study, 500 standardised questionnaires were distributed to Harare, Bulawayo, and selected peri-urban locations' licensed vehicle drivers. Of these, 400 completed and usable questionnaires were returned, and the response rate was 80%. The questionnaires were distributed face-to-face at transportation hubs like taxi ranks, bus stops, and intersections.

This response rate is typical for individuals working on low- and middle-income country transport behaviour research, which enables one to utilise a 70–80% response rate for statistical analysis and generalisation (Mohamed et al., 2024; Zhou et al., 2023). The high response rate was facilitated by the employment of trained enumerators, face-to-face interviewing, and convenient locations for administering surveys.

For the qualitative component, 30 in-depth interviews were planned and successfully achieved with a 100% response rate. Participants included 10 traffic police officers, 10 road safety experts,

and 10 experienced drivers. The interviews were made possible with pre-planning and purposive recruitment, making sure they achieved 100% participation. Interviews were conducted in secure and accessible venues such as municipal offices, driver resting areas, and safety council offices. The excellent response rates in both data streams enhanced the validity and reliability of results through demographic variety and fair representation across groups of stakeholders. Dual-method response also provided an excellent foundation for effective data triangulation, consistent with mixed-method best practice (Liu et al., 2023; Braun & Clarke, 2023).

Table 1: Participant Demographics

Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	230	57.5%
	Female	170	42.5%
Age Group	18–25	80	20.0%
	26–35	120	30.0%
	36–50	130	32.5%
	51 and above	70	17.5%
Driving Experience	< 5 years	95	23.8%
	5–10 years	140	35.0%
	10–20 years	110	27.5%
	> 20 years	55	13.8%

Descriptive Findings

Survey data and field observation revealed many common types of informal communication used by Zimbabwean drivers. These included hand signals (e.g., hand waving or finger signals), flashing, short horn taps, and subtle vehicle movements like minor deviation to indicate passing intention. Among the 400 surveyed drivers, 71% admitted to using at least one informal signal quite often, where formal signals were not sufficient or visible.

Hand signals were utilised most often within city traffic or at uncontrolled intersections. Headlight flashing was typically employed on highways or rural roads, generally to indicate police roadblocks or checkpoints. Horn beeps, short toots, or long horns were used to show impatience, caution pedestrians, or request right-of-way. Usage was highest among male drivers aged 25–40 and among those driving in Harare and Bulawayo.

Table 2: Informal Signal Types, Contexts, and Frequencies

Signal Type	Common Meaning	Usage Context	Frequency Reported (%)
Hand Gestures	"Proceed" or "Wait"	Intersections, overtaking	68%
Headlight Flashing	Warning / Permission to go	Highways, night driving	52%
Horn Beeping (short)	Alert or acknowledgment	Urban traffic	73%
Horn Beeping (long)	Aggression or urgency	Congestion, emergencies	39%

Signal Type	Common Meaning	Usage Context	Frequency Reported (%)
Vehicle Positioning	Intention to yield or overtake	Two-lane roads	48%

Thematic Analysis

Thematic analysis of thirty in-depth interviews revealed five interconnected themes: safety perceptions, stress responses, miscommunication, cultural norms, and adaptive learning. These themes illustrate the practical, emotional, and social dimensions of informal driver communication in Zimbabwe and are supported by rich, first-hand narratives from participants.

Safety Perceptions

Informal communication among drivers is a vital safety mechanism while driving. In situations where there is a shortage of formal signals or they are inadequate, the participants consistently highlighted the safety role played by informal signals. As one driver elaborates, *"When I flash my headlights, I'm warning the driver in front of the hazard. It's faster than waiting for them to see a road sign."* The same sense of urgency was echoed by another interviewee who stated, *"Tapping my hand to warn a car behind me to stop is sometimes the only thing that works."* A third interviewee pointed out the inadequacy of official signals in high-reactive environments: **"***In traffic congestion, the use of indicators can be too slow. I just wave my hand so the other driver understands immediately."* These comments attest that informal communication is not merely an addition but, at times, a necessary substitute for official communication in hazardous situations.

Stress Responses

Informal signalling frequently emerges as a spontaneous reaction for drivers under high-stress situations. Instead of using cautious, rule-governed communication, most informal gestures are affective displays in times of stress. *"When somebody cuts me off, my reaction is to honk, not to think,"* remarked one driver. Another said, *"It's stressful during rush hours. You just start flashing your lights or honking out of habit."* A third participant described the sensory overload of peak-hour driving: *"Friday nights, everybody's in a hurry. Signals are loud and quick horns and flashing lights; it's like driving through noise at high speed."* These accounts draw attention to the psychological stress undergone by drivers in panicked contexts and reveal how informal signals are both employed as communicative devices and emotional releases.

Miscommunication

The informality of driver signals can generate very substantial miscommunication on the road. Respondents gave several examples in which the ambiguity of informal signals resulted in near-accidents or confusion. One driver admitted, *"I once flashed my lights to let someone pass, but he thought I was signalling him to stop. We almost collided."* The lack of conventional meanings invites dangerous confusion, as one participant clarified: *"You don't know what a short beep means to each driver. To me, it's 'thanks.' To someone else, it's 'get out of the way.'"* Others noted that the

origin of this is that there is no formal training: *"There's no instruction on this. So, we all do our own thing. It works until it doesn't."*

Cultural Norms

Informal communication among drivers is influenced by cultural norms. Not only does this form of communication function, but it is also culturally ingrained. One respondent remarked, *"Here in Zimbabwe, hand signals are common sense. It's how our fathers drove."* Regional differences further complicate understanding: *"Flashing lights mean different things in different areas. In Harare, it means 'I'm going first.' In Masvingo, it can mean 'slow down.'"* Participants pointed out that cultural reliance on informal norms often overrides official procedures, especially when institutional trust is low: *"We don't wait for traffic lights to work. If they're not functioning, drivers just use their own judgment and signals."*

Adaptive Learning

Adaptive learning is the process by which drivers learn informal communication skills through experiential learning and not formal learning. As one other driver explained, *"No one ever taught me to flash headlights. I picked it up by copying other drivers when I was learning."* Others mentioned the implicit nature of this learning process: *"You learn by the process of time. The more you drive, the more you learn the 'hidden language' of the road."* One of the actual-world incentives arose from participant observation: *"Sometimes your car indicator is not working. So, you pick up other forms of quick communication."* This illustrates the ingenuity of drivers in managing faulty infrastructure or vehicle capacity through socialised practice.
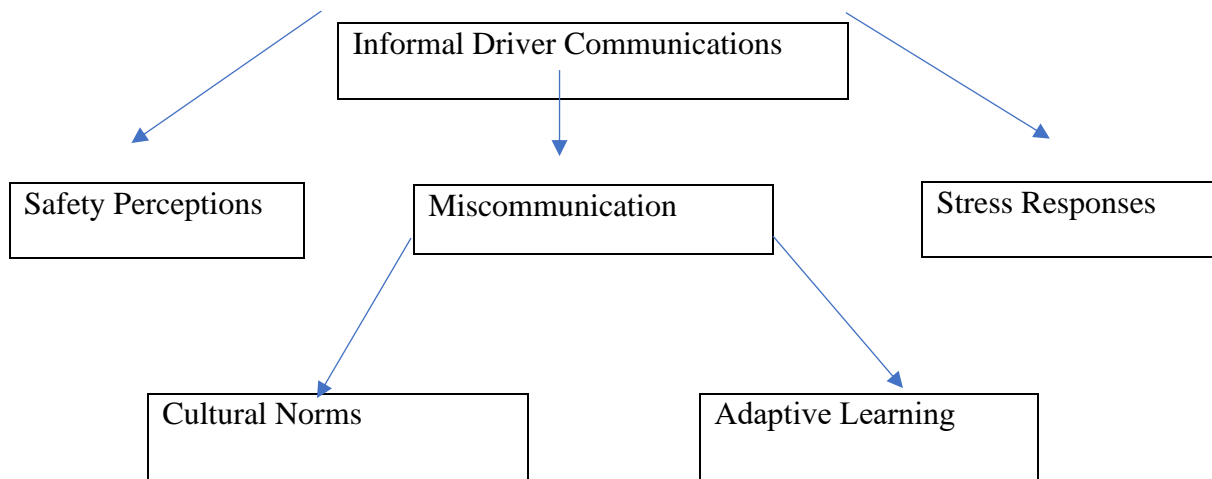
Figure 1: Hematic Map of Informal Driver Communication

Source: Authors (2025)

Quantitative Associations (Summary)

Though qualitative depth was the priority in this research, supporting survey data illuminated broader trends that are in agreement with the themes. Informal signal use was discovered to be much greater in city drivers, thanks to dense traffic and the need for instant communication. Cross-tabulation analysis revealed that less experienced drivers were more likely to misinterpret informal cues, which reported a greater rate of near-miss incidents. Drivers who depended more on horn beeps as a primary cue reported more near-miss incidents that nearly resulted in accidents. These findings lend empirical credence to qualitative observations of participants, reinforcing the position that while informal communication is a deeply rooted cultural survival strategy, it also creates systemic vulnerabilities when left unregulated and misunderstood.

Hypothesis Testing Results

This section presents the results of statistical tests conducted to assess the research hypotheses outlined earlier. Hypotheses were tested using SPSS (v26), employing chi-square tests for categorical variables and binary logistic regression where applicable.

H1: There are statistically significant differences in the types of informal communication signals used by drivers based on age, driving experience, and location.
A chi-square test of independence was conducted to examine the relationship between driver age group and the use of hand gestures, headlight flashing, and horn beeping.
- Hand gestures were significantly associated with age group: χ^2 (3, N = 400) = 14.82, p = 0.002
- Horn use showed a significant difference by driving experience: χ^2 (3, N = 400) = 18.44, p = 0.001
- Headlight flashing was more common in peri-urban drivers than urban: χ^2 (1, N = 400) = 6.75, p = 0.009

These findings support H1, indicating that informal signal usage differs across demographic subgroups.

H2: Increased frequency of informal signalling is positively associated with the incidence of near-miss road safety events among Zimbabwean drivers.
A binary logistic regression was conducted with self-reported near-miss incidents as the dependent variable (Yes = 1, No = 0) and frequency of horn use, headlight flashing, and hand gestures as predictors.
- Frequent horn use (>5 times/day) significantly increased the odds of near-misses: OR = 2.42, 95% CI [1.52, 3.87], p < 0.001
- Headlight flashing was moderately associated with near-misses: OR = 1.61, 95% CI [1.03, 2.54], p = 0.037
- Hand gestures showed no statistically significant effect: p = 0.087

These results partially support H2, particularly highlighting horn use as a predictor of risky encounters on the road.

H3: Informal driver communication practices show low compatibility with standardised vehicle-to-vehicle communication protocols.

While this hypothesis was assessed qualitatively, drivers and road safety experts overwhelmingly expressed scepticism about the compatibility of informal gestures with V2V systems. However, a supplementary survey item asked:

"Do you think current informal signals (e.g., hand waves, headlight flashes) could be recognised by smart vehicles or autonomous systems?"

- Only 16% (n = 64) responded "Yes"
- 58% (n = 232) said "No"
- 26% (n = 104) were "Unsure"

A one-sample chi-square goodness-of-fit test showed a significant skew in distribution: χ^2 (2, N = 400) = 129.36, p < 0.001

This supports H3, indicating that most drivers perceive a disconnect between informal signals and technological systems, reinforcing concerns about system-human integration.

Table 3: Summary of Hypothesis Testing

Hypothesis	Test Used	p-value	Result
H1	Chi-square	p < 0.01	Supported
H2	Logistic regression	p < 0.001 (horn use)	Partially supported
H3	Chi-square	p < 0.001	Supported

Table 4: Signal Use and Self-Reported Accident Frequency

Signal Use Type	Low Use (0–2 times/day)	High Use (>5 times/day)	Near-Miss Reports (%)
Hand Gestures	20%	38%	28%
Headlight Flashing	12%	26%	19%
Horn Beeping (general)	30%	60%	42%

Source: Authors (2025)

Discussion
Interpretation of Key Findings

The results of this study confirm the behavioural and technological complexity of informal communication among drivers in Zimbabwe. Quantitative analysis revealed that informal signal usage significantly varies across driver demographics, particularly age, experience, and location. For instance, younger and less experienced drivers were more likely to rely on gestures and horn beeps, while peri-urban drivers frequently employed headlight flashing. This supports Hypothesis 1 (H1), which proposed statistically significant differences in informal signalling practices based on socio-demographic characteristics. These findings align with Zhou et al. (2023) and Dong et al. (2024), who noted that age, regional driving culture, and accumulated experience influence non-verbal driver communication patterns. Similarly, Chikodzi (2023) observed that informal occupational behaviours among transport workers in Southern Africa often vary by generational and locational subcultures, making them difficult to regulate uniformly.

Furthermore, the study established a statistically significant association between the frequency of informal signalling, particularly horn use, and the incidence of near-miss events, as confirmed by logistic regression analysis. Drivers who utilised horns more than five times per day had a 2.42-times higher likelihood of experiencing near-misses ($p < 0.001$). The finding is partly in support of Hypothesis 2 (H2) and is consistent with earlier research by Adedeji et al. (2024) and Zhang et al. (2023), who argued that informal signals are adaptive, but their ambiguity creates dangerous misinterpretation. Kumar and Wamala (2023) also support this by revealing that horn utilisation in urban cities of East Africa often serves as a substitute for deteriorated formal infrastructure, but could escalate rather than reduce conflict. Likewise, Kim and Heerden (2024) demonstrated that excessive reliance on horn signals among high-capacity urban corridors in South Africa led to higher tension, poor driver judgment, and rising incident frequency. Interestingly, gestures of the hand, while widespread, failed to consistently forecast near-miss incidents ($p = 0.087$), suggesting risk variance by type of informal signal used. This complements Frerichs (2016), who explained the way in which some non-verbal signs are more interpretable and low-risk in that they are part of local driver norms, while others, e.g., horn beeps, are meaning non-standardised and open to a range of interpretations.

Qualitative research outcomes show increased sensitivity to the adaptive and psychological underpinnings of informal signalling. Interview narratives found themes including signalling under stress, cultural embeddedness, and learning through experience. These support findings presented by Liu et al. (2023) on how sensation-seeking and risk-perception variables underpin informal driving conduct in poorly regulated environments. Additionally, Kim and Mwale (2023) and Mujuru and Merwe (2024) suggest that anxious drivers will tend to resort to informal and intuitive signals, typically overestimating others' communicative intent, particularly in circumstances of weak regulatory enforcement or institutional mistrust. Kettle et al. (2023) also argue that stress-exacerbated informal driving responses are forms of emotional signalling that render traffic less predictable.

Technologically, the research investigated attitudes towards the compatibility of informal communication with new systems such as Vehicle-to-Vehicle (V2V) communication and AI-driven platforms. More than half (58%) of the respondents to the survey were of the view that informal gestures like hand waves or horn taps cannot be trustworthily interpreted by smart systems, while a mere 16% were confident about such compatibility. One-sample chi-square goodness-of-fit test ($p < 0.001$) revealed statistically significant scepticism, thus confirming Hypothesis 3 (H3). This is in line with the arguments of Schumann et al. (2023) and Suryana et al. (2024), who argue that the formal, standardised nature of V2V systems is not harmonious with spontaneous, culturally embedded human signals. Reflecting on this, Liao et al. (2023) recommend that AI systems in mobility contexts be trained on locally gathered behavioural datasets so that the human nuance can really be captured.

Apart from this, Kettle et al. (2023) found that systems that do not possess human-like communicative properties are not capable of developing trust among drivers in mixed traffic, particularly in Africa and Southeast Asia. This emphasises the need for systems that can interpret social and cultural cues, not mechanical inputs.

This twin discovery, that informal signalling is technologically incompatible and culturally influential, reveals a central flaw in the African smart mobility transition. Informal signals are

essential to survival within communication on the under-regulated roads, but they become significant barriers to automation. The findings support arguments made by Chibaro and Foya (2024), who promote policy regimes that recognise, rather than deny, indigenous traffic ways of being in framing intelligent transport systems.

Behavioural Implications

Psychological stressors and societal values have a significant role in influencing behaviour and the use of informal cues. The driving culture in most African nations still relies to a great extent on informal cues such as hand signals or flashing lights (Adedeji et al., 2024). While in some environments such systems work, they lead to misinterpretation, especially among inexperienced drivers. Psychological stressors like time pressure and traffic density are also responsible for informal signal use. Under pressure, drivers might react with automatic reactions like honking or hostile hand gestures that could be misinterpreted by other drivers and escalate into conflict or an accident (Kettle et al., 2023). Peer influence is also significant; novice drivers learn from experienced drivers and are therefore inducted into the informal communication loop without formal training or knowledge.

Technological Integration Challenges

The use of technology like V2V communication and AI systems is helpful and detrimental. Although these systems are intended for road safety through the visibility of communication between the vehicles, their success depends upon the belief and perception of the drivers. Experimental evidence indicates that the automated systems can be misjudged or distrusted by the drivers, and these can be potential safety hazards (Suryana et al., 2024).
Furthermore, system development needs to consider how individuals act and the cultural factors that are a part of human lives. For instance, autonomous vehicle anthropomorphism, or the ability to mimic human-like interaction, shapes driver behaviour and acceptance (Kettle et al., 2023). Therefore, developers need to make technology solutions more human-oriented, culture-sensitive, and backed by widespread driver training programs.

Policy Relevance

There are both drawbacks and advantages to informal signalling in low-regulation environments. The drawbacks are that the lack of formalised communication channels may lead to miscommunication and accidents. The advantages are that such informal sources are evidence of drivers' ability to fill infrastructural and regulative gaps. Policymakers must incorporate informal communication practices within formal driving schools to educate drivers in situational and standardised communication skills. The legislation must be changed to keep up with the evolving face of road communication, merging technological advancements without sacrificing cultural identity. Governments, technology, and societies must harmoniously support each other in having an integrated and successful road safety program. Such a breakdown emphasises the informal nature of driver engagement and the wide-ranging implications for road safety, technology incorporation, and policy-making. Addressing these challenges demands an integrated solution balancing cultural understanding, technological innovation, and regulatory reform.

Conclusion

This study examined the nature, scope, and importance of informal driver communication in Zimbabwe and determined that it is both a widespread cultural practice and an operational adjustment to the nation's challenging road network. Utilising a mixed-methods design, the study identified common informal signalling practices, hand signs, flashing headlights, and horn use, and examined usage patterns, situational meaning, and accompanying safety risks. The qualitative narratives emphasised the adaptive and intuitive nature of such signals, while the quantitative reports revealed high correlations between informal communication and road safety outcomes and driver experience levels.

The conclusions are an important contribution to road safety discussions in low- and middle-income nations, where formal traffic control practices are poor or patchily enforced. By highlighting the ambivalence of the informal signals, as lifesaving but equally risk-causing, this study problematises traditional road safety models that are usually indifferent to behavioural and cultural processes.

Policy and Practice Recommendations

Drawing directly from the findings of this study, the following recommendations are proposed to address the behavioural and technological challenges posed by informal communication among drivers in Zimbabwe. These recommendations aim to enhance road safety through evidence-based interventions grounded in local driving practices.

Public Awareness and Safety Campaigns

The study revealed widespread reliance on informal signals such as hand gestures, horn use, and headlight flashing, many of which are ambiguous and prone to misinterpretation. Targeted public education campaigns should focus on raising awareness about the risks associated with inconsistent signalling. Messaging should emphasise safer signalling habits, promote mutual understanding among drivers, and reduce miscommunication, particularly in high-traffic zones.

Culturally-Informed Driver Training

Driver training programs should be revised to include informal communication practices observed in local road environments. Current curricula are often limited to formal traffic rules and ignore the nuanced, adaptive behaviours that drivers develop in practice. By integrating these behavioural realities into official training, instructors can better prepare drivers to interpret and respond to informal signals safely and consistently.

Adaptive Technology Design

The study found that most drivers perceive low compatibility between informal signals and V2V or AI-driven systems. As Zimbabwe gradually moves towards smart mobility integration, there is a need for adaptive technology that can operate effectively in non-standard environments. Sensor systems, AI algorithms, and communication protocols should be tested and adapted to recognise

informal cues common on Zimbabwean roads, ensuring both human and machine drivers can coexist safely.

Regulatory Strengthening and Stakeholder Engagement

While driver behaviour plays a central role in road safety, regulatory frameworks must support behavioural change. Enforcement of signalling-related traffic rules should be enhanced, and penalties for negligent communication practices must be clarified and applied consistently. Simultaneously, partnerships among regulatory authorities, transport operators, and driver associations should be established to co-develop practical, enforceable guidelines for safe informal signalling.

Integrated Multi-Sectoral Approach

Improving road safety in Zimbabwe requires collaboration across government agencies, driver training institutions, technology developers, and civil society. This study demonstrates that addressing informal signalling is not just a behavioural issue but also technological and institutional. Therefore, multi-stakeholder coordination is essential for designing education campaigns, adapting intelligent systems, and developing responsive policy frameworks that reflect the realities of Zimbabwe's transport ecosystem.

Limitations and Future Research

Despite its virtues, there are several significant limitations to this research. First, the geographical scope of the study was limited to selected urban and peri-urban spaces in Zimbabwe, e.g., Harare and Bulawayo. Although these are busy locations, they fail to represent rural driving behaviour, whose road conditions, traffic flow, and unofficial communication habits may be vastly dissimilar. Thus, the findings might not be fully applicable to the national context or to neighbouring rural areas with diverging mobility patterns.

Second, the study relied on self-reported data collected through surveys and interviews. Although efforts were made to reduce social desirability bias (i.e., ensuring anonymity and confidentiality), there remains the possibility that respondents underreported or exaggerated their signalling behaviour or histories of accidents. Self-reports are necessarily susceptible to recall error and subjective memory of past events.

Third, non-driver road users were not included. Excluding these populations narrows the scope of the research because these populations may differently interpret informal signals or may be more exposed to miscommunication. Incorporating their perspectives into future research could provide an integral picture of road safety in Zimbabwe.

Further research would be well advised to extend this foundation through the utilisation of longitudinal designs to track driver behaviour change and informal signalling practice development over time. Cyclists and pedestrians should also be incorporated into the samples, since these individuals often utilise the same informal communication spaces as drivers and can serve to key into cross-modal interaction and road safety flaws.

Additionally, experiments and simulations can be employed to study informal signal interpretation in controlled environments and how miscommunication can be mitigated. Merging virtual reality software or traffic micro-simulators can enable further understanding of risk dynamics and aid in AI system development that reacts to localised informal signals. In short, future scholarship must bridge the gap between informal roadside practices and formal safety models, pursuing more equitable, responsive, and efficacious interventions into transport safety planning.

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