A COST–BENEFIT ANALYSIS OF NG-ECALL DEPLOYMENT FOR CYCLIST SAFETY IN THE EU-27

Daniela ZIRRA[1*], George CĂRUŢAŞU[2], Nicoleta Luminiţa CĂRUŢAŞU[3]

[1]*Department of Commerce, Economic Integration and Business Administration, School of International Business, Bucharest, Romania*
[2]*Department of IT, Statistics and Mathematics, School of Computer Science for Business Management, Romanian-American University, Bucharest, Romania*
[3]*Department of Robotics and Production Systems, Faculty of Industrial Engineering and Robotics, University Politehnica of Bucharest, Bucharest, Romania*
daniela.zirra@rau.ro; george.carutasu@rau.ro; nicoletacarutasu@yahoo.com

Abstract: *This paper seeks to evaluate the economic and social feasibility of implementing NG-eCall technology to enhance cyclist safety in the European Union (EU-27). Furthermore, it was designed to determine to what degree the benefits generated by this technology outweigh the costs associated with its implementation. The study is empirical and quantitative in nature, based on the cost-benefit analysis (CBA) method, applied using European statistical data on road accidents, as well as projected scenarios for the period 2026–2035. The research employs economic indicators such as net present value, benefit-cost ratio, and rates of reduction of fatalities and serious injuries. Both direct costs (software development, equipment, operation) and monetized benefits (lives saved and reduction of severe injuries) were incorporated, estimated through standard indicators such as the value of avoiding a death and a serious injury, based on the Value of a Statistical Life (VSL). The analysis begins from the observation that cyclists represent a vulnerable category of road users, accounting for approximately 9% of all road deaths and over 21% of serious injuries at EU level, and the evolution of these indicators has remained relatively stable over the last decade, which indicates the limited effectiveness of existing measures. The paper develops three scenarios (Do nothing, Do minimum and Do something), which differ in the degree of implementation of NG-eCall technology, from the absence of intervention to the extensive integration of smart devices and dedicated applications. The results demonstrate that the scenarios involving the adoption of the technology lead to significantly higher benefits than the associated costs, both by reducing the intervention time in the event of an accident, and by increasing the chances of survival and reducing the severity of injuries, while also contributing to enhancing perceived safety and promoting cycling as a sustainable mode of transport. The conclusions indicate that the implementation of NG-eCall for cyclists is economically and socially justified, providing value for public decision-makers, contributing to effective road safety policies and supporting European sustainable mobility objectives.*

Keywords: *Cost Benefit Analysis; Cyclists Safety; NG-eCall Technology; Vulnerable Road Users; European Union.*

JEL Classification: *R41; O31*

1. Background

Cycling has become a central component of sustainable mobility strategies within the European Union (EU-27), particularly in the context of ambitious policy frameworks such as the European Green Deal (EU SWITCH-Asia Policy Support Component and European Environment Bureau, 2024) and the Sustainable and Smart Mobility Strategy (European Commission, 2020), which aim to reduce transport-related emissions while promoting active modes of transport. The formal recognition of cycling as a strategic transport mode, reinforced by the European Declaration on Cycling (Council of the European Union, European Commission and European Parliament, 2024), underscores its growing importance not only for environmental objectives but also for public health and accessibility. However, cycling remains associated with considerable safety challenges, as cyclists are classified as vulnerable road users (VRUs) under Directive 2010/40/EU due to their limited physical protection in traffic environments.

This study explores the economic and social implications of deploying Next Generation eCall (NG-eCall) technology for cyclists in the EU-27, focusing on its potential to enhance road safety outcomes for VRUs. The central problem arises from persistently high levels of fatalities and serious injuries among cyclists despite sustained policy efforts and investments in infrastructure (Elvik et al., 2019; European Commission, 2022; European Cyclists' Federation, 2023). Empirical evidence (Eurostat, 2026) shows that cyclists account for approximately 9% of road deaths and over 21% of serious injuries at EU level, with little improvement over the past decade. This stagnation raises a key question: to what extent can advanced emergency response technologies like NG-eCall reduce the severity of cycling-related accidents, and are such interventions economically and socially justified?

The main objective is to evaluate the economic and social viability of implementing NG-eCall for cyclists in the EU-27 through cost-benefit analysis (CBA). Specifically, the study aims to:

Quantify and compare total costs of development, deployment, and operation of NG-eCall systems, including infrastructure and user-level investments.

Estimate benefits in terms of reduced fatalities and serious injuries, using economic valuation metrics such as the Value of a Statistical Life (VSL), Value of Avoiding Fatality (VAF), and Value of Avoiding Serious Injury (VASI).

Develop alternative implementation scenarios (Do nothing–DN, Do minimum–DM, Do something–DS) to assess relative efficiency.

Provide evidence-based recommendations for policymakers.

The research is based on literature concerning CBA, transport safety, and VRU protection. Foundational works by Mishan and Quah (2020) and Riegg Cellini and Kee (2015) define CBA as a systematic framework comparing monetized costs and benefits, supporting rational decisions. Subsequent studies have applied CBA to transport infrastructure (Vickerman, 2008), environmental policy (Feuillette et al., 2016), and public health (Ananthapavan et al., 2021), emphasizing its utility in assessing complex socio-economic impacts. More recent analyses (Parvez & Moridpour, 2024) stress integrating safety, accessibility, and quality-of-life indicators in VRU-related interventions. Policy-oriented work by the European Commission and the European Transport Safety Council (Carson et al., 2025) confirms persistent cyclist risks and calls for innovations beyond infrastructure measures.

Despite progress (Parvez & Moridpour, 2024), key debates persist—particularly the relative effectiveness of preventive versus reactive measures. Infrastructure improvements such as cycling lanes are essential but unevenly implemented, leaving ongoing risks. Technologies like NG-eCall address post-accident phases, aiming to reduce response times and improve outcomes, though their impact depends on adoption rates and system performance. Another contested issue involves monetizing life and health impacts. The use of VSL and VASI, though standard in CBA, raises ethical and methodological concerns, while inconsistencies in data reporting (e.g., between police and MAIS3+ medical statistics) may underestimate safety benefits.

Within the X_HeERO project (no. 101175713 – 23-EU-TG-eCall NG), this study provides a rigorous, data-driven assessment of an emerging technological solution not yet widely evaluated for cyclists. By integrating statistical data, scenario-based analysis, and economic evaluation methods, it bridges technological innovation and policy implementation. Its value lies in offering a structured framework to assess whether NG-eCall investments can yield net societal benefits, supporting efficient allocation of resources.

The study's contributions are both theoretical and practical. Theoretically, it advances CBA applied to reactive safety technologies for VRUs, adapting evaluation techniques to cyclists' specificities. Practically, it provides insights for policymakers, transport authorities, and industry stakeholders on the feasibility and impact of NG-eCall deployment. Ultimately, the research supports EU goals of improving road safety, reducing human and economic accident costs, and promoting sustainable, inclusive mobility.

2. Methodology

The methodological framework of this study is based on Cost-Benefit Analysis (CBA), a widely used economic evaluation tool for evaluating public investments and policies. CBA is defined as a systematic approach that identifies, quantifies and compares all costs and benefits associated with a project, including direct, indirect and external effects, to determine whether the benefits outweigh the costs (Tamboli and Kulkarni, 2025). Its main objective is to support efficient resource allocation and evidence-based decision-making, particularly in contexts where social welfare and public safety are at stake. In the present study, CBA is applied to assess the economic and social viability of implementing NG-eCall technology for cyclists, a key category of vulnerable road users (VRUs).

The main objective of the methodology is to assess whether the implementation of NG-eCall technology for cyclists generates net social benefits over a defined time horizon. Specifically, the analysis aims to compare alternative implementation scenarios, estimate and monetize costs and benefits, and determine the economic efficiency of each scenario using key performance indicators.

The study adopts an ex-ante, quantitative and scenario-based cost-benefit analysis (CBA) conducted over a 10-year forecast period (2026–2035), using a social discount rate (SDR) of 3% per year, in line with the European Commission's guidelines (2023, pp. 58-67).

The research follows a 6-step CBA methodology, adapted from the established frameworks proposed by Riegg Cellini and Kee (2015) and JASPERS (2020). Each step is tailored to the specific context of cyclist safety and NG-eCall implementation. A summarized breakdown of the steps is presented below.

- Problem definition and objectives

The analysis starts with the identification of the main problem, namely the persistently high number of cyclist deaths and serious injuries in the EU-27. The objectives are to reduce emergency response times, improve survival rates, increase cyclist safety and promote cycling as a sustainable mode of transport.

- Identifying alternatives

Three scenarios are defined to reflect different levels of technological intervention, as follows:

DN: NG-eCall technology is not implemented. The slow reduction in the number of cyclist deaths and serious injuries is due only to equipping newly registered light road vehicles in the EU-27 (M1 – passenger vehicles and N1 – vehicles up to 3.5 tonnes, for the transport of goods, also called Light Commercial Vehicles), which are the majority, with standard eCall technology.

DM: integration of NG-eCall functionality in mobile applications, together with equipping M1 and N1 with classic eCall.

DS: combined approach including mobile applications and wearable or embedded devices, together with the measure mentioned in the first scenario.

These alternatives allow for the comparative assessment of different levels of adoption and technological complexity.

- Identifying costs and benefits

The relevant costs and benefits are identified. In short, the costs include development costs, like for example software, hardware and training of Public Safety Answering Points (PSAPs) staff, those related to integration with other systems in use, as well as the operational costs of using the NG-eCall technology. The benefits include reducing response times, saving lives, reducing the severity of injuries and improving the perceived safety of cyclists. In addition, broader societal benefits may be considered, like including reduced road congestion and improved public health.

Regarding costs, we would like to make some extremely important clarifications (European Commission, 2019). In general, there are three categories of costs related to road traffic, namely congestion costs and scarcity costs, accidents costs, and environmental costs. Each of these has two categories of costs, namely social costs, and external costs. For a more prudent approach, especially regarding benefits, only the external component of the cost of accidents was considered in our analysis. Furthermore, accident costs include 6 main groups of costs (Table 1). Of these, only the first group is considered when determining the value of benefits, namely human costs.

For each casualty, fatality, serious injury and slight injury, the costs mentioned in Table 1 have different values. The starting point is the human costs of a fatality, which is equal to the VSL, for which the European Commission manual (2019) has taken the sum of €2,907,921 into account (at least at the European level, the VSL has not been updated to date).

Table 1: The components of accident costs

Cost component	**Details**
Human costs	A proxy for estimating the pain and suffering caused by traffic accidents in monetary value.
Medical costs	The costs of the victim's medical treatment provided by hospitals, rehabilitation centres, general practitioners, nursing homes, etc. as well as the costs of appliances and medicines. Covers the time from the moment of the accident until complete recovery or, in the case of fatal accidents, death.
Administrative costs	The expenses of the deployed police force, fire service and other emergency (non-medical) services that assist at the crash location site, etc.
Production losses	Appear because after an accident victims are not directly capable of returning to work, and in some cases may never return to work.
Material damages	Consists of the monetary value of damages to vehicles, infrastructure, freight and personal property resulting from accidents.
Others	Covers the costs of congestion resulting from road crashes, vehicle unavailability and funeral costs.

Source: European Commission, 2019.

According to the HEATCO project (Grant agreement ID 502481, 2006), the human costs of injuries are valued at 15.98544% of the VSL for serious injuries (€464,844) and at 1.22964% of the VSL for slight injuries (€35,757).

Table 2: The share of external accident cost components per casualty, EU-27 (%)

Casualty	**Human costs**	**Production loss**	**Medical costs**	**Administrative costs**	**Total external cost**
Fatalities	88.82	11.04	0.08	0.06	100.00
Serious injuries	93.23	4.82	1.68	0.26	100.00
Slight injuries	92.84	3.82	1.87	1.46	100.00

Source: European Commission, 2019.

- Quantifying and monetizing costs and benefits

This step involves assigning monetary values to the identified costs and benefits. The benefits related to reducing mortality and severity of serious injuries are estimated using VSL.

Thus, the benefits associated with reducing the number of deaths are evaluated in terms of the savings generated by changing the status of road traffic victims from the category of deaths to that of serious injuries, while in the case of serious injuries the benefits are evaluated based on the savings resulting from changing the status from the category of serious injuries to the category of minor injuries (Table3). We specify that, for an increased rigor of the analysis, only human costs and rehabilitation were considered.

Table 3: The economic value of avoiding a fatality or a severe injury (€)

The economic value per casualty	Calculation	Result
Value of Avoiding a fatality (VAF)	2,907,921 - 464,844	2,443,077
Value of Avoiding a Severe Injury (VASI)	464,844 - 35,757	429,087

Source: Own calculation based on European Commission, 2019.

- Discounting costs and benefits

Future costs and benefits are discounted to current values using an SDL of 3% per year, ensuring the comparability over time of the projected cost and benefit flows.

- Calculating key performance indicators and choosing the best implementation scenario of NG-eCall technology for cyclists.

The economic performance of each scenario is evaluated using standard CBA indicators, such as Net Present Value (NPV) and Benefit-Cost Ratio (BCR). These key performance indicators provide a quantitative basis for comparing alternatives and determining economic efficiency.

The scenario that produces the highest net benefits and demonstrates resilience to uncertainty is selected as the preferred option. This step ensures that the recommendations are based on both efficiency and reliability criteria. The findings are presented in a structured and transparent manner, including assumptions, data sources and calculated indicators.

The comparative analysis of the scenarios highlights the relative advantages of each approach. The methodology applied in this paper is adapted to the specific characteristics of cyclists, being based on the use of detailed and relevant statistics on the consequences of road accidents involving cyclists. Also, for added rigor, especially in terms of monetization of benefits, underreporting of injury cases at EU-27 level was not considered.

According to official data (European Commission, 2019), the underreporting rate differs depending on the vehicle type and the severity of the accident. Thus, it is estimated that, in the case of cars, Light Commercial Vehicles (LCVs), Heavy Goods Vehicles (HGVs) and buses, the correction coefficient for the underreporting of serious injury is 1.25, and for slight injury it is 2, while in the case of motorbikes the same correction coefficients are 1.55 for serious injury and 3.2 for slight injury.

The costs were estimated based on available market data for standard commercial devices and the infrastructure requirements of PSAPs, while the benefits were calculated based on the savings achieved by reducing the severity of road accident consequences, namely the number of deaths and serious injuries, using the VSL and related indicators mentioned above.

The general formula applied to estimate the benefits is based on the product of the number of deaths and serious injuries avoided and their economic values already presented, ensuring consistency with established CBA practices. Finally, it should be noted that the adopted methodology combines theoretical rigor with practical applicability, integrating standard CBA principles with scenario-based analyses, tailored to increase cyclist safety.

This approach ensures a comprehensive assessment of the NG-eCall implementation, supporting robust and relevant conclusions for decision-makers in this field.

3. Results and discussions

Between 2014 and 2023, cyclists remained one of the most vulnerable categories of road users in the EU-27, with an average of 1,964 deaths per year, which increases to 1,989 if the pandemic years are excluded (ESTAT and DG MOVE-CARE data). The share of road deaths among cyclists remained almost constant at around 9%, indicating limited progress in safety. The overall reduction in the number of deaths over this period was only 4.5%, while the annual variations confirm the stagnation: –7.73% in 2020 (mobility restrictions) and +9.03% in 2022 (return to normal activity).

In 2022, 50% of cyclist deaths involved people aged over 65 and 26% aged between 50 and 64, indicating high vulnerability among older populations (European Commission, Facts and Figures Cyclists 2024). Deaths occurred mainly on urban roads (57%), followed by rural roads (41%), with men accounting for 80% of deaths. Serious injuries add a significant burden: between 2020 and 2023, cyclists accounted for over 21% of all serious road injuries in the EU-27, with 33,833 serious injuries recorded in 2023 (Carson et al., 2025). Underreporting remains substantial, as not all Member States use MAIS3+ medical data systems, suggesting higher real figures (Bouwen et al., 2023).

These trends demonstrate that cyclist safety has improved little over the past decade. While long-term investments in infrastructure are essential, their implementation is slow and uneven. Complementary measures that ensure a rapid response to emergencies are therefore essential.

In this context, the introduction of the Next Generation eCall (NG eCall) system for vulnerable road users - in particular cyclists - offers a promising solution. By enabling automatic accident notifications and faster intervention, the NG eCall system could reduce the severity of deaths and injuries.

The objective of this CBA, carried out within the framework of the X_HeERO - Next Generation eCall for Europe project, is to assess the economic and social viability of implementing the NG eCall system for cyclists in the EU-27, determining whether the expected reductions in the number of deaths, injuries and social costs outweigh the necessary investments.

Several technological alternatives were assessed. Commercial off-the-shelf (COTS) solutions, such as helmets or smart headphones (Sena, Lumos, UNIT 1), integrate impact sensors and smartphone alert systems, with prices ranging from 130 to 230 euros (Dhere et al., 2025).

Bike computers from Garmin or Wahoo also offer incident detection via Bluetooth (Matyja et al., 2022), and dedicated devices, such as the Garmin Varia RCT715, integrate radar, lighting and video recording (Berge et al., 2023). Four main implementation options have been identified: smartphone-based systems (low cost but less reliable), helmet-integrated devices (ergonomic but dependent on new equipment), bike-mounted solutions (less accurate for cyclist impact) and wearable devices (flexible but requiring user compliance). Based on these, three scenarios - DN, DM and DS - were defined to represent different levels of technological adoption and safety outcomes.

The costs cover device acquisition, infrastructure and operation. The smart headsets cost around €130, the wearables around €50, and operational costs remain low thanks to the existing infrastructure of the 112 PSAPs.

Benefits are calculated using the formula: Annual benefits = ($\Delta FC \times VAF$) + ($\Delta SC \times VASI$), where ΔFC and ΔSC represent reductions in fatalities and serious injuries.

The baseline scenario (DN) assumes no NG-eCall deployment for cyclists, with safety improvements driven solely by increased penetration of eCall IVS in annually new registrations M1+N1 vehicles, at a unit price of €75.

Table 4: Annual total cost for DN scenario

Year	New M1 registr. (Mill)	M1 eCall adoption rate (%)	Cost for M1 (€Mill)	New N1 registr. (Mill)	N1 eCall adoption rate (%)	Cost for N1 (€Mill)	Total cost M1+N1 (€Mill)
2026	10.73	36.86	804.67	1.43	41.37	107.00	911.67
2027	10.58	40.25	793.31	1.44	45.48	108.14	901.45
2028	10.43	43.50	781.94	1.46	49.51	109.27	891.22
2029	10.27	46.61	770.58	1.47	53.48	110.41	880.99
2030	10.12	49.58	759.22	1.49	57.37	111.55	870.76
2031	9.97	52.43	747.85	1.50	61.2	112.68	860.54
2032	9.82	55.15	736.49	1.52	64.96	113.82	850.31
2033	9.67	57.75	725.13	1.53	68.67	114.95	840.08
2034	9.52	60.24	713.76	1.55	72.32	116.09	829.86
2035	9.37	62.59	702.40	1.56	75.96	117.23	819.63

Source: Calculations based on EUROSTAT, New passenger cars by type of motor energy and engine size [road_eqr_carmot$defaultview].

Fatalities decrease by 3.5% annually and serious injuries by 5%. Starting from 1,948 deaths and 33,833 injuries (2023), this results in 69 lives being saved and 339 injuries avoided annually.
Total annual benefits amount to €314,032,806 (69 x €2,443,077 + 339 x €429,087). However, costs remain high due to vehicle equipment, while no additional cyclist-focused investments are made.
The DM scenario assumes partial adoption through mobile applications and smart helmets (at a unit price of €130) used by at least 10% of active cyclists, in addition to penetration of eCall IVS in annually new registrations M1+N1 vehicles, at a unit price of €75 (Table 4).
The total cost of operating the application infrastructure for NG eCall is €2,500,000 per year, of which €400,000 is allocated to cyclists (project X_HeERO, 101175713 – 23-EU-TG-eCall NG), proportional to the share of cyclist deaths and serious injuries, in total, at EU-27 level.
In this scenario, we considered that minimum 2/3 of active cyclists own a smartphone.
Fatalities decrease by 5% and injuries by 10% annually. Based on EU-27 population (aged 16-74) projections and an estimated 14% active cyclist rate (Møller & Jensen, 2024; Dharani et al., 2020), the number of active cyclists increases steadily, reaching 57.7 million by 2035. Annual costs rise from €1.51 billion in 2026 to €1.57 billion in 2035, driven mainly by helmet adoption.

Table 5: Annual total cost for DM scenario

Year	EU-27 aged 16-74 pop. (Mill)	Active cyclists (Mill)	Active cyclists with smartphone (Mill)	Cost of the App op. (€Mill)	Cost of smart helmet (€Mill)	Total cost M1+N1 (€Mill)	Annual total cost (€Mill)
2026	329.3	46.1	30.73	0.4	599.30	911.67	1,511.37
2027	337.9	47.3	31.53	0.4	614.90	901.45	1,516.75
2028	346.4	48.5	32.33	0.4	630.50	891.22	1,522.12
2029	355	49.7	33.13	0.4	646.10	880.99	1,527.49
2030	364.3	51	34.00	0.4	663.00	870.76	1,534.16
2031	373.6	52.3	34.87	0.4	679.90	860.54	1,540.84
2032	382.9	53.6	35.73	0.4	696.80	850.31	1,547.51
2033	392.1	54.9	36.60	0.4	713.70	840.08	1,554.18
2034	402.1	56.3	37.53	0.4	731.90	829.86	1,562.16
2035	412.1	57.7	38.47	0.4	750.10	819.63	1,570.13

Source: Own calculations based on Møller & Jensen, 2024, Dharani et al., 2020, and EUROSTAT, New passenger cars by type of motor energy and engine size [road_eqr_carmot$defaultview].

Benefits are significantly higher, reaching €1.69 billion annually, due to 98 lives saved and 3,384 serious injuries avoided each year (98 x €2,443,077 + 3,384 x €429,087). This scenario demonstrates clear economic viability.
DS is the most comprehensive scenario because it combines the penetration of eCall IVS in annually new registrations M1+N1 vehicles, at a unit price of €75, mobile applications, smart helmets at a unit price of €130 and basic wearable devices (adopted by two-thirds of cyclists), at a unit price of €50.
Fatalities decrease by 15% and injuries by 20% annually, resulting in 293 lives being saved and 6,767 injuries avoided each year. Annual costs range from €3.05 billion to €3.49 billion (Table 6), reflecting large-scale device deployment.
However, benefits are substantial, reaching €3.62 billion annually (293 x €2,443,077 + 6,767 x €429,087). This scenario delivers the highest safety impact and overall economic return. As we already said, for indicators calculation a SDR of 3% is applied over the 2026-2035 period (European Commission, 2023).
Key indicators include:

- ✓ Net Present Value (NPV
- ✓ Benefit-Cost Ratio (BCR),

calculated using discounted costs and benefits. For the calculation of the indicators, the already known discount factor (z’) will be applied:
$z' = (1+0.03)^{-n}$, where n = 10 years (2026-2035), 0.03 = SDR/100
Net Present Value (NPV): NPV = TDB – TDC
Benefit Cost Ratio (BCR): BCR = TDB / TDC
NPV = TDB – TDC
TDB = Total discounted benefits, and TDC = Total discounted cost

Table 6: Annual total cost for DS scenario

Year	Cost of the App op. (€Mill)	Total cost M1+N1 (€Mill)	Cost of smart helmet (€Mill)	Cost of the basic wearable (€Mill)	Annual total cost (€Mill)
2026	0.4	911.67	599.30	1,536.67	3,048.04
2027	0.4	901.45	614.90	1,576.67	3,093.41
2028	0.4	891.22	630.50	1,616.67	3,138.79
2029	0.4	880.99	646.10	1,656.67	3,184.16
2030	0.4	870.76	663.00	1,700.00	3,234.16
2031	0.4	860.54	679.90	1,743.33	3,284.17
2032	0.4	850.31	696.80	1,786.67	3,334.18
2033	0.4	840.08	713.70	1,830.00	3,384.18
2034	0.4	829.86	731.90	1,876.67	3,438.82
2035	0.4	819.63	750.10	1,923.33	3,493.46

Source: Own calculations based on Møller & Jensen, 2024, Dharani et al., 2020, and EUROSTAT, New passenger cars by type of motor energy and engine size [road_eqr_carmot$defaultview].

The DN scenario yields a negative NPV of -€4.73 billion and a BCR of 0.36 (Table 7), indicating that costs exceed benefits. Although slight improvements occur over time, the scenario fails to meet EU road safety targets.

Table 7: BCR for DN scenario

Year	z'	Annual cost (€Mill)	TDC (€Mill)	Annual benefits (€Mill)	TDB (€Mill)	BCR
2026	0.971	911.67	885.12	314.03	304.89	0.34
2027	0.943	901.45	849.70	314.03	296.01	0.35
2028	0.915	891.22	815.59	314.03	287.38	0.35
2029	0.888	880.99	782.75	314.03	279.01	0.36
2030	0.863	870.76	751.13	314.03	270.89	0.36
2031	0.837	860.54	720.69	314.03	263.00	0.36
2032	0.813	850.31	691.38	314.03	255.34	0.37
2033	0.789	840.08	663.17	314.03	247.90	0.37
2034	0.766	829.86	636.01	314.03	240.68	0.38
2035	0.744	819.63	609.88	314.03	233.67	0.38
Total	-	8,656.51	7,405.42	3,140.33	2,678.76	**0.36**

Source: Own calculation based on Table 4 and forecasted annual benefits.

The DM scenario produces a positive NPV of €1.32 billion and a BCR of 1.10 (Table 8). Benefits consistently exceed costs, although BCR declines slightly from 1.12 to 1.08, suggesting diminishing marginal returns over time.
The DS achieves the best performance, with an NPV of €3.14 billion and a BCR of 1.11 (Table 9).
Although BCR decreases slightly over time (1.19 to 1.04), it remains above unity, confirming strong economic justification.

Table 8: BCR for DM scenario

Year	z'	Annual cost (€Mill)	TDC (€Mill)	Annual benefits (€Mill)	TDB (€Mill)	BCR
2026	0.971	1,511.37	1,467.35	1,691.45	1,642.19	1.12
2027	0.943	1,516.75	1,429.68	1,691.45	1,594.36	1.12
2028	0.915	1,522.12	1,392.95	1,691.45	1,547.92	1.11
2029	0.888	1,527.49	1,357.16	1,691.45	1,502.83	1.11
2030	0.863	1,534.16	1,323.38	1,691.45	1,459.06	1.10
2031	0.837	1,540.84	1,290.43	1,691.45	1,416.56	1.10
2032	0.813	1,547.51	1,258.27	1,691.45	1,375.31	1.09
2033	0.789	1,554.18	1,226.89	1,691.45	1,335.25	1.09
2034	0.766	1,562.16	1,197.26	1,691.45	1,296.36	1.08
2035	0.744	1,570.13	1,168.32	1,691.45	1,258.60	1.08
Total	-	15,386.71	13,111.69	16,914.52	14,428.43	**1.10**

Source: Own calculation based on Table 5 and forecasted annual benefits.

Table 9: BCR for DS scenario

Year	z'	Annual cost (€Mill)	TDC (€Mill)	Annual benefits (€Mill)	TDB (€Mill)	BCR
2026	0.971	3,048.04	2,959.26	3,619.45	3,514.03	1.19
2027	0.943	3,093.41	2,915.84	3,619.45	3,411.68	1.17
2028	0.915	3,138.79	2,872.43	3,619.45	3,312.31	1.15
2029	0.888	3,184.16	2,829.08	3,619.45	3,215.84	1.14
2030	0.863	3,234.16	2,789.82	3,619.45	3,122.17	1.12
2031	0.837	3,284.17	2,750.44	3,619.45	3,031.24	1.10
2032	0.813	3,334.18	2,710.99	3,619.45	2,942.95	1.09
2033	0.789	3,384.18	2,671.50	3,619.45	2,857.23	1.07
2034	0.766	3,438.82	2,635.57	3,619.45	2,774.01	1.05
2035	0.744	3,493.46	2,599.46	3,619.45	2,693.21	1.04
Total	-	32,633.38	27,734.41	36,194.53	30,874.67	**1.11**

Source: Own calculation based on Table 6 and forecasted annual benefits.

Table 10: Synthesis of CBA results

Scenario	DN Scenario	DM Scenario	DS Scenario
Annual Benefits: - Decreasing fatalities (%) - Decreasing severe injuries (%)	 3.5 5	 5 10	 15 20
NG eCall interventions	None	- Mobile App. - Smart helmet used by 10% of active cyclists.	- Mobile App. - Smart helmet used by 10% of active cyclists. - Basic wearable adopted by 2/3 of active cyclists.
NPV (€Mill)	-4,726.66	+1,316.74	+3,140.26
BCR	0.36	1.10	1.11

Source: Own calculation based on Tables 7, 8, and 9.

Therefore, we can observe (Table 10) that scenario comparison shows that the DN approach is economically inefficient, while both intervention scenarios are viable. The DS scenario is recommended as the optimal strategy due to its highest NPV and comprehensive safety impact.

5. Conclusions

The analysis confirms that cyclist safety remains a major concern in the EU, with fatalities representing nearly 9% of total road deaths and limited improvement over the past decade. Policy measures should include standardisation of smart devices, financial incentives for adoption, and integration with emergency systems. Improved injury reporting (MAIS3+) is essential for accurate assessment (Carson et al., 2025). Infrastructure investments, particularly in urban areas where 57% of cyclist fatalities occur, remain critical. Targeted interventions should address vulnerable groups, especially cyclists aged 65+, who account for 50% of deaths (European Commission, 2024). Awareness campaigns and training for emergency services should complement technological deployment. The analysis highlights that the main barrier to NG-eCall implementation is not technological but regulatory. Existing solutions are mature but fragmented, which means that future efforts should focus on standardisation of the Minimum Set of Data, communication protocols based on NG-eCall (4G/5G), and certification frameworks ensuring interoperability across EU Member States. By addressing these challenges, the EU can significantly reduce cyclist fatalities and injuries, contributing to its long-term “Vision Zero” objective.
We note that our analysis also has limitations. First, the last year with complete data available is 2023, which could slightly bias the results. However, given the extremely slow annual reduction in the number of cyclist deaths and serious injuries in road accidents over the 10 years analyzed, we consider that the impact on the robustness of the CBA can be considered negligible. Second, the choice of a constant value of the annual benefits seems to induce some inconsistency with

respect to the reference trends. The reason for this choice is simple. According to Eurostat data, it is extremely difficult to correctly forecast the evolution of the number of active cyclists in the EU Member States, or of the number of deaths and serious injuries. Thus, it was established that adopting an average annual value of the benefits based on data from 2023 is appropriate for the objective in mind, namely the impact of NG eCall on increasing cyclist safety. Finally, the CBA does not include a sensitivity analysis based on the variation of the VSL, the adoption rates of smart headsets and/or wearable devices, the update rates or the underreporting of injuries. The decision to stop the analysis at the current stage considered several aspects. On the one hand, the VSL value is not updated at the EU level since 2017. Being a reference value for the analyses carried out in this field, it would be difficult to assess to what extent the VSL could change over the forecast horizon. Then, the adoption rate of headsets and devices is directly influenced by the potential number of users, price, or other variables that are difficult to quantify. On the other hand, the update rate is the one recommended in the EU programmatic documents and guidelines for socio-economic CBA. Finally, underreporting accidents is a major problem not only for the EU but also for other countries at various levels of development, and the data that can be accessed are currently few and still irrelevant. There are indications that progress is being made in this regard, which will lead to an increase in the quality of research in the field.
For the reasons detailed above and to ensure the robustness of the results, our analysis considered cautious forecasts, with undersized benefits and higher costs. In the coming period, we intend to both deepen this analysis and extend the research to other categories of VRUs, considering various aspects, such as refining and diversifying the data, performing sensitivity analyses and testing other measures that contribute to increasing the safety of VRUs on European roads.

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