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# Analysis of vehicle safety elements in category M1, according to INEN 034 standard.

Análisis de los elementos de seguridad vehicular en categoría M1, según normativa INEN 034

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#### **Abstract**

At the regional level, different types of vehicles imported from other regions and continents are offered. It is important to know in what percentage the safety systems benefit the driver and passengers at the time of a frontal accident. In terms of safety, there are agencies that regulate the active and passive systems of the vehicle. For the present study, the Latin-Ncap tests were taken into consideration, as part of the vehicles that are offered regionally and the Euro-Ncap of European vehicles. The research used the indirect deductive method based on the RTE INEN 034 regulation, the variables that influence the research were analyzed, standardizing the speed in frontal impacts, and the dummies of the driver and passenger in vehicles that are offered at a national level, comparing the regulations related to vehicle safety at a regional level. After the impact tests, the values of the driver injury criteria show that the percentage of injury in Latin vehicles

exceeds the level of acceptable risk based on AIS ratings, i.e. a score higher than 3, while European vehicles maintain injury rates between 1 and 3.

#### Resumen

A nivel regional, se ofertan diferentes tipos de vehículos importados de otras regiones y continentes. Lo que es importante conocer en qué porcentaje los sistemas de seguridad benefician al conductor y a los acompañantes al momento de un siniestro frontal. En cuestión de seguridad existen organismos que regulan los sistemas activos y pasivos del vehículo. Para el presente estudio se tomó a consideración las pruebas de la Latin-Ncap, como parte de los vehículos que son ofertados regionalmente y la Euro-Ncap de los vehículos europeos. La investigación utilizó el método deductivo indirecto basándose en la normativa RTE INEN 034, se analizaron las variables que influyen en la investigación, estandarizando la velocidad en impactos frontales, y los dummies del conductor y del acompañante en vehículos que se ofertan a nivel nacional, comparando las normativas relacionadas con la seguridad vehicular a nivel regional. Luego de las pruebas de impacto los valores del criterio de lesión del piloto muestran que el porcentaje de lesión en lo vehículos latinos sobrepasas el nivel del riesgo aceptable en base a las valoraciones AIS, es decir un puntaje mayor a 3 mientras que los vehículos europeos mantienen citereos de lesión entre 1 v 3.

## Palabras clave/ Keywords

Injury criteria, frontal impact, vehicle safety.

Criterios de lesión, impacto frontal, seguridad vehicular.

## Introduction

There are several studies on regulations related to M1 vehicle safety for occupants (Moreno Samaniego, 2019), which have shown a great variation in safety between the different regulations in relation to the makes and models of domestic and imported vehicles, and many of them do not meet the safety criteria at the time of an accident. Regarding the mortality study mentions that, In the study period June 2016 to the month of March 2017 1,671 people died from AT, the AVPP is 3,495.6 years, with a rate of 3.4 years per 1,000 inhabitants, the frequency of mortality is higher in male drivers and pedestrians between the ages of 20 to 39 years (Peñafiel Gallegos, 2017). We began

by assessing risks in M1 vehicles, thus seeking to reduce the vulnerability of occupants represented through percentages in injuries and loss of life, for example; the type of impact at the time of a vehicular accident. The improvement of safety elements such as passive and active elements will also be promoted with the help of the RTE INEN 034 minimum safety elements in automobiles. This regulation had three reforms from 2009 to 2013, with the third and last revision remaining in force.

The safety systems in the different vehicles manufactured locally and imported were examined; then the types of existing accidents were investigated to identify the vehicle brands that generate greater injury or death to the occupants; finally, the impact tests were compared according to the origin and regulations established by Latin NCAP and Euro NCAP, to compare the percentage of injury risks and their severity levels to the occupants at the time of an impact according to the proposed variables, and vehicle manufacturing origin.

Objective 1 of the National Development Plan 2017-2021 determines "Guarantee a dignified life with equal opportunities for all people" (INSTITUTO NACIONAL DE EVALUACIÓN EDUCATIVA, 2018). Based on this objective is the line of research focused on health and quality of life, which is affected by the different traffic accidents. It is important to compare the regional and continental impact tests of the vehicles offered, in order to determine whether the active and passive vehicle safety elements in category M1 comply with the standards established in the region of distribution, to establish which mitigation strategies each commercial automotive company has in correlation to the severity levels of the occupants at the moment of an impact, according to the standards established by the national governments.

One study indicates that the risk of suffering the accident (measured absolutely or after adjusting for the intensity of exposure of each vehicle), the intrinsic severity of the accident (amount of energy released) and the vulnerability of each user to the impact of this energy, closely related to the type of vehicle used and causing most of this variability (Bouaoun, 2015). This would mitigate the effects that occur in an accident in M1 category vehicles.

According to statistics on traffic accidents recorded in Ecuador Traffic Statistics (National Traffic Agency, 2019), it is identified that in 2020 there was a total of 16,972 accidents taking into consideration that frontal crashes represent 5%, side crashes 30%, rear crashes 10%,

collisions 2% crashes 15% others such as run over, hit and run over, loss of lane, In addition, the number of fatalities in the same year is 1,591, taking into consideration that those killed by frontal collisions represent 13%, those killed by side collisions 12%, rear collisions 9%, crashes 15%, others 52%, and the number of injured is 13,099, being these by frontal collisions 8%, side collisions 34%, rear collisions 11%, crashes 9%, and others 40%. Side impacts are the second most important cause of fatalities and the first cause of serious injuries compared to frontal impacts, so there is very little space inside the vehicle to absorb the energy and, consequently, serious injuries to the head and thorax are more common. A study on Effectiveness of evidence-based road safety interventions: a review of the literature, Novoa (2009), determines that there are few reviews on interventions focused on the vehicle (e.g., reminders on seat belt use, vehicle design, technical inspection of the vehicle) and on the post-crash phase (e.g., population skills on first aid), skills of the population on first aid, training of professionals in assisting the injured), in the same way a study says that everything seems to indicate that most of the observed associations depend on the type of vehicle driven and not so much on the driver "Association of the type of vehicles with the risk of causing a collision between vehicles" (Luis Reyes, 2018), also an article on Estimating the effect of vehicle model year on crash and injury involvement tells us that the possible confounding effect of vehicle age, a variable positively associated with traffic crash risk (PJ Cooper, 2010). In view of these studies of statistics and regulations, it is important to promote training in all areas of society, to raise awareness that when acquiring a vehicle, safety is a priority, since the direct beneficiaries of this study will be the occupants of M1 category vehicles in Ecuador, knowing the safety features and mitigation strategies in reference to the types of accidents.

A study by the United Nations Institute for Training and Research (2014), tells us that the constant economic and population growth, technological changes and the increasing urbanization of the region led to the development of new mobility needs. Thus, the increase in population and the use of means of transportation generated a collective action problem: the increase in the number of road accidents in increasingly motorized countries. According to the World Health Organization (WHO) report, in 2013 the number of people killed and injured in road accidents was 1.24 million and 50 million people, respectively. The same study concludes that road crashes are the eighth leading cause of death worldwide, and among the top three causes for people aged 5 to 44 years. The report predicts that "if urgent

action is not taken, road traffic crashes will become the fifth leading cause of death by 2030" (WHO, 2013).

In 2010, the Decade Plan was held in Buenos Aires and was presented at the II Ibero-American Road Safety Congress CISEV. In this document it is proposed to work around the 5 pillars of road safety to carry out improvements in this area as shown in the following image (Sminkey, 2011). For this study, the pillar with the greatest interest in reducing risks to occupants is to have safer vehicles.

It is well known that the risk of dying or suffering an injury as a consequence of a traffic accident varies considerably depending on the type of user and the type of vehicle (pedestrian, cyclist, motorcyclist, driver or occupant, etc.) (M.J. Trowbridge, 2007), to this we add the classification of the direction of impact: frontal impact, side impact, rear-end collision, etc., these are the criteria that are considered in the level of injury to determine a category to it.

These criteria are investigated by Latin NCAP, which considers the UN 127 standard, which details the maximum permitted (acceptable) level of injuries caused by a vehicle, evaluating injuries to different parts of the body of adult and child occupants in frontal crashes, which determine the injuries that may occur in an accident.

**Table 1.** Hospital discharge criteria for traffic injuries, serious injury.

- A. Hospital discharge for traffic injuries (ICD9-MC): must meet criteria 1, 2, 3 and 4.
- 1. Urgent admission (excluding scheduled admissions)
- 2. No readmission (readmission is defined as a new hospitalization within 30 days for the same reason that caused the primary admission).
- 3. Traumatic injury code in principal diagnosis (ICD9-CM codes: N800-N904, N910-N957, N959)
- 4. Either of the following two criteria:
  - 4.1. Code E for external cause according to ICD9-CM: E810-819 and E826
  - 4.2. Financing code: traffic insurance company
- B. Person with serious traffic injury: A "serious injury" will be considered to be any hospitalized person who: Meets the criteria for hospital discharge for traffic injury set forth in the previous item, and Obtains a score ≥3 on the *Maximum Abbreviated Injury Scale* (MAIS), for any diagnosis of injury.

C. Death due to traffic injuries (ICD10): Death due to traffic injuries

Source: (Perez and Gomez, 2014)

The U.S. has legislated intensively on vehicle safety, but its regulations have not always had an impact in several countries; Japan also has extensive legislation, and other countries on a smaller scale, as shown in Table 2.

**Table 2.** Regulations according to country and tests performed

Region	Standard	Tests
USA	NOM-194-SCFI-2015	HNTSA
<b>EURO</b>	INI-2085-2017	Euro NCAP
<b>MEXICO</b>	LFMN, NMX, NOM	Latin NCAP
<b>KOREA</b>	KMVSS	KNCAP
ECUA	INEN 034	Latin NCAP

Source: Authors

Based on globalization, automobiles, their parts and components are not produced or marketed in a specific country; rather, there are more and more international manufacturers, regionally there are criteria according to each country based on perfectly defined and established norms or standards, which will depend on the country where they require more or less safety elements.

**Table 3.** Safety equipment in vehicles in Ecuador and the region.

Additional requirements	EC	СН	AR	PE	CO	BR	MX
034							
Power steering	X						
ISOFIX anchorages	X					X	
	X	X				X	X
belts							
ABS brakes	X					X	
Tachograph (buses and trucks)	X		X				
Visual and audible warning	X	X					

of seat belt non- use							
Electronic stability control	X		X				
Vehicle brakes	X	X	X	X	X	X	X
Heavy vehicle brakes	X	X		X		X	
Glass	X	X		X		X	
Headrests on all seats	X	X	X			X	
Seats and their anchorages	X	X					
Frontal collision protection	X	X					
Side collision protection	X	X					
Airbags	X	X	X			X	X
Front and rear bumpers	X	X	X	X	X	X	
	Sour	ce: Aut	hors				

# **Materials and Methods**

The research used the indirect deductive method based on the RTE INEN 034 regulation, which refers to the fact that vehicles entering Ecuador must comply with said regulation in order to guarantee a good level of safety for the occupants. In the first stage of the research, the most commercialized vehicles in the country were analyzed, and then the compliance with INEN 034 focused on safety criteria, to determine how safe they are at the time of an accident, and how the percentage of death of the driver and occupants decreases, in relation to the safety requirements of vehicles of regional and European manufacture, taking into account the criteria of injury in the impacts carried out in the laboratories of Latin NCAP and Euro NCAP.

In order to make the comparison, the Latin NCAP and Euro NCAP laboratory tests were used, each of which complied with standardized procedures and regulations to validate the impact data. The tests require the use of dummies or electronic dummies, which have deceleration sensors in specific points of the body, obtaining values of the injury criteria caused in a controlled impact, as shown in Table 4.

**Table 4.** NCAP Considerations

NCAP Considerations	LatinNCAP	<b>EuroNCAP</b>
Frontal impact velocity	64 km/h,	50 km/h,

Source: Authors

The vehicles used in the injury criteria comparisons are part of the 3 most sold vehicle brands in Ecuador, according to data presented by the AEADE, between the years 2019-2020, considering that they must comply with the RTE INEN 034 Standard, as shown in Table 5.

**Table 5.** Vehicle Sales by Brand 2019-2020

Brands	2019		2020	
	Nov	Jan - Nov	Nov	Jan - Nov
CHEVROLET	3.171	36.623	2.067	15.684
KIA	2.226	20.352	1.851	13.808
HYUNDAI	751	8.717	647	5.436
TOYOTA	726	7.150	633	4.769
GREAT WALL	627	6.615	510	4.295
JAC	468	3.759	499	3.087
RENAULT	348	3.010	397	2.719
NISSAN	350	4.323	378	2.711
HINO	314	3.859	283	2.307
CHERY	263	3.289	262	2.023

Source: (Aso 201)

Two of the most widely offered vehicles in the country, which comply with their respective regional and European safety standards, were used and were named VP and VS . These vehicles are part of the impact tests analyzed in the Latin NCAP and EuroNCAP laboratories.

RTE INEN 034 is taken as a reference, which determines the "minimum safety elements", considering this regulation with the UN regulations such as frontal collision protection UN 94, seat belts and child restraint systems UN 16. In the same way, UN 127 is taken into consideration for the injury criteria, thus identifying the deficit or the adequate safety system provided by the vehicles under study to the occupants.

Euro NCAP Test according to (Motor.es, 2017), means European New Car Assessment Program. It is a voluntary safety program which is

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responsible for assessing the safety of vehicles available on the market through impact tests at a given speed, the results are reflected by a star scale, up to a maximum of five, so that each vehicle on the market is perfectly measured and classified according to the injury criteria presented.

This criterion quantitatively assesses the safety of the vehicle for the occupants in relation to the number of stars obtained after a controlled impact (Emol, 2017). The number of stars shows the usefulness of the vehicle in the tests, but at the same time, it is influenced by the type of safety equipment provided by the manufacturer in each market. Thus, a high number of stars not only shows an optimistic result, but also boasts the safety equipment of the evaluated vehicle.

102 **Table 6.** *Interpretation of the stars* 

Rating					Meaning
$\Rightarrow$	$\Rightarrow$	☆	$\Rightarrow$	$\Rightarrow$	Vehicle meeting minimum legal requirements
$\Rightarrow$	$\Rightarrow$	$\Rightarrow$	$\Rightarrow$	$\Rightarrow$	Minimal collision protection.
$\Rightarrow$	$\Rightarrow$	☆	$\Rightarrow$	$\Rightarrow$	Nominal collision protection but lack of collision avoidance technology.
$\Rightarrow$	$\Rightarrow$	$\Rightarrow$	$\Rightarrow$	$\Rightarrow$	Good occupant protection overall but lack of collision avoidance technology.
$\Rightarrow$	$\Rightarrow$	$\Rightarrow$	$\Rightarrow$	$\Rightarrow$	Good overall crash protection performance; possible presence of collision avoidance technology.
$\Rightarrow$	☆	$\Rightarrow$	$\Rightarrow$	$\Rightarrow$	Good overall collision protection performance. Well-equipped with robust collision avoidance technology.

Source: The World of Ton (2019)

Anthropomorphically representative impact dummies of various sizes and ages of people are used to assess the level of risk under certain crash conditions reproduced in the tests. These instrumented anthropomorphic dummies, commonly referred to as Construction of the Knee Joint of the Dummy Designed for Crash Tests will allow to assess the level of risk that the person they represent would suffer under the same impact conditions (Marek Jaśkiewicz, 2020). For the

present investigation, Hybrid II and III type dummies were used since they are the ones used in frontal impacts in relation to the male and female build, as well as the Q-series types of child type.

## Results

At the national level, there are different norms related to vehicle safety related to the fundamental pillars of road safety in terms of safer vehicles, management and control. These two pillars were analyzed in relation to occupants and vehicle with impact tests at average speeds, taking into account that at national level the maximum speeds in urban areas are 50 km/h less than or equal to 60 km/h and in perimeter zone is 90 km/h less than or equal to 120 km/h (Executive Decree 1196, 2016), which means that for these impact tests the urban speed level of 50km/h was used. Local regulations are considered to be based on European regulations, in this case taking speeds of 50 km/h. There are regulations applied to adjusted internal policies of each country, therefore the tests performed in LATINCAP are adjusted to speeds of 64 km/h as shown in Table 7.

**Table 7.** *Impact tests in relation to velocity* 

Program	Speed	Impact	Vehicle Class
LAN VP1	64km/h	Front	Hatchback
ERO VP2	50km/h	Front	Hatchback
LAN VS1	64km/h	Front	Hatchback
ERO VS2	50km/h	Front	Hatchback

Source: Authors. Input data

In order to analyze the variables that influence the research, it is very important to standardize the samples in the different impact tests; vehicles that are offered in the European and South American sector were taken into consideration, specifically the study is focused on vehicles that are offered in the country. The quantitative values were taken from the impact tests with controlled speeds, evaluating the severity level of the occupants and the driver according to the anthropomorphic characteristics of the European and South American occupants. The percentage of severity caused by these controlled impacts to the vehicle occupants was evaluated using Hybrid II - III dummies. For this purpose, it is important to know the safety

equipment of the vehicles under study, in order to relate or compare the active and passive safety systems that the vehicles have and to analyze the percentage in which the vehicles under study protect the occupants in a frontal impact. As can be seen in Table 8.

**Table 8.** *Safety equipment in study vehicles* 

Safety equipment		LAN VP1		EUR	RO V	P2	LA	N VS	<b>S</b> 1		URO /S2	)
	C	A	T	C	A	T	C	A	T	C	A	T
Front airbag	O	X	X	О	О	X	X	X	X	0	O	X
Belt pretensioner	0	0	X	0	О	0	X	X	X	0	0	X
Belt load limiter	X	X	X	O	О	О	X	X	X	О	О	X
Knee airbag	X	X	X	О	X	X	X	X	X	X	X	X
Side chest airbag	X	X	X	-	-	-	X	X	X	-	-	-
Side head airbag	X	X	X	О	0	О	X	X	X	О	О	О
Lateral thoracic airbag	X	X	X	O	O	X	X	X	X	О	O	X
Lateral pelvic airbag	X	X	X	O	0	X	X	X	X	О	О	X
Isofix	-	X	X	-	X	O	-	X	O	-	X	O
Integrated child seat	-	X	X	-	X	X	-	X	X	-	X	X
Airbag disconnect switch	-	X	-	-	O	-	-	X	-	-	X	-
Belt warning light	О	X	X	0	О	0	X	X	X	0	О	О

C: Driver

A: Companion

T: Rear companion

Source: Authors

Injury criteria according to the safety stars in connection with AIS

The star rating is evaluated in a quantitative way in relation to safety and the types of injuries according to the AIS that the vehicle presents to the occupants after a controlled impact. Based on what was proposed, the final objective is to measure the injury criteria in relation to the controlled impacts generated in Latin NCAP and Euro NCAP, for this reason the driver and occupants were individually assessed. The number of stars in terms of active and passive safety of the vehicles offered in Europe and South America was examined by means of the injury criteria, analyzing the injury criteria of the driver and occupants.

**Table 9.** Risk assessment scale in the polytraumatized patient.

AIS Score	Injury	Morbidity or mortality	By Color	Stars
1	Menor	16.666%		***
2	Moderate	33.333%		***
3	Serious	50%		***
4	Severa	66.666%		****
5	Critique	83.333%		***
6	Incompati ble with survival	100%		***

Source: Authors

Considering that each body region plays a vital role in human survival, HAI correlates with morbidity, mortality and other measures of severity and is defined in six body regions, such as: thorax, abdomen - visceral pelvis, head - neck, face, bony pelvis - extremities and external structures.

#### **Driver Analysis**

The data collected by the dummies in the Latin NCAP and Euro NCAP frontal impact tests were examined, taking into consideration the colors reflected in Figure 2, making a quantitative assessment and identifying the level of injury according to the AIS score, demonstrating the level of risk that the driver may receive during an impact as shown in Table 9.



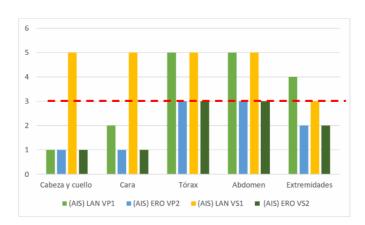
Figure 2. Drivers frontal impact test



106 Source: Latin NCAP (2019)

The comparison was made in the study vehicles on the data obtained from the Latin NCAP and Euro NCAP programs with their respective analysis of the injury criteria, generating a score in each of the body regions where the level of acceptable risk was interpreted being this  $\leq$  50% and where > to 50% will have less probability of life of the driver as shown in Table 9 This helps us to verify the importance of passive and active safety of a vehicle when an impact occurs.

Figure 3. Driver impact test analysis



Source: Authors

As shown in Figure 3, the injury criteria at specific points determined by the laboratory tests were considered, taking into account the speed of the impact to be controlled in relation to the internal policies of each country. It was verified that the most vulnerable body regions in a frontal impact vehicle accident in the study vehicles are: abdomen, thorax, face, extremities, head and neck, which exceed the acceptable risk level. Observing that the vehicle LAN VS1 has a percentage of 83.333% in four body regions, followed by LAN VP1 which has two body regions in 83.333% and one in 66.666% generating injuries or death to the driver, which means that these points generate a high risk of injury due to the lack of safety elements as shown in Table 3 and unfortunately many of the countries at the local level do not even require an airbag for the driver, much less safety systems that help mitigate the risk levels of morbidity and mortality in the event of a vehicle accident.

It is necessary to take into account the prehospital response time, in order to provide timely and adequate care to the patient after the accident. According to Martín (2000), response time is the indicator that helps to assess a component of quality, of extraordinary importance in emergencies and emergencies, such as the timeliness of care. It has specificity in each of the levels of care, although it tries to measure the same aspect: average time elapsed from the moment the patient requests assistance or arrives at the Functional Unit until he/she makes contact with the physician or the health team. This means that from the moment the call is made to ECU 911, the response time of the arrival of the first responders will be counted.

# **Companion Analysis**

The data collected by the dummies in the Latin NCAP and Euro NCAP frontal impact tests were analyzed, taking into consideration the colors shown in Figure 4, making a quantitative assessment and identifying the level of injury according to the AIS score, demonstrating the level of risk that the passenger may receive during an impact as shown in Table 9.

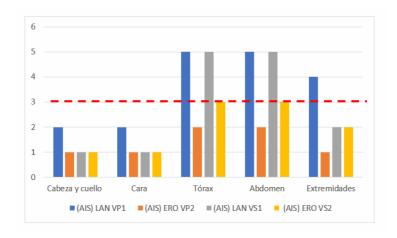


Figure 4. Passenger frontal impact test

Source: Euro NCAP (2020)

The comparison was performed on the study vehicles on the data obtained from the Latin NCAP and Euro NCAP programs with their respective analysis of the injury criteria, generating a score in each of the body regions where the level of acceptable risk was interpreted being this  $\leq 50\%$  and where > to 50% will have less probability of life of the passenger as seen in Table 9.

Figure 5. Analysis of accompanying frontal impact tests



Source: Authors

As shown in Figure 5, the injury criteria were analyzed in specific points determined by the laboratory tests. It was verified that the most vulnerable body regions in a frontal impact vehicle accident in the study vehicles are: thorax, abdomen and extremities, which exceed the acceptable risk level. Observing that the vehicle LAN VP1 has a percentage of 83.333% in two body regions and one in 66.666%,

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followed by LAN VS1 which has two body regions in 83.333% generating injuries or death to the passenger, which means that these points generate a high risk of injury due to the lack of safety elements as shown in Table 3, where it is identified that the injury levels are lower than those analyzed in the driver. In the study, one of the five pillars of road safety is the post-crash response; therefore, it is necessary to take into consideration the arrival time of the rescuers by performing a triage classification. For this reason, an acceptable risk level of triage III was taken into consideration, since it will have an arrival time of 30 to 60 minutes in an accident to rescue the patient. According to the Ministry of Health and Social Protection (2015), triage III is the clinical condition of the patient requires diagnostic and therapeutic measures in the emergency department. Being those patients who need a complementary examination or rapid treatment, since they are stable from the physiological point of view, although their situation may worsen if no action is taken.

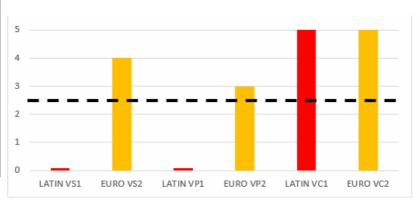
It was analyzed that regarding the comparison of standards of active and passive safety equipment in the different vehicles that were studied in each of the tests at a speed of 50 km / h in urban areas we consider that the arrival time of the rescue unit is about 30 minutes this will depend on several factors such as the weather time, the sector where the accident occurs among others.

# Global Analysis of Vehicle Ownership Stars

The evaluation performed by Latin NCAP and Euro NCAP of vehicles based on the number of stars, taking into account both active and passive safety elements, not only the driver but also the occupants and bystanders as such, these input data were considered to assess the vehicles in our analysis. An additional vehicle was also considered for this star rating, generating a better comparison of minimum safety elements that a vehicle must have to obtain a five-star rating; this vehicle was designated as VC1 in Latin NCAP and VC2 in Euro NCAP. These vehicles are among the most sold in Latin America and also in Europe, this implies that similar vehicles in Europe and Latin America with similar characteristics were evaluated.



Figure 6. Global analysis by stars



Source: Authors

According to the data of the Latin NCAP and Euro NCAP programs of the study vehicles, Figure 8 shows that there is a difference in the safety elements in reference to the stars where it was observed that the vehicles of the Latin NCAP program obtained a zero star rating and the vehicles of the Euro NCAP program obtained between three and four stars. It is unfortunate that they do not consider safety criteria, as many countries in South America do not have regulations or policies that benefit the safety of drivers, occupants and bystanders.

On the other hand, it was identified that the VC1 and VC2 vehicles that are Latin NCAP and Euro NCAP respectively obtained a five star rating, these results are reflected in vehicles with better minimum safety elements being these marketed in both Latin America and Europe with the difference in the PVP in each of the regions as appropriate.

That is why several improvements are needed in relation to passive and active safety elements. in the Latin NCAP (2015) statement it mentions that, it was evident that the safety of many of the best-selling cars in the region was twenty years behind compared to Europe and North America. Since then, some manufacturers have committed to Latin NCAP to improve occupant protection, this means that not all vehicles evaluated in Latin NCAP have a zero star rating, as manufacturers have implemented more safety elements in correlation to the various NCAP's programs, reaching 5 stars reducing the level of risk to occupants in an accident.

## **Conclusions**

The analysis of the different regional and international standards showed that there is a great difference between the active and passive safety elements of M1 category vehicles. Demonstrating that the RTE INEN 034 standard is one of the best in the region, however, when compared with international standards, it is clear that we must improve, thus reducing the risk of injury or death to the occupants in a traffic accident. In the tests carried out by the Latin NCAP and Euro NCAP programs on the study vehicles, the results were not expected, since the vehicles marketed in Latin America obtained a very low level of safety for the driver and occupants. In the analysis of the driver, it could be seen in Figure 5 that Latin NCAP vehicles exceed the acceptable level of risk in seven body regions, increasing their vulnerability, since the response time to an accident with these conditions should be immediate. On the other hand, it was evidenced that in Euro NCAP they do not exceed the acceptable risk level.

In the tests concerning the passenger, as shown in Figure 3 of the Latin NCAP and Euro NCAP programs, different results were obtained from the driver injury criteria. In the Latin NCAP vehicles, risk data were obtained between five and four, generating that immediate attention to patients will be needed before an accident under these conditions of the safety of these vehicles, and in the Euro NCAP vehicles in the analysis of the passenger, they do not exceed the acceptable risk level. The most commercialized vehicles in Latin America are unfortunately the most unsafe in the event of a traffic accident, this may be due to the PVP which is accessible to the population, without considering the risk that the occupants are exposed to due to the lack of minimum elements of passive and active safety, this is proven with additional vehicles to the study being considered in Latin America as high-end vehicles.

This study identified that it is not possible to determine the level of star rating according to NCAP's for vehicles marketed in the country, since the RTE INEN 034 standard is one of the best in the region, and has more minimum safety elements than the standards or regulations of neighboring countries, generating a reduction in morbidity and mortality in vehicle occupants in the event of an accident. However, it should be considered that international regulations are designed to provide more safety to vehicle occupants, so we must work on improving our regulations to achieve high standards of vehicle safety, both active and passive.

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