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Evaluation of Road Safety Performance Based on an Innovative Composite Index-Based Strategy for Gulf Cooperation Council (GCC) Countries

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Abstract

Road traffic injuries are a major public health and socio-economic problem worldwide, causing more than 1.35 million people to die each year, and causing deaths in particular at high rates in Gulf Cooperation Council (GCC) countries. This research was set to assess the performance of road safety in the GCC countries and come up with a strategy for reducing traffic accidents, deaths, and injuries based on an innovative composite road safety performance assessment framework. The study was conducted using a quantitative, descriptive and analytical design with secondary traffic data from six countries: Kuwait, Saudi Arabia, UAE, Qatar, Bahrain and Oman for the period 2015-2019 along with questionnaires and expert consultations for 810 drivers. Key to the development of an innovative composite road safety performance index incorporating five dimensions of road safety: accident frequency, death, injuries, traffic violations, road safety policy effectiveness and performance of road safety countermeasures was an Ordered Weighted Averaging (OWA) approach. The results showed a general overall decrease in the level of accidents throughout the GCC with an average annual decrease of 28% in Kuwait and 18.49% in Saudi Arabia. But there were known issues of fatalities, injury severity and high-risk driving behavior. Bahrain has the highest innovative composite road safety score at 0.91, followed by Qatar, with a score of 0.87, then the UAE, with a score of 0.82, and finally Oman with the fewest points, at 0.68. Education and emergency response initiatives were perceived as moderately effective countermeasures, while engineering interventions and enforcement measures were perceived as the most effective countermeasures. The research has introduced a framework for an assessment of road safety in multiple dimensions to address the shortcomings of current single-indicator assessments and offers a useful tool for policy makers to benchmark their efforts and formulate data-driven, targeted and safe system-based road safety plans for the GCC region.

Keywords: Road Safety, Gulf Cooperation Council, Innovative Composite Road Safety Index, Ordered Weighted Averaging, Traffic Accidents, Traffic Violations, Safe System Approach, Road Safety Performance, Traffic Fatalities, Transportation Policy.

Introduction

Risk of road traffic collisions remains a major public health challenge for the world, with over 1.35 million annual deaths, of which 93% is in low- and middle-income countries. The toll of traffic accidents was not limited to loss of life, many were injured and suffered from permanent disabilities, as well as significant economic losses. During a specific period, an estimated 2.5% to 4.5% of national Gross Domestic Product (GDP) is lost as a result of road traffic accidents in certain parts of the world. Especially, there was a significant concern in society, a development issue, with disproportionate effects on young adults (15-29 years) as compared to other age groups (R. Goel et al., 2024; He et al., 2021). While there has been improvement in traffic infrastructure and vehicles, road safety still remains a pressing concern in developing and developed nations, including the Gulf Cooperation Council (GCC) countries (Kuwait, Saudi Arabia, United Arab Emirates (UAE), Qatar, Bahrain and Oman (Alfaki, 2024).

In the GCC countries, the socio-economic and cultural factors that influence road safety had a distinct relationship between them: on one hand, high oil consumption, rapid urbanization and high rates of vehicle ownership influenced road safety; on the other, all these factors were closely related to each other. From the population growth point of view, the average growth rate for the region was 3.2% between 2015 and 2019, while the registered vehicles experienced growth during the same period of

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time (Alfaki et al., 2026; Mahmood et al., 2022). Despite these infrastructural and economic advantages, the rates of deaths per 100,000 population in GCC countries were still much higher at 22-27 per 100,000 than in other developed European countries, with the average at 13.5 per 100,000. Some factors that exacerbated the accident were aggression, violation of the rules and traffic signs, lack of experience when driving, vehicle features and environment (Al Saidi et al., 2025; Masood et al., 2024). Additionally, there were most socio-cultural norms and lack of enforced strong norms that further exacerbated the risk, highlighting the need for systematic evidence-based interventions.

A single performance indicator, like fatalities per capita or per vehicle, was often used in history to measure road safety performance. These measures gave a good snapshot, but were not considered as a multi-dimensional measure of road safety, as behavior, technology, infrastructure, and policy issues all play a part. However, it is important to acknowledge that these measurements come with limitations. Contemporary research has focused on ways to develop innovative composite indices derived from a combination of these different indicators, such as traffic fines, accident rates, levels of injury severity, whether the law is being effective, and public perception of the effectiveness of countermeasures (Golfiroozi et al., 2024; Mohanty et al., 2022; Pires et al., 2025; Todosijević et al., 2022). This allowed for a more representative capture of overall safety performance and insightful information that could be used to inform appropriate prioritizations of interventions by policymakers.

Road safety assessment in the GCC was further hampered by variation in the data available, the way this data was reported, and the capacities of the institutions performing the assessment. The overall statistics of incidents in Kuwait showed a reduction in them between 2015 and 2019. However, there were fluctuations in injury rates, the level of fatalities per incident sometimes increased, revealing inconsistencies in safety outcomes in terms of reductions in incident frequency (Alfaki, 2025; Gasana et al., 2022). Furthermore, traffic violation profiles showed that there were discrepancies in the pattern of violations between both genders and between individuals who had committed the same violations repeatedly during the reporting period. Moreover, traffic violation profiles identified gender differences in traffic violations that had been reported, as well as repeated violations, with speeding, failure to renew a driving license, and traffic light violations being reported consistently at high levels. Across the other GCC countries, the same pattern was observed, where initiatives were required to change either behavior or enforcement to enhance the level of development (Benjamin et al., 2022; Grdinić Rakonjac & Pajković, 2025; Lee & Kim, 2026).

Consequently, this research has applied an innovative composite road safety performance index using the Ordered Weighted Averaging (OWA) approach to meet the above challenges. This method allowed for the integration of multiple indicators while still allowing consideration of their relative importance, giving an overall evaluation framework. The analysis, along with surveys of road users and experts, was a key part of the development of a detailed plan which was based on the internationally accepted “Safe System” approach to increasing safety on the road (Libório et al., 2025; Pereira Libório et al., 2024). In this approach, an assumed tolerance for human error, focused on preventative treatment, instead of or in addition to reactive treatment, accounted for the fewer number of fatal crashes. It adhered to best practices in countries like Sweden, the United Kingdom, and the Netherlands and has been tailored to the reality of the GCC.

The goal of this research was to thoroughly evaluate road safety overall performance within the GCC nations and to establish a practical approach to lessen the rate of accidents and fatalities on roadways. It involved identifying trends, assessing the road safety challenges in GCC countries, analyzing the key causes of road accidents, ranking the GCC countries according to a multi-faceted innovative composite index based on evidence, and developing an evidence-based, multi-faceted road safety strategy (Khaula, 2023; Rahman et al., 2022). This strategy was accompanied by a customized five-year national action plan, with consideration of the priorities of each region.

Research Questions

1. What are the prevailing trends and magnitudes of road traffic accidents, fatalities, and injuries in GCC countries?
2. Which human, vehicle, environmental, and behavioral factors most significantly contribute to road accidents in the region?
3. How do traditional road safety indicators compare with an innovative composite road safety performance index in evaluating national performance?
4. What evidence-based strategies and countermeasures can be implemented to enhance road safety across GCC countries effectively?

Literature Review

Road safety was a multi-dimensional public health and engineering problem, which brought together behavior, infrastructure, technology, and policy-related concerns in one. Historically, systems would be assessed using a single measure per capita or per registered vehicle, giving limited information on the overall safety performance. The complexity of traffic systems and the interdependency of risk factors required complex evaluation methods, which involved direct and indirect factors of accidents (Ehsani et al., 2023).

Road Safety Evaluation Techniques

Road safety evaluation mainly uses three methods: the public health approach, Haddon's matrix, and the systems approach. The public health strategy involves four steps: identifying problems, assessing risk factors, developing countermeasures, and monitoring their success. (Lin et al., 2023). The framework allowed for the measurement of the impact of an accident on a community and targeted intervention. It is noteworthy that it incorporated cost-effectiveness and cost-benefit analyses, as well as optimizing the allocation of resources in relation to safety (Dyreborg et al., 2022; Toraldo et al., 2025).

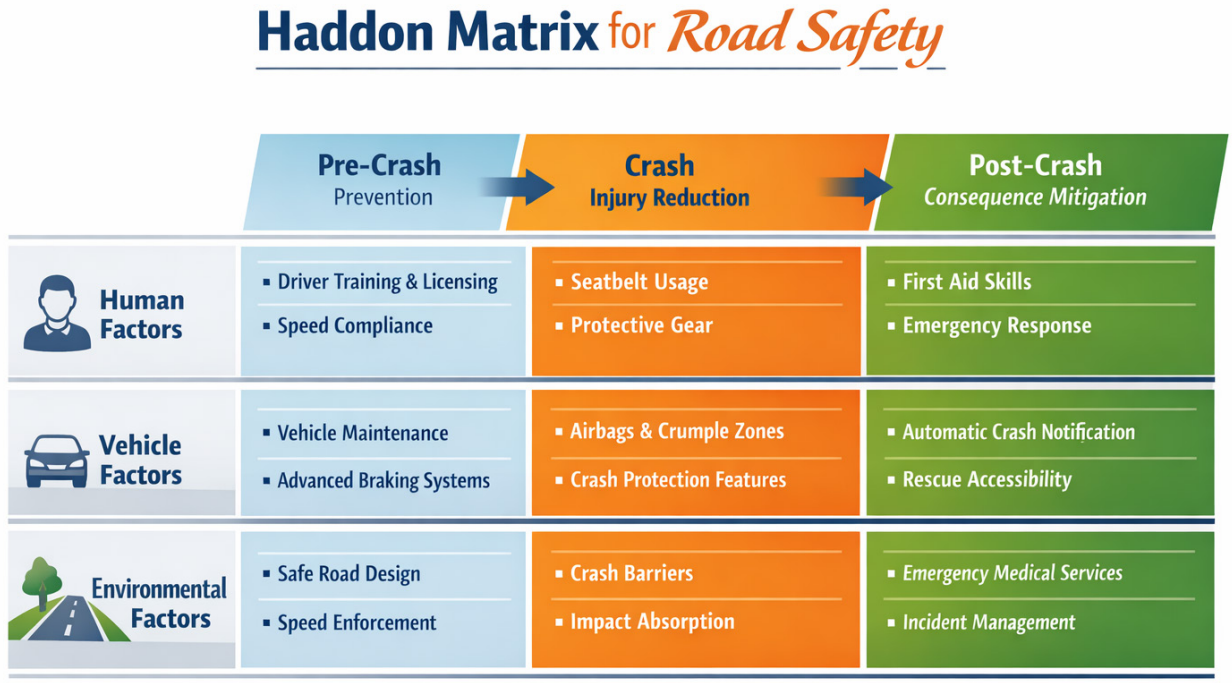

Figure 1: Haddon Matrix Applied to Road Safety
Source: Author

Each accident was assigned one of three categories by Haddon's matrix: pre-accident, accident, and post-accident. Human, vehicle and environmental factors are studied (Ali et al., 2023). They evaluate programs, services, and methods to avoid and minimize injuries in crashes, including driver education, roadway design, and vehicle safety. Primary focus is incident responses, medical aid provision and crash fatalities. A systems approach takes into account the interdependence of elements of the road, driver, vehicle, environment and regulations. The purpose was considering unintended outcomes (congestion induced violations), as well as desired outcomes, which gave a holistic perspective on which policy/design interventions can be considered (Fisa et al., 2022; Sara et al., 2024).

Factors Affecting Road Safety Performance

Safety can be affected by elements like humans, vehicles, the environment, and organizations. In an accident investigation, human factors, driver behavior, age, gender, fatigue and compliance are some of the critical factors. Studies from Kuwait and South Africa reveal that more than 90% of the causes of crashes are attributed to human faults, which are primarily caused by inattention, carelessness, aggressive driving and alcohol.

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Risks include vehicle age, vehicle model, safety features and maintenance. Factors affecting crash risk and severity include road conditions, weather, traffic and urban planning (Balamurugan & Sankaran, 2023; Giri & Koirala, 2026; McCarty & Kim, 2024). Through their interactions, it was identified that there is a need for multi-dimensional risk analysis. Socio-cultural and economic factors also were involved. Gender inequality is evident in the relatively high male/female driving ratio in the GCC countries. The risks were aggravated by rising speed, motorization, urban development and economic pressures which led to extraordinary exceptions to the traffic code. The absence of regulations and enforcement has been linked to higher rates and worse outcomes of crashes (Cullen et al., 2021; Praveen et al., 2025).

Road Safety Performance Indicators

There was a lack of progress monitoring and benchmarking to best practice, and indicators of progress were vital for this. They might be direct (such as death rates per 100,000, deaths per billion vehicle km or deaths per 10,000) or indirect (such as traffic infractions, seatbelt wearing rates, emergency response times, etc.). If the traditional indicators were useful, they were no longer useful to capture the effects of the safety program, the implementation of policies, or infrastructure changes (Claude, 2025; González-Sánchez et al., 2021). An inverse relationship between the number of accidents and the extent to which they are reported as "fatal" injuries also was evident in that a reduction in accidents was not necessarily accompanied by a reduction in Fatality Per Accident (FPA) rates. Various approaches to composite measurement are becoming increasingly suggested as a way to present a variety of measurements in a single, coherent and useful instrument.

Benchmarking and Best Practices

Benchmarking enabled comparisons of countries or regions against the "best-in-class" standard. Lessons from international studies indicated that benchmarking should consider local socio-economic and traffic characteristics. (Narayanan et al., 2022). Policy development, resource allocation, and interventions used positive benchmarking. Some studies on GCC countries found that safety performance varies between states and that tailored interventions are more effective than generic policies. (Kissi et al., 2022; Saeed Reza et al., 2026). The benchmarking techniques used OWA to evaluate indicators with varying importance, emphasizing critical safety aspects in the performance score. Experience gained from other countries around the world indicates that it is crucial to apply structures and evidence-based measures for road safety management. Multiple countries have seen the success of the Safe System approach by taking a look at all three elements - human, vehicle and road infrastructure - to reduce injuries and avoid unnecessary deaths.

Sweden: The Vision Zero for Zero collision concept was introduced in Sweden in 1997, in a proactive manner, using 'Safe System' thinking. The aim of the vision is that no education users or drivers of the road transport system be killed or harmed significantly. The underlying premise of the approach is the acceptance of forgiving road designs, sharing of social responsibility and the on-going monitoring and focus, and the strategy has spread to other countries such as Australia.

New Zealand: The Safer Journeys strategy (2010-2020) is based on Safe System principles, working towards an increasingly safer road network, recognizing that all crashes cannot be stopped but actively pursuing the systematic reduction of the number of deaths and serious injuries.

United States of America (USA): Toward Zero Deaths is the national strategy that is attempting to reach a point of zero deaths by 2030. It focuses on cultural changes towards road safety and basic safety measures. The USA has a similar goal to the Safe System, but only partially uses Safe System principles, adding a Cause Problem Solving (CPS) model to the interventions it implements in a resource-poor setting.

United Kingdom: The UK's strategic framework (2011-2030) aims to reduce fatal and serious injuries by 50%, 60%, and 70% by 2020, 2025, and 2030, respectively. The strategy is based on long term planning, stepped-up targets and the progressive roll-out of evidence informed interventions according to the risk assessment.

Spain: The Road Safety Strategy (2011-2020) of Spain included measures from the state level in a multidisciplinary approach. It utilized principles and application of Safe Systems in the national context, highlighting certain factors and target groups that have significant importance to improve the coordination and effectiveness of road safety programs.

Austria: In the period 2002-2010, the Austrian Government created a failure-tolerant system for road safety. The approach was a management process approach to road safety, which was complex, planned and evaluated. Thus,

it is not specifically referred to as the Safe System, but it is strongly based on the principles of the Safe System, and seeks to reduce road fatalities by 50% by the year 2020. Implication for GCC Countries: These results show that the Safe System approach is one of the best practices for developing a road safety strategy in the context of the GCC countries. This adoption will allow interventions to be created that take into consideration complex interactions in the infrastructure, human behavior and vehicle safety, offering a fuller understanding to enable a comprehensive approach to road safety and reductions in both road deaths and serious injuries.

Road Safety Management Systems

Effective Road Safety Management (RSM) depends on a systematic, structured process that combines vision, strategy, targets, coordination, funding, and implementation processes (Petrov, 2025; Robert Tama et al., 2026). Successful countries like Sweden, the Netherlands, and the UK demonstrated the importance of long-term vision, medium-term planning, and measurable short-term goals for improvements. RSM included program monitoring, evaluation, institutional coordination, and policy development. A system ensured accountability, resource efficiency, and data-driven decisions (Al Moaiad & Ts, 2023; Vuong & Nguyen, 2022). The literature showed that innovative composite indicators are needed to address management system gaps, lack of agency coordination, and differences in funding and enforcement in the GCC.

Innovative Composite Road Safety Index

Since using a single indicator is not enough, the research used an innovative composite road safety index for GCC countries. It includes accident frequency, deaths, injuries, traffic offenses, countermeasure effectiveness, and policy implementation quality (Gursoy & Yılmaz, 2020). The OWA method enabled weighting critical indicators, allowing policymakers to prioritize interventions. Some ASEAN applications using related indicators have shown moderate to high correlation with safety outcomes, offering a replicable model for evaluating performance in various contexts (Li et al., 2025; Qin et al., 2025).

Methodology

Research Design

A quantitative, descriptive, and analytical research design was deemed suitable for assessing the performance of the road safety system in the GCC countries. The research used a combination of secondary and primary traffic data analysis, facilitating both statistical analysis and assessment of the perceptions of the road users about the effectiveness of the countermeasures (Alobaidallah et al., 2025; Jameel & Evdorides, 2021). The design helped to generate a full view of accident trends, fatal and injury patterns, traffic crime data, and prioritization of countermeasures on the basis of evidence that informed the creation of an innovative composite road safety performance index and evidence-based strategic recommendations.

Population and Sample

The population for this research consisted of road users in the six countries of the GCC, namely Kuwait, Saudi Arabia, the United Arab Emirates, Qatar, Bahrain, and Oman. Secondary data obtained in the research were concerning crash data, death, injury, vehicle registration, and traffic offenses that occurred between 2015 and 2019 from national traffic departments and statistical bureaus (Rohrer et al., 2021). A sample of 810 drivers was selected for the primary survey to get a snapshot of how effective each of the countermeasure tactics in the data was from multiple perspectives, including engineering, education/awareness, enforcement, and emergency response. The findings, practicality of countermeasures, and strategic recommendations were confirmed through expert consultation with traffic authorities.

Data Collection Instrument

Data were collected using a structured questionnaire to assess public perceptions of road safety countermeasures across the GCC countries. The survey evaluated favorability and effectiveness in the domains of engineering, education, enforcement, and emergency response through indices adapted from prior studies. It was conducted online in Kuwait with 384 participants selected from an initial pool of 1,162 respondents, resulting in a 95% confidence level and a 5% confidence interval. Demographic information such as gender, age, nationality, education, residence, and vehicle type was also recorded. Secondary data on accidents, fatalities, injuries, registered vehicles, and traffic violations from 2015 to 2019 were obtained from official traffic authorities and statistical bureaus. All data were cleaned and validated for consistency and reliability. This combination of survey responses and longitudinal data enabled a robust evaluation of countermeasure effectiveness. It supported the construction of an innovative composite Road Safety

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Performance Index (RSPI) for the GCC countries.

Validity and Reliability

The questionnaire was piloted and expert-reviewed for content validity, clarity, and comprehensiveness. Cronbach's alpha was used to test internal consistency among the survey items, with a value over 0.7 for every section. To test the reliability, alpha values exceeding 0.7 were obtained for each section of the survey. The items are analyzed for reliability results, as shown in Table 1. The alpha scores are high, suggesting that the instrument measures what it is supposed to measure and is useful for analytical purposes.

Table 1: Reliability Analysis of Survey Instrument

Construct/Section	Number of Items	Cronbach's Alpha
Engineering Countermeasures	5	0.82
Education and Awareness Measures	4	0.79
Enforcement Initiatives	5	0.85
Emergency Response Interventions	3	0.77
Overall Instrument Reliability	17	0.84

Data Analysis

Analysis of the data was performed on several levels. Accident trends, fatalities, injuries, registered vehicles, and traffic violations, including type, frequency, and gender distribution, were summarized using descriptive statistics. For instance, the Top 5 traffic violations in 2018-19 in Kuwait are speeding, parking violations, expiration of driving license, passing at traffic lights, and breaking the law within the emergency lanes, in which males are always in the majority of violations. The OWA operator was employed to create an innovative composite road safety performance index to overcome the weakness of using a single indicator for performance measurement (Owen et al., 2022; Song et al., 2024). This index combined several important metrics, namely, the number of accidents, fatality rate, percentage of injuries, rate of traffic tickets, effectiveness of countermeasures, and quality of policy implementation, which were given relative weights selected by experts. This enabled a comprehensive performance ranking of the GCC countries. The effectiveness of countermeasures was additionally assessed by survey responses and validated by experts for practical application (Al-Kumaim & Alshamsi, 2023; Albali et al., 2023; Goldani, 2024). Participants had been informed about extra security measures taken and had voluntarily agreed to participate in the survey; data had been anonymized for confidentiality, and a second data set was used in line with local requirements on data sharing.

Results

Analysis of road safety across the GCC countries reveals significant variations in accidents, fatalities, injuries, traffic violations, and the effectiveness of countermeasures from 2015 to 2019. National traffic data were supplemented by information solicited through a survey from users of the road, giving a full picture of trends on safety and effectiveness of interventions.

Road Safety Trends

Accidents gradually reduced from 80,827 (2015) through 13,050 (2019) over the previous four years, reflecting an average annual reduction of 28%, but despite this decrease in accidents, the severity of the accidents did increase during that same four-year period from 2015 to 2018. Though fewer accidents, deaths/10,000 accidents increased when adjusted for numbers on the roads, indicating that severity problems still exist. Saudi Arabia has seen the accident rates fall by 18.49% since 2016, despite an increase in vehicles being registered in the Kingdom (from 17.2 million to 19.1 million). Injury and fatalities tended to decrease, with 2017 showing an increase of fatalities from injuries, suggesting that some injuries were severe. However, despite regional variations in the impact on infrastructure on accident rates, there were slight reductions in rates of accidents in other GCC countries which had continued growth in the numbers of registered cars.

Traffic Violations

Traffic violations are an important aspect of road safety. Common traffic law violations in Kuwait in 2018-2019 were: speeding, parking meter violations, illegal parking, non-renewal of driving license, running a red

light and driving in an emergency lane. The majority of violations were made by male drivers (70.8% in 2019); speeding accounted for the highest percentage of violations by male drivers at 69% in 2019. This was the same in other GCC countries and overall compliance remained weak despite the robust response by the regulators. Table 2 displays the percentage of high frequency violations in Kuwait and highlights some gender differences.

Table 2: Top Five Traffic Violations in Kuwait (2018-2019)

Violation Type	2019 Male (%)	2019 Female (%)	2018 Male (%)	2018 Female (%)
Speeding	69	19	68	19
Parking meter/no parking	72	17	71	18
Non-renewal of a driving license	69	16	69	16
Passing traffic lights	60	27	62	26
Driving in the emergency lane	80	20	82	18

Road Safety Performance Indicators

Data were transformed into traditional indicators (deaths per 100 000 people, deaths per 10 000 registered cars and deaths per 10 000 accidents) to facilitate comparisons between countries. Table 3 shows that rankings based on the implementation and outcome performance indicators showed that Bahrain was always the top ranked country. Oman was seen as performing less well with gaps in implementation and enforcement of safety measures identified.

Table 3: GCC Countries - Implementation Performance Indicator

Country	Funding (Yearly)	Strategy	Action Plan (Yearly)	Programs	Total	Weight	Rank
Kuwait	No	Yes	No	Yes	2	50	3
Saudi Arabia	No	No	No	Yes	1	25	4
Oman	No	No	No	Yes	1	25	4
Qatar	Yes	Yes	No	Yes	3	75	2
UAE	No	Yes	Yes	Yes	3	75	2
Bahrain	Yes	Yes	Yes	Yes	4	100	1

Table 4: GCC Countries - Policy Performance Indicator

Country	Avg. Change in Accidents	Weight	Avg. Change in Fatalities	Weight	Avg. Change in Violations	Weight	Total Weight	Rank
Kuwait	-28	100	-1.33	8.86	-1	50	158.86	2
Oman	-19	67.85	-2	13.33	16	2	83.21	4
Bahrain	-12	42.85	-15	100	-2	100	242.85	1
UAE	-4	14.28	-10	66.66	-1	50	130.94	4
Qatar	-10	35.71	-8.89	59.26	16	2	96.97	3
Saudi Arabia	-18	64.28	200.49	0	N/A	2	66.28	5

Policy Performance Indicator

The performance of policies is a measure of the ability of national policies and regulatory frameworks to help minimize accidents, deaths and offences. Changes in the number of accidents and fatal accidents, as well as the changes in traffic violations are tabulated in Table 4 with weights based on their relative importance in the individual countries. Bahrain received the highest total weight based on the significant decreases in fatalities and also on the regular enforcement results whereas Oman has received

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the lowest total weight, reflecting the lack of good policy implementation.

Innovative Composite Road Safety Performance Index

To provide a comprehensive assessment, an innovative composite road safety performance index was developed using OWA to integrate data on accidents, fatalities, injuries, traffic violations, countermeasure effectiveness, and policy implementation. The index assigns weights based on each country's relative performance, and the final score reflects multiple dimensions of road safety. A sample calculation is as follows:

Compute the average change in accidents for each country:

Average change = (〖Accidents〗_2015 - 〖Accidents〗_2014)/ 〖Accidents〗_2014 ×100

Example for Kuwait: (80827 - 99040)/ 99040 × 100 = -18

Assign the maximum score (100) to the country with the largest improvement.

Calculate weights for other countries as a percentage of the maximum:

UAE weight =(-4)/(-28)×100=14.28, Bahrain weight =(-12)/(-28)×100=42.85

Repeat for other indicators.

Combine using the composite formula:

Road Safety Composite Index =0.5×RSPI/3+0.25×KPI/3+0.25×Policy/3

Final index per country:

Kuwait: (2.81+12.5+13.23)=28.54

Bahrain: (27.16+25+20.23)=72.39

UAE: (33.41+18.75+10.91)=63.07

Qatar: (16.91+18.75+8.08)=43.74

Oman: (19.51+6.25+6.93)=32.19

Saudi Arabia: (2.98+6.25+5.17)=5.52

The first number in the sum is from the Road Safety Performance Indicator, the second from the Implementation of Key Performance Indicator, and the third from the Policy Performance Indicator. The final rankings and weights are summarized in Tables 5 and 6, providing a multi-dimensional view of GCC road safety performance.

Table 5: GCC Countries Ranking - Road Safety Performance Indicator

Country	Accident/10,000 pop	Weight	Accident/1,000 Vehicles	Weight	Fatality/10,000 Accidents	Weight	Total Weight	Final Rank
Kuwait	136	3.67	28	7.14	116	6.03	16.84	6
Bahrain	8	62.5	2	100	1493	0.46	162.96	2
UAE	5	100	2	100	1365	0.51	200.51	1
Oman	10	50	3	66.66	1618	0.43	114.09	3
Saudi Arabia	125	4	25	8	118	5.93	17.93	5
Qatar	1125	0.44	189	1.05	7	100	101.49	4

Table 6: GCC Countries - Final Innovative Composite Index Ranking

Country	Innovative Index	Rank	Traditional Ranking
Bahrain	72.39	1	1
UAE	63.07	2	1
Qatar	43.74	3	5
Oman	32.19	4	2 (2 years only)
Kuwait	28.54	5	3
Saudi Arabia	5.52	6	4

Countermeasure Effectiveness

Survey responses indicate that engineering interventions, including improved signage, traffic-calming devices, and intersection redesign, were consistently rated as highly effective. Enforcement initiatives, such as automated fines and traffic monitoring, were also perceived as highly effective, particularly when enforcement visibility was high. Education and awareness

programs were rated as moderately effective, suggesting that behavioral interventions require reinforcement. Emergency response measures, including rapid medical services and coordinated post-accident care, received moderate-to-high ratings, underscoring their importance in mitigating injury severity. Tables 7 and 8 summarize the ranking of countermeasures.

Table 7: Top Ten Favorable Countermeasures

Countermeasure (CM)	Influence	Rank	Favorable	Rank
CM 21 Intensify punishment against truck and goods-vehicle drivers who break the law	4.807	1	1.944	1
CM 16 Foreign chauffeurs' eligibility for private homes driving license	4.732	3	1.940	2
CM 20 Forbid truck/big-vehicle drivers from using the middle lanes unnecessarily	4.729	4	1.928	3
CM 23 Increase punishment for mobile phone use while driving	4.800	2	1.923	4
CM 22 Intensify punishment for misuse of road shoulders	4.688	5	1.879	5
CM 3 Improve road safety education in schools	4.486	6	1.807	6
CM 24 Vehicle safety checks before registration renewal	4.406	9	1.804	7
CM 26 Increase monitoring cameras on main roads and intersections	4.473	7	1.797	8
CM 17 Improve traffic sign placement	4.336	13	1.795	9
CM 11 Compulsory training courses before the driving test	4.384	10	1.790	10

Table 8: Five Least-Effective Countermeasures

Countermeasure (CM)	Influence	Rank	Favorable	Rank
CM 18 Traffic policemen in civilian clothes & ordinary cars	3.732	22	1.461	23
CM 10 Apply roundabouts more than traffic signals	3.471	24	1.500	21
CM 6 Increase legal driving age to 20	3.505	23	1.292	24
CM 1 Reduce speed limit to 100 km/hr on expressways	3.386	25	1.278	25
CM 8 Increase speed limit to 140 km/hr on expressways	2.278	26	1.251	26

Descriptive Statistics

The survey sample included 1,162 respondents, with 384 representing a 95% confidence level and a 5% confidence interval. Table 9 summarizes demographic characteristics.

Discussion

Road safety performance comparison in the GCC countries illustrates the tangible measures implemented to reduce the number of incidents. But there are still wide discrepancies in deaths, injuries and harmful activities. The number of accidents declined in Kuwait, Saudi Arabia, and the UAE from 2015 to 2019, possibly due to improved infrastructure and road regulations which led to safer road conditions during the period (Alfaki, 2024). Whilst reducing the number of incidents is important, the

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Table 9: Demographic Information of Survey Respondents

Road User Category	Group (Class)	Total Respondents	Percent (%)
Gender	Male	755	64.97
	Female	407	35.03
Age (years)	18-25	287	24.70
	26-35	432	37.18
	36-45	228	19.62
	46-55	126	10.84
	Over 55	89	7.66
Nationality	Kuwaiti	890	76.59
	Arabian	179	15.40
	Asian	52	4.48
	Western	41	3.53
Education Level	Less than high school	29	2.50
	High school	206	17.73
	Diploma	184	15.83
	Graduate	599	51.55
	Post-graduate	144	12.39
Area (Governorate)	Capital	271	23.32
	Hawalli	320	27.54
	Farwania	195	16.78
	Mubarak Kabeer	158	13.60
	Ahmadi	147	12.65
	Jahra	71	6.11
Vehicle Type	Saloon	520	44.75
	Van	16	1.38
	Jeep	540	46.47
	Pickup	29	2.50
	Truck	23	1.98
	Bus	21	1.81
	Motorcycle	13	1.12

level of injury and loss (deaths and serious injuries) was not necessarily reduced where incidents were reduced, this shows that reducing the number of incidents is not sufficient to increase the overall level of road safety.

Traffic violations proved to be an important factor in determining the occurrence of accidents. Most traffic offenses, such as speeding, non-renewal of driving licenses, red-light offenses, etc., were committed by male drivers, indicating a need for specially tailored behavior change interventions. Despite enforcement and educational efforts over the years, behavioral change appears to be a persistent challenge to the GCC countries. These results are in line with the worldwide evidence indicating that human factors are responsible for most of the traffic accidents, highlighting the value of multi-pronged measures (Ben Laoula et al., 2023; Fonseca & Ferreira, 2025).

Conventional metrics focused on gauging national safety outcomes but did not adequately reflect road safety's multi-dimensionality. The innovative composite road safety performance index combines the three elements of

accidents, fatalities, and traffic violations, with elements of the effectiveness of countermeasures and policy with regard to these events, to create a more comprehensive measure. Bahrain continually ranked first in both traditional and innovative composite scores (Alfaki, 2024; Rahul Goel et al., 2024; Song et al., 2024). Meanwhile, countries like Saudi Arabia and the UAE achieved better relative results in the innovative composite index, owing to the implementation of enforcement and countermeasures that were effective, but did not solely reflect in the individual metrics.

The survey-based evaluation of countermeasures indicated that engineering countermeasures such as intersection redesign, traffic calming devices, or improved signage were highly trusted. There was positive feedback on automated fines and visible policing as enforcement methods. Behavioral interventions required reinforcement, education and awareness campaign, and it was moderate effective. Moderate to high was the score of emergency responses, including rapid access to medical care, which helped minimize injury severity along with emergency measures before and during the accident (Layegh et al., 2025; Sadeqi Bajestani & Pirdavani, 2026). The results are consistent with the Safe System approach, which embraces engineering, enforcement, education and emergency response as strategies for tackling different elements of traffic risk.

Enforceable policies emphasize the importance of strong regulation. Scores were extreme in Bahrain and Oman, with Bahrain decreasing the number of fatalities and violations and gaps in implementation in Oman. Combining various behavioral, infrastructural, enforcement and policy approaches may be important for road safety, as these results indicate. Although there are fewer accidents in GCC countries, serious outcome and risky behavior still exist (Aamri et al., 2025; Alfaki, 2024). The index is used as a tool to prioritize the interventions and traditional indicators are lacking. The best approach is to use engineering, enforcement, education and emergency response. Lessons assist the creation of strategies based on data for each of the GCC countries focusing on accident and injury reduction.

Conclusion

The research reveals that after the reduction in traffic accidents in the GCC countries, there is still a significant number of severe accidents and fatalities, mainly among male drivers and in riskier activities. A comprehensive road safety index can be adopted that covers accidents, fatalities, violations, policies, and related factors. The best measures are engineering and enforcement, assisted by education and emergency response. The findings indicate the importance of implementing an evidence-based policy approach that integrates fresh accident reduction and injury severity reduction policy investments across borders in the GCC.

Limitations and Future Research

This research has its limitations as traffic data differed among the countries in the GCC region, there could be some bias in traffic survey responses regarding how effective the countermeasures were, and due to cultural differences in enforcement and driving practices, certain parts of the research could only be generalized to the countries of the GCC region. While being multi-dimensional, the innovative composite road safety index is also based on subjective expert weights.

Future research could improve accuracy and capture dynamic driver behavior patterns by incorporating real-time traffic monitoring and telematics data. It would be helpful to increase the size and variety of the samples of the surveyed population in all of the GCC nations to improve representativeness and minimize survey bias. The methodology to produce the innovative composite index could be validated through comparative regional or long-term research. However, the potential of AI or machine learning for predictive modeling can also benefit policymakers in forecasting high-risk situations and fine-tuning road safety strategies.

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