BY ASEAN NCAP & UTAC

Deliverable 3.1

Test and Assessment Protocol

WP3: Test and Assessment Protocol

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UTAC

Executive Summary

The OASIM project aims to improve the safety of motorcycle users in the ASEAN region by establishing active safety test protocols representative of the accident situations in this region. Work Package 3 is dedicated to the definition a test procedure and assessment protocol. The work was conducted based on the 12 most common accidents between a passenger car and a motorcycle, from the Work Package 1 study. These situations represent around 80% of the seriously and fatal car-to-motorcycle accidents from the data observed. The ones that are addressable by ADAS systems within the cars have been studied to be set-up as test scenarios and their parameters. The consortium, with automotive manufacturers and suppliers, test laboratories and testing equipment suppliers, have been discussing the test feasibility of the scenarios.

The outputs' purpose of the Work Package 3 is to support ASEAN NCAP Assessment of Motorcyclist Safety by defining the relevant tests to evaluate the ADAS systems. The report presents the OASIM proposal to ASEAN NCAP for the test scenarios to be integrated in the existing assessment. In addition, it introduces the recommendation for upcoming updates based on the observation of the real accident cases and the systems and test feasibility.

The current ASEAN NCAP protocol integrated in 2021 introduce a first scenarios evaluating Blind Spot Technologies with three tests: the motorcycle entering the blind spot area at a steady speed, the motorcycle overtaking the vehicle, and a false warning test.

For 2026 ASEAN NCAP Assessment for Motorcyclist Safety, the test scenarios identified to focus on are the four below:

- CMFtap – Car to Motorcycle Front turn across path, representing the passenger car turning farside in front of the motorcycle coming from the opposite direction at an intersection.
- CMRm – Car to Motorcycle Rear-end moving, representing the passenger car following the motorcycle travelling at a constant slower speed, and impacting it on the rear.
- CMCrossing – Car to Motorcycle Crossing, representing the passenger car and the motorcycle arriving perpendicularly at an intersection.
- CMOncoming – Car to Motorcycle Oncoming, representing the passenger car and the motorcycle travelling on opposite direction and the car is drifting into the lane of the motorcycle leading to a front-to-front impact.

These scenarios in addition to the existing overtaking scenario tested in the protocol, evaluating with Blind Spot Technology with 3 tests, cover a third of the serious and fatal accidents from the Work Package (WP) 1 data study.

This report also highlights the accident scenarios and suggestions to be added in the future assessment. The objective of ASEAN NCAP is to be the most challenging program to assess ADAS systems applied to motorcycle safety in view of the ASEAN countries critical context and the proportion of motorcycles in the fleet. The main limitation for the current assessment and 2026 test scenarios proposal is the testing experience and the ASEAN market. Therefore, the test scenarios shall be updated within the future of the assessment next to 2026. Especially two of the 2026 scenarios should be reviewed to cover more cases. Concerning the CMFtap test scenario, the vehicle under test (VUT) speed increase to a 30km/h turn scenario in wider intersection (4 lanes) enable to cover 75% of the cases observed. Looking at the CMCrossing scenarios, the real accidents situation observation show that more than half of the accidents happen with an obstruction. The motorcycle speed should be also reviewed to be increase according to these observations.

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Introduction

With 43% of fatalities among their road users, the South-East Asian countries have the highest rate of death among riders of motorized 2- and 3-wheelers (according to the Global Status report on Road Safety 2018). The Association of Southeast Asian Nations (ASEAN), an intergovernmental organization created in 1967, represents ten countries: Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, the Philippines, Singapore, Thailand, and Vietnam.

With pedestrians and cyclists, motorcyclists are considered as Vulnerable Road Users (VRU) as they respectively account for 26% (pedestrians and cyclists) and 28% (motorcycles) of all deaths in the world. Looking at the ASEAN countries situations, their proportion goes up to 59% of the fatalities on the road.

Since 2011, the ASEAN New Car Assessment Program (ASEAN NCAP) aims to elevate vehicle's safety standards. ASEAN NCAP places high importance on motorcyclist safety and claim to become the most challenging protocol of a kind. Thus, the Motorcyclist Safety Pillar was specifically created in the 2021-2025 Roadmap, to urge the automotive industry to reduce motorcyclist's road traffic deaths through new technologies. The industrial consortium Overall ASEAN market Safety Improvement for Motorcycles (OASIM) coordinated by UTAC was set off in September 2020 with the support of the ASEAN NCAP. The OASIM project aims to improve the motorcyclist safety in the ASEAN region by promoting an official rating.

The third Work Package (WP3) aims at defining a test and assessment protocol based on the most common accidents between a passenger car and a motorcycle. This will be the based for the OASIM proposal to ASEAN NCAP assessment to help promote the ADAS systems to be integrated in the future vehicles to address the situation by avoiding the impact and reduce the consequences of the accidents.

The 12 most common accident situations described in *D1.2 Accident parameters description for the chosen scenarios* of WP1 has been studied in order to identify the most relevant ADAS system to be applied in terms of technologies and testing feasibility. This report summarized the work conducted within the WP3, processing the main accident scenarios and their conditions to reproduce it on the track to test and assess the ADAS systems. The objective is to help the development of these systems to avoid the impacts and limit their consequences between a passenger car and a motorcycle.

The first part of this document introduces the methodology to process the inputs of the accident cases leading to the test scenarios and their parameters. The second chapter describes the OASIM proposal and the test scenarios explanations and recommendations for the ADAS roadmap for ASEAN NCAP Motorcyclist Safety Assessment. Finally the third part deals with the testing tools and conditions.

1 Glossary

OASIM	Overall ASEAN market Safety Improvement for Motorcycles
ASEAN	Association of Southeast Asian Nations
NCAP	New Car Assessment Programs
ASEAN NCAP	New Car Assessment Program for Southeast Asian Countries
Euro NCAP	European New Car Assessment Programme
Latin NCAP	Latin American & Caribbean New Car Assessment Programme
C-NCAP	Chinese Car Safety Assessment Program
ADAS	Advanced Driver Assistance systems
VUT	Vehicle Under Test
AMT	ASEAN NCAP Motorcycle Target
AEB	Autonomous Emergency Braking
FCW	Forward Collision Warning
LSS	Lane Support System
LDW	Lane Departure Warning
LKA	Lane Keeping Assist
ELK	Emergency Lane Keeping
BST	Blind Spot Technology
BSI	Blind Spot Information
BSD	Blind Spot Detection
BSV	Blind Spot Visualisation
BSW	Blind Spot Warning
CMRm	Car-to-Motorcycle Rear-end moving scenario
CMFtap	Car-to-Motorcycle Front Turn Across Path scenario
CMCrossing	Car-to-Motorcycle Crossing scenario
CMOncoming	Car-to-Motorcycle Oncoming scenario
TTC	Time to Collision
ISO	International Organization for Standardization
RHD	Right-Hand Drive
LHD	Left-Hand Drive
EPS	Electronic Power Steering system
WP	Work Package

2 Methodology for Work Package 3

The test scenarios and their parameters defined in this deliverable are deduced from the accident situations and their detailed characteristics studied in Work Package 1.

Therefore, the OASIM approach applied to define the test procedure proposal for the ASEAN NCAP assessment is the following:

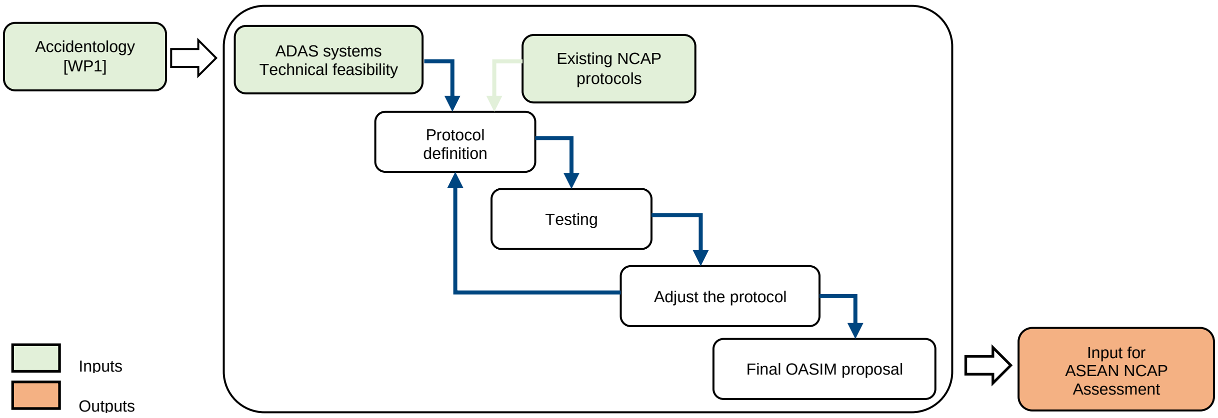


Figure 1: OASIM scheme - definition of the test scenarios

The proposal of the test scenarios takes also into consideration inputs on the technical feasibility of the ADAS systems to address the accident situations, based on the discussions with the automotive industry, car manufacturer and suppliers, as well as the experience from the other NCAPs assessments.

Once the protocol defined, the test procedure is then tested on the track to check the feasibility and the conditions of the test. The protocol is then reviewed to adjust some values for the parameters and boundaries of the test.

2.1 Test Scenarios Selection

The objective of the test and assessment protocol definition is to describe the parameters and the requirements to test the ADAS systems. The conditions must meet real accidents ones observed in the ASEAN countries roads and be repeatable. Therefore, the first step was to process the twelve main car-to-motorcycle accidents to possible test scenarios. Following this first overview, an ADAS technologies roadmap has been defined to identify the possible actions with the type of ADAS systems, their operating range, limits, and other challenging issues. Based on it, an achievable integration date of the systems has been estimated. The doable testing scenarios have then been classified by priority, depending on their criticality and feasibility, to be studied for the test definition to be integrated in the proposal.

The accidentology highlighted 12 most dominant accident situations between a passenger car and a motorcycle, grouped in 6 main accident situations.

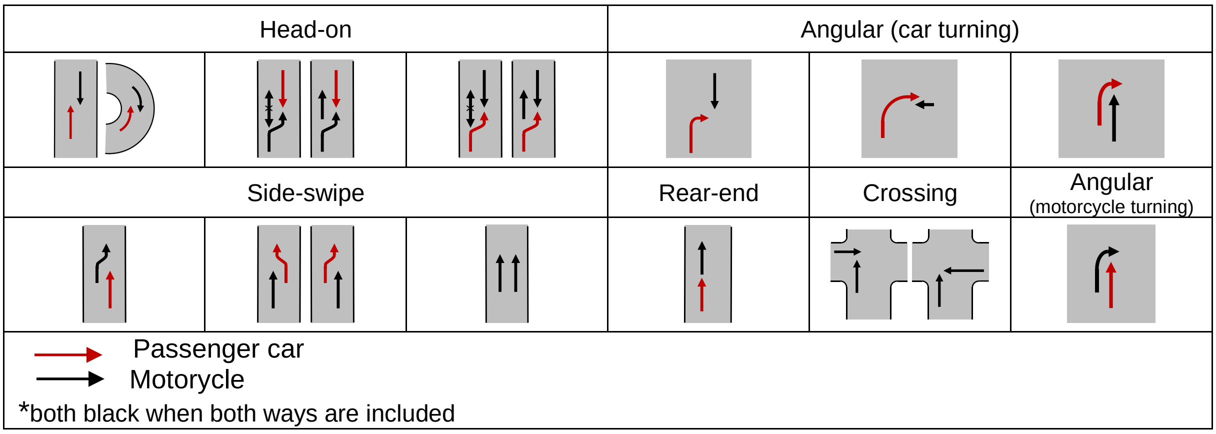
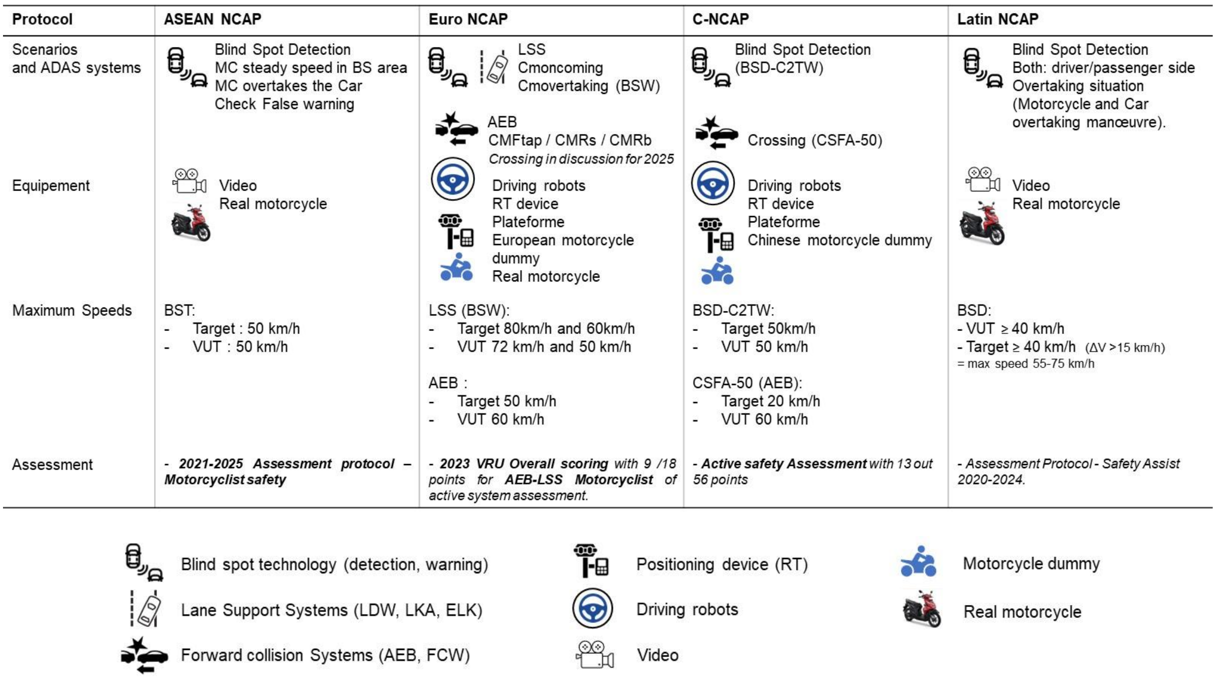


Table 1: Twelve most important accident scenarios from WP1

These accident cases to be further analysed in detail correspond to 78% and 83% of the Killed and Seriously Injured (KSI) cases, respectively from the countries studied. Refer to the deliverable *D1.1 Accident Scenarios Description v1.0 - OASIM,* to have more details about the most common accident scenarios between a passenger car and a motorcycle. To have more details about the scenarios such as the general conditions, accidents, and vehicles characteristics, refer to the deliverable *D1.2 Accident Parameters Description -v1.1 - OASIM*.

Finally, all the scenarios cannot be implemented into the next ASEAN NCAP assessment in 2026. This methodology allows to identify an overview of the evolution of the possible test scenarios overtime to develop the technology step-by-step. The objective the OASIM project is to make a proposal for the ASEAN roadmap based the test and ADAS technology feasibility.

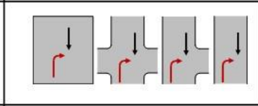
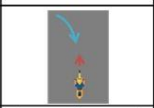
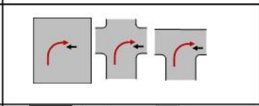
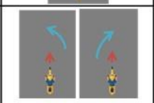
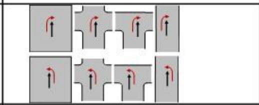
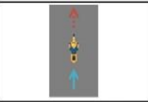
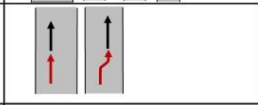
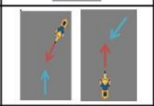
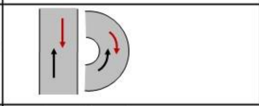
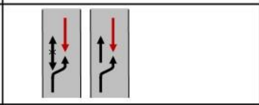
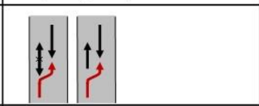
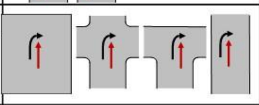
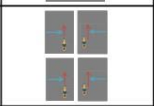
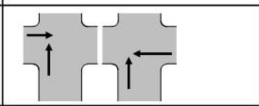
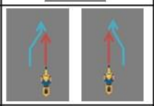
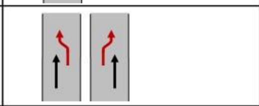
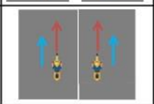
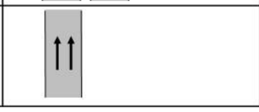
A literature review of the existing NCAP scenario has been done to review the experience from the other NCAP. It also gives a good overview of the technologies implemented with the market all over the world.



Protocol	ASEAN NCAP	Euro NCAP	C-NCAP	Latin NCAP
Scenarios and ADAS systems	Blind Spot Detection MC steady speed in BS area MC overtakes the Car Check False warning	LSS Cmoncoming Cmovertaking (BSW) AEB CMFtap / CMRs / CMRb *Crossing in discussion for 2025*	Blind Spot Detection (BSD-C2TW) Crossing (CSFA-50)	Blind Spot Detection Both: driver/passenger side Overtaking situation (Motorcycle and Car overtaking manœuvre).
Equipement	Video Real motorcycle	Driving robots RT device Plateforme European motorcycle dummy Real motorcycle	Driving robots RT device Plateforme Chinese motorcycle dummy	Video Real motorcycle
Maximum Speeds	BST: - Target : 50 km/h - VUT : 50 km/h	LSS (BSW): - Target 80km/h and 60km/h - VUT 72 km/h and 50 km/h AEB : - Target 50 km/h - VUT 60 km/h	BSD-C2TW: - Target 50km/h - VUT 50 km/h CSFA-50 (AEB): - Target 20 km/h - VUT 60 km/h	BSD: - VUT ≥ 40 km/h - Target ≥ 40 km/h (ΔV >15 km/h) = max speed 55-75 km/h
Assessment	*- **2021-2025 Assessment protocol – Motorcyclist safety***	*- **2023 VRU Overall scoring** with 9 /18 points for **AEB-LSS Motorcyclist** of active system assessment.*	*- **Active safety Assessment** with 13 out 56 points*	*- Assessment Protocol - Safety Assist 2020-2024.*

Figure 2: Sum-up table of the existing NCAP test protocol with Motorcycles.

This first step also allows to have a first overview of the feasibility from the ADAS technologies point of view.

#	WP1 accident sub-scenarios	Pictogram WP1 (— Car, — Motorcycle)		Naming WP3 – accident scenarios	Pictogram WP3 (— Ego vehicle - car)	Possible ADAS Systems	Realistic Time-bound
1	Angular - frontal and lateral impact - MC going straight "group 1"		→	Turning scenario, Right Turn Across Path – Opposite Direction		FCW, AEB	2026
2	Angular - frontal and lateral impact - MC going straight "group 2"		→	Turning scenario, Right Turn Into Path – Perpendicular Direction		AEB	Later in time
3	Angular - frontal and lateral impact - MC going straight "group 3"		→	Turning scenario, Right/Left Turn Across Path – Same Direction		BSI, LSS – ELK	2021* Later in time
4	Rear-end		→	Rear-end scenario, front to rear – slower		FCW, AEB	2026
5	Head-on - "group 1"		→	Head-on scenario, Straight Path – Opposite Direction		LSS-LDW/ELK AEB	2026 & Later in time
6	Head-on - "group 2"		→	Head-on scenario, opposite direction - lane change motorcycle manoeuver		AEB	Later in Time
7	Head-on - "group 3"		→	Head-on scenario, lane change vehicle manoeuvre - opposite direction		AEB	Later in time
8	Angular - frontal and lateral impact - MC turning right		→	Turning scenario, straight path - right turn across path – same direction		BSI, AEB,ESS	2021* Later in time
9	Right - angle		→	Crossing scenarios, Straight Crossing Path - Perpendicular direction		AEB, ESS, V2X	2026 & Later in time
10	Side-swipe "group 1"		→	Side-swipe, straight path - lane change (motorcycle) – same direction		BSI AEB	2021* Later in time
11	Side-swipe "group 2"		→	Side-swipe, straight path - lane change (motorcycle) – same direction		BSI LSS- LDW/ELK	2021* 2026
12	Side-swipe "group 3"		→	Side-swipe, straight (passenger car) - straight (motorcycle) – same direction		AEB	Later in time

* 2021 for Blind Spot Information systems as the existing ASEAN NCAP protocol already assess this kind of system

Figure 3: Conclusions on the systems to address the accidents situation and the respective test scenarios.

Within the potential system to address the accidents, Blind Spot Information (Warning, Detection, and Visualization) are indicated as it could address part of the initial situation, which is the parallel driving of the vehicles, however it cannot be the solution to avoid or limit the accident itself.

A realistic roadmap has been discussed, based on the three following criteria: the configuration challenges, the test feasibility and the ADAS technology readiness. Those elements helped to determine whether the accident could be cover by an ADAS system to be assessed in 2026 or not. The “later in time” label means that we need more inputs from the configuration, experience and the relevant ADAS technology to address it.

Based on this establishment, the accident situations have been classified into four priority categories to be studied in order to address it through the test and assessment protocol to be defined and proposed to ASEAN NCAP.

Three scenarios have been defined in the first priority to be addressed by the test protocol and to be applied for the 2026 assessment: (#1) Turning scenario, Front turn across path – opposite direction, (#4) Rear-end scenario, front to rear – moving, (#5) Head-on scenario, straight path – opposite direction.

More completed scenarios are gathered in the second priority. However, the situations could be addressed by the ADAS systems: (#9) Crossing scenarios, Straight path – perpendicular direction, and (#10) Side-swipe, straight path – lane change (motorcycle) – same direction.

The third priority represents the test scenarios feasible and less critical, with a lower number of KSI cases observed or already partly address by the existing ASEAN NCAP protocol: (#11) Side-swipe, straight path – lane change (car) – same direction, (#12) Side-swipe, straight (passenger car) – straight (motorcycle) – same direction.

In fourth priority, the scenarios classified are the ones that are difficult to adress in 2026 and expected futur updates of the protocol afterwards:

- (#2) Turning scenario, Right Turn Into Path – Perpendicular direction
- (#3) Turning scenario, Right/Left Turn Across Path – Same direction
- (#6) Head-on scenario, opposite direction – lane change motorcycle manoeuvre
- (#7) Head-on scenario, lane change vehicle manoeuvre – opposite direction
- (#8) Turning scenario, straight path – right turn across path – same direction
- (#5) Head-on scenario, Straight path – Opposite direction (case: motorcycle enters car lane)

The top 3 priorities to be studied to define a test protocol cover over the accident situations observed as shown on the Figure 4 and Figure 5.

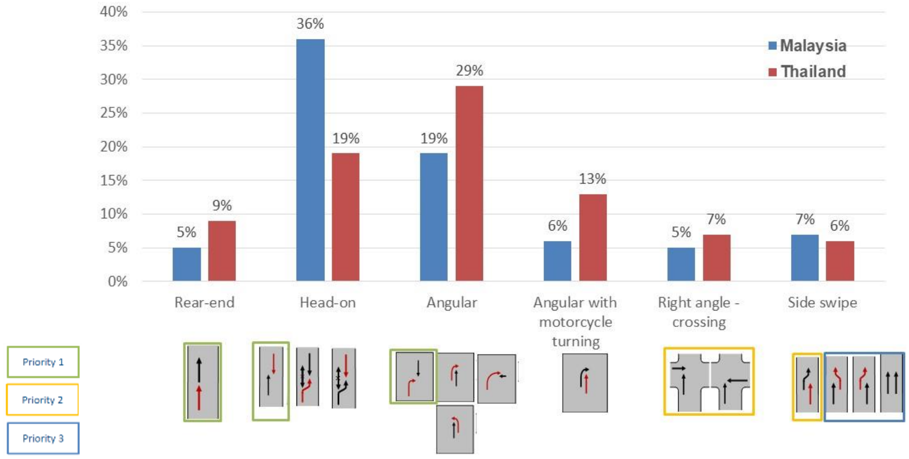


Figure 4: Group of accidents configuration based on the KSI cases over the databases studied.

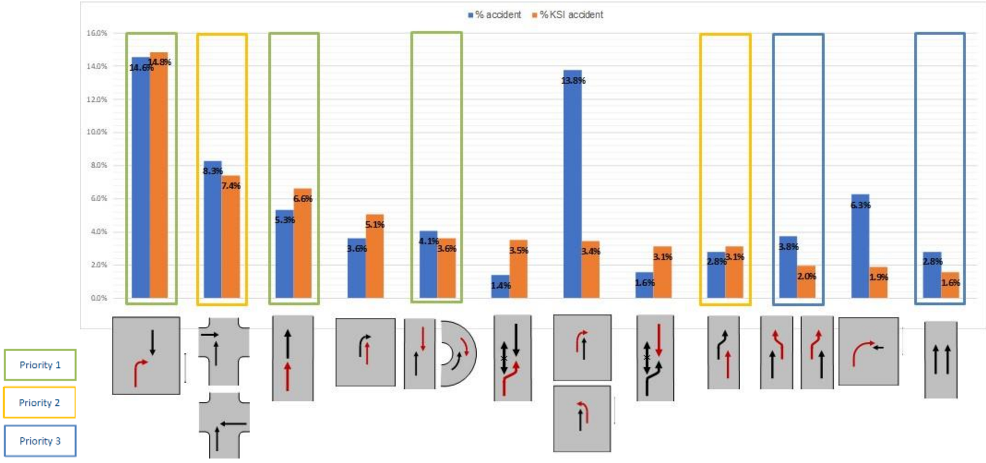


Figure 5: Criticality of the scenarios from the Thai in-depth database.

Looking at the accident by criticality (with the percentage of KSI), the three major accidents are considered to be integrated as test scenarios. Based on this steps to process the inputs of the WP3, the test protocol definition method is described within the next paragraph 2.2 Test protocol definition.

2.2 Test protocol definition

Once the accident classified by priority to be studied, they were reviewed in detail to define respective test scenarios to rate the ADAS systems. The objective of a test scenario is to reproduce the accident situation. The definition is based on the accident characteristics to test the ADAS solutions in a realistic situation, relevant with the ASEAN traffic observed.

Indeed, the accident configurations have been studied in further details thought the in-depth Thai database. Their parameters to describe the general conditions of the accidents are the weather, light and road surface conditions. Then the road characteristics are described by the information of the location, the road category and configuration, the bend, the slope, the lane markings, the speed limits, the number of the lane, and the travelled lane. Finally, the accidents characteristics are also described through the information from the vehicles with the visibility, the impact angle, the impact points, the initials and collisions speeds, the manoeuvres, and the action before the crash.

The protocol definition will ensure the clarity of the OASIM proposal and help the integration of the tests in the ASEAN NCAP assessment. The framework for this task is based on the current state of the ASEAN NCAP protocols and completed by the other NCAP test procedure for the similar test scenarios. The main requirements for the protocol are:

- To be challenging to improve the motorcyclist safety.
- To be based on the most common scenarios identified in the accident data study.
- That the respective assessment must be built around possible active system performance.
- That the test feasibility must meet safety requirements, in respect to the operator safety and, the vehicle and test equipment integrity.
- That it must be defined clearly enough to allow any accredited laboratory to perform the test with all the requirements defined to ensure that laboratories can satisfy it.

3 OASIM Proposal for the test roadmap

The aim for the next ASEAN NCAP protocol is to be the most challenging assessment for ADAS systems applied to accidents with motorcycles. The amount of powered-two-wheels in the ASEAN countries makes it a priority to develop the tools helping the automotive industry to implement such systems. To be able to address the maximum of the critical accidents and due to limitations (road condition, test feasibility, technological feasibility), the proposal is to proceed step by step and update the protocol along with the ASEAN NCAP assessment update.

The proposal of roadmap is as below and detailed in the following part of this report.

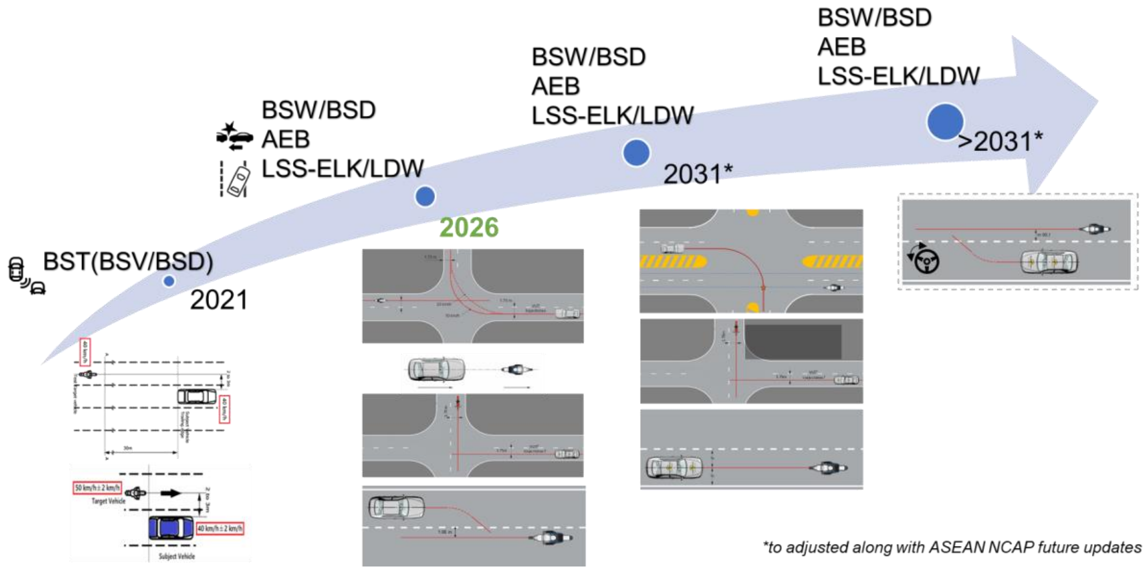


Figure 6: OASIM Final proposal for ASEAN NCAP Motorcyclist Assessment Roadmap

The current protocol with motorcyclist integrated in 2021 introduce a first scenarios evaluating Blind Spot Technologies with three tests:

- Target vehicle entering the 30 meters zone with a steady speed
- Target vehicle overtaking the Subject Vehicle speed
- False warning

For the next update, expected in 2026, OASIM identified 4 test scenarios, evaluating Autonomous Emergency Braking (AEB), Forward Collision Warning (FCW), and Lane Support Systems (LSS):

- Car to Motorcycle Rear-end moving (CMRm) [FCW - AEB]
- Car to Motorcycle Front Turn Across Path (CMFTap) [AEB]
- Car-to-Motorcycle Crossing (CMCrossing) [AEB]
- Car-to-Motorcycle Oncoming (CMOncoming) [LSS – LDW/ELK]

For the upcoming updates of the assessment after 2026, currently to be expected for 2031, it would be suggested to add relevant updates on the 2026 test scenarios. These recommendations are taking into consideration the need of further study and first experience.

- CMFTap with an additional speed for the vehicle under test: 30km/h
- CMCrossing with obstructions and higher speed for the target.
- Add the Car-to-Motorcycle Head-on test scenario.

The last part of this roadmap refers to the other accidents situations, that cannot be covered within this timeline, however they are still relevant situation that should stay under consideration and may be addressed later in time with new ADAS technologies and test experience. It also entailed ADAS technologies, such as a steering action, for which the ASEAN market is not ready yet, as the integration within the specific ASEAN countries traffic should be studied.

3.1 Test scenarios proposal for 2026

3.1.1 Review of the existing scenarios for Motorcyclist Assessment

The first step for the proposal of the test scenarios for 2026 is to review the existing protocol from the Motorcyclist ASEAN NCAP Assessment in comparison to the real situations brought by the studies of the OASIM project.

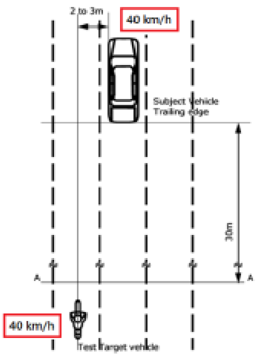
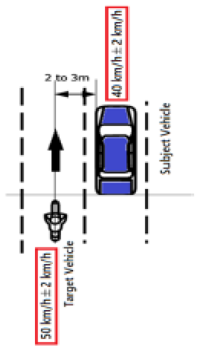
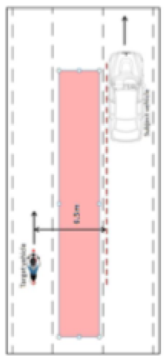
Target vehicle entering the 30 meter zone with steady speed	Target Vehicle overtaking Subject Vehicle speed	False warning test
		

Figure 7: Extract from the ASEAN NCAP Motorcyclist Test and Assessment protocol.

The conclusion from the accident data study shows that the speeds applied for the test are relevant with the real cases observations. The mean values respectively for the passenger car and the motorcycle are 38 km/h and 59 km/h, with a relative speed mostly between 10 km/h and 45 km/h. The actual test values respectively for the passenger and the motorcycle are 40 km/h and 50 km/h. In terms of ADAS system, a smaller relative speed is more challenging.

As for the configuration of the test, the study shows that these accidents, within parallel driving situations, happened mostly on highway and city roads (for details on refer to 4.2.1.1) which are composed of 4 to 8 lanes. With a 2- and 3-lanes one-way configuration for the test, the configuration is also relevant.

The actual test is assessing only warning and visualization system in the car. Within the existing ADAS technologies, it has been identified that the addition of a steering control such as ELK could help avoiding the collision with the motorcycle. It has been brought to the attention that the existing ELK system may not be applicable within the ASEAN countries traffic and the risk of false positive is too important. However, an alternative solution would be to activate the function with a specific operating range such as the highest speeds and only on highway.

In conclusion, the tests are relevant with the accident data study and there are no specific proposal for the test set-up and configuration from the OASIM project.
The proposal also to investigate furthermore on the feasibility of ELK with more experience in the future. The improvement identified is the addition of a test scenarios with a vehicle manoeuvre, intentional and unintentional lane change through the motorcycle lane, to assess an emergency steering action (ELK) that would avoid the vehicles collision.

3.1.2 Relevant test scenarios for 2026

Four scenarios have been identified for the next step of the ADAS assessment for the ASEAN NCAP evaluation. Those scenarios allow to cover around 30% of the accidents observed from the accident data study. In this report, we refer to the VUT as the vehicle under test and the AMT as the motorcyclist target.

3.1.2.1 CMRm – Car to Motorcycle Rear-end Moving

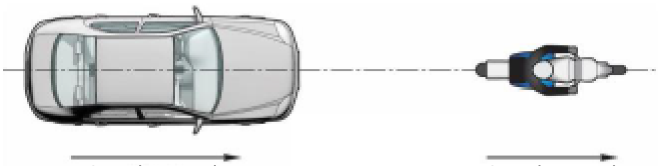


Figure 8: CMRm 2026 scenario

Over all the situations where the car is following the motorcycle and collide front to rear, the accident data study has shown that the most represented situation was both vehicles driving at constant speed. Then, the motorcycle speeds within the accident cases are mostly represented from 40km/h to 60 km/h. As for the relative speeds between the vehicles, it happened to be mostly between 10 km/h and 44 km/h, as the vehicle speed is distributed between 30 km/h to over 100 km/h (with a mean value around 80 km/h).

The technologies applied to this situation are a front forward collision warning (FCW) and an active braking (AEB) system. The minimum relative speed for the efficiency of the system and to limit false positives is 10km/h.

Based on the existing protocol and the observed accident data, the proposal for the test speed combinations is as in Table 2 below, with the motorcycle velocity from 30 km/h to 60 km/h and the vehicle speed from 40 km/h to 80 km/h.

Table 2: Speed combinations for CMRm

50% impact point				
Speed (km/h)		AMT		
		30	45	60
VUT	40	AEB/FCW	-	-
	45	AEB/FCW	-	-
	50	AEB/FCW	-	-
	55	AEB/FCW	AEB/FCW	-
	60	AEB/FCW	AEB/FCW	-
	65	FCW	FCW	-
	70	FCW	FCW	FCW
	75	FCW	FCW	FCW
	80	FCW	FCW	FCW

		25% impact point		
Speed (km/h)		AMT		
		30	45	60
VUT	40	FCW	-	-
	45	FCW	-	-
	50	FCW	-	-
	55	FCW	FCW	-
	60	FCW	FCW	-
	65	FCW	FCW	-
	70	FCW	FCW	FCW
	75	FCW	FCW	FCW
	80	FCW	FCW	FCW

The vehicle speed should be tested with 10km/h steps and reduced to 5 km/h steps if there is an impact.

For the impact point, most of cases are covered with a collision within the middle of the car front bumper. However, a relevant number of cases (around 30%) happened with an impact on front left side (considering the Right-Hand Drive vehicle).

Therefore, we would suggest testing the configurations with two different impacts, with the first one as priority to integrate to the protocol:

Figure 9: 50% impact point for CMRm scenario (AEB-FCW)

Figure 10: 25% impact point for CMRm scenario (FCW)

The FCW and the AEB system are assessed with the tests with 50% impact point up to 60km/h. In case, the VUT react sufficiently to avoid the impact, the points for FCW should be validated.

The 25% of the vehicle width impact point is more challenging from a system point of view. Within the heavy traffic, there are greater chances to activate a false positive. Considering that information and the context of the ASEAN countries road traffic, it has been suggested to consider only FCW assessment for this impact point of this scenario.

3.1.2.2 CMFtap - Car-to-Motorcycle Front Turn Across Path

The scenario represents the VUT turning towards the driver side at an intersection with the AMT coming from the opposite direction and going straight within the intersection.

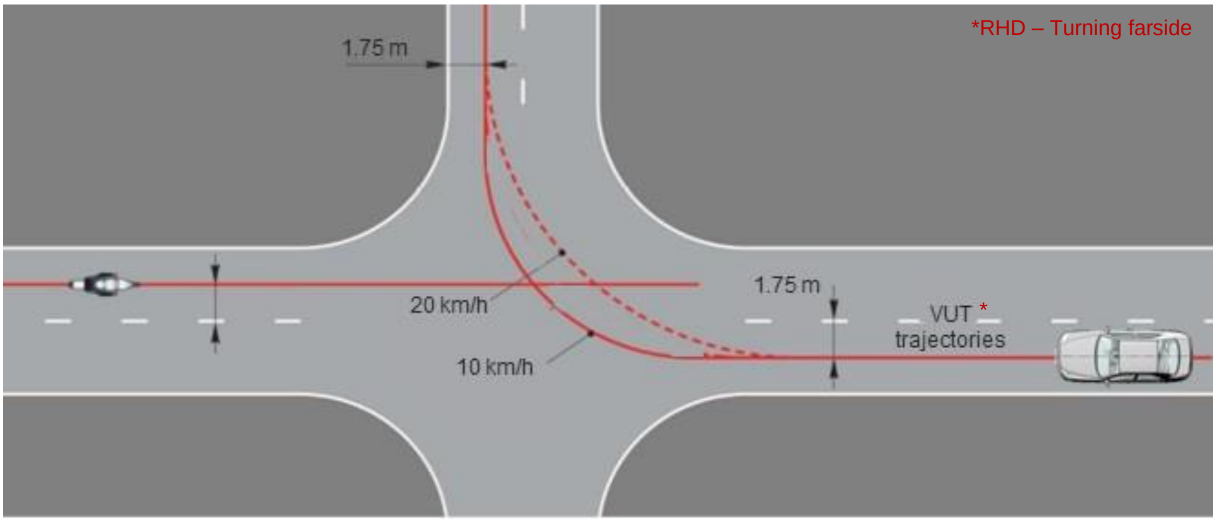


Figure 11: CMFtap 2026 scenario

Turning manoeuvres up to 20km/h represent half of the accidents observed, looking at the speed when the collision occurs. The configuration of the test was then firstly based on the test protocol *Euro NCAP AEB LSS VRU Test Protocol – v4.2* for the speeds and the related trajectories. The trajectories are limited by a relevant lateral acceleration within this kind of intersection. From the research on road dimensions in ASEAN region, the dimensions for 2-lanes intersection are relevant with the European intersection dimensions defined.

However, the first highlight of the accident data study is that the car speed is relevant to be integrated to the protocol up to 30km/h. Considering a 30km/h speed for the VUT, allows to cover 75% of the cases observed, as a relevant amount of collision speed is registered at 30 km/h.

In terms of feasibility, it brings an issue in terms of maximum lateral acceleration within an intersection of 2 ways-2 lanes roads. A literature review has been done to have more inputs about the road configurations and intersections in ASEAN countries through a focus on Thailand, Malaysia, and Indonesia (refer to the paragraph 4.2.1.2 Intersections for the main conclusions). It was decided to keep only 10 and 20 km/h as VUT test speed (with the same trajectories defined on 2way-2lanes from European intersection) as the inputs within the scope of OASIM are not sufficient to define the 30km/h trajectory, adapted to the wider intersections of the ASEAN countries.

From the data observed with the accident data study, the motorcycle speed is registered from 30km/h to 120km/h. Most of the cases happened at a high speed, the mean value of the collision speed is around 60km/h if we consider all cases, up to 72 km/h if we look at the KSI cases. However, the proposal is based on the feasibility for the ADAS system through Euro NCAP experience and has been defined between 30km/h and 60 km/h.

Therefore, the speed combinations are described as in Table 3 below.

Table 3: Speed combination for CMFtap

Speed (km/h)		AMT		
		30	45	60
VUT	10	AEB	AEB	AEB
	20	AEB	AEB	AEB

The impact location is in the middle of the front bumper of the passenger car and the front of the motorcycle. It has been defined according to the system action feasibility limits based on the discussions with the automotive industry and the experience from the existing other NCAP test. Around 30% of the impacts happened on the front (14% at the vehicle middle front bumper). It has been highlighted that part of the accident situations cannot be covered by an AEB systems. Indeed, the sides impacts implied that it is too late for the car to react and avoid the collision. In that case, the only possibility is a reaction from the motorcyclist to avoid the accident.

3.1.2.3 CMCrossing – Car-to-Motorcyclist Crossing

The situation of accident is represented by the VUT and the AMT driving straight and perpendicularly at an intersection.

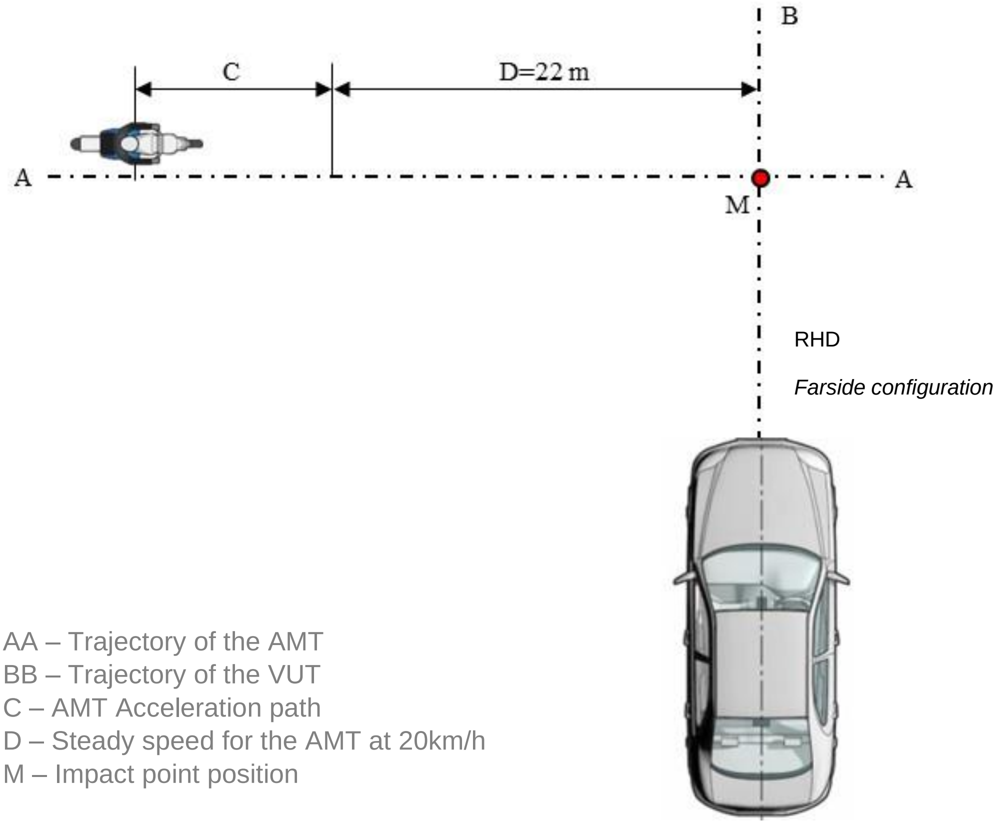


Figure 12: CMCrossing 2026 scenario

The speed combination suggested to be tested are: 20 km/h for the AMT and 20 to 60 km/h for the VUT. The vehicle speed should be tested with 10km/h steps, and reduced to 5 km/h steps if there is an impact.

Table 4: Speed combination for CMCrossing scenario.

Speed Km/h		AMT
		20
VUT	20	AEB
	25	AEB
	30	AEB
	35	AEB
	40	AEB
	45	AEB
	50	AEB
	55	AEB
	60	AEB

From the accident data study, most of the cases shows higher speed than 20 km/h for the motorcycle, with mean values for initial speeds and collision speeds between 40 and 50km/h. In terms of technological feasibility, the lowest speeds of AMT can be handled with conventional front sensing field of view. However, covering situations with higher speed of AMT mandates wider sensing field of view (with corner radar for example). Therefore, it was decided to integrate the situation at the lowest speed for the motorcycle as a first step in 2026 to address this accident situation.

As for the passenger car speed to be tested from 20 to 60 km/h, the accident data shows that most of the case are represented with speeds between 20 and 70km/h.
However, it was decided for the OASIM test scenario proposal for 2026 to lower the maximum speed of the VUT down to 60 km/h. Based on the time to collision (TTC), the AEB system would have to operate too early. This could bring false positive situations and the motorcycle could also decide to brake, therefore the vehicle braking would not be necessary.

The impact point has been defined following the study of the Thai in-depth data base, with three main situations identified:

Table 5: Main impact points observed in the accident data study for Crossing situation.

		
21.57%	29.41%	9.81%

The accidents cases with a frontal impact on the motorcycle cannot be addressed by the ADAS systems on the car as the motorcycle collide with the car.

Finally, the impact point to be tested are, with the motorcycle coming from the right or left side, the middle of the car front bumper collides with the middle side of the motorcycle:

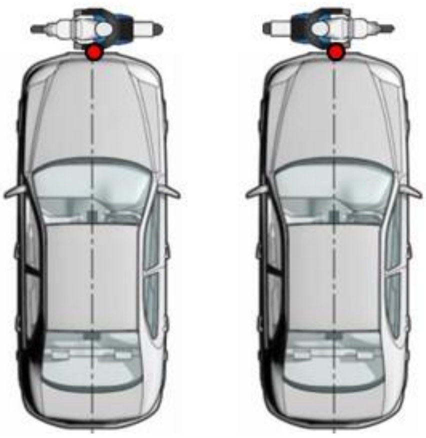


Figure 13: Impact points for CMCrossing test scenario

The side of the test and the number of configurations for each side should be under the final discussion of the ASEAN NCAP Assessment.

The Figure 12 represents the farside situation for Right-handed driven vehicle.

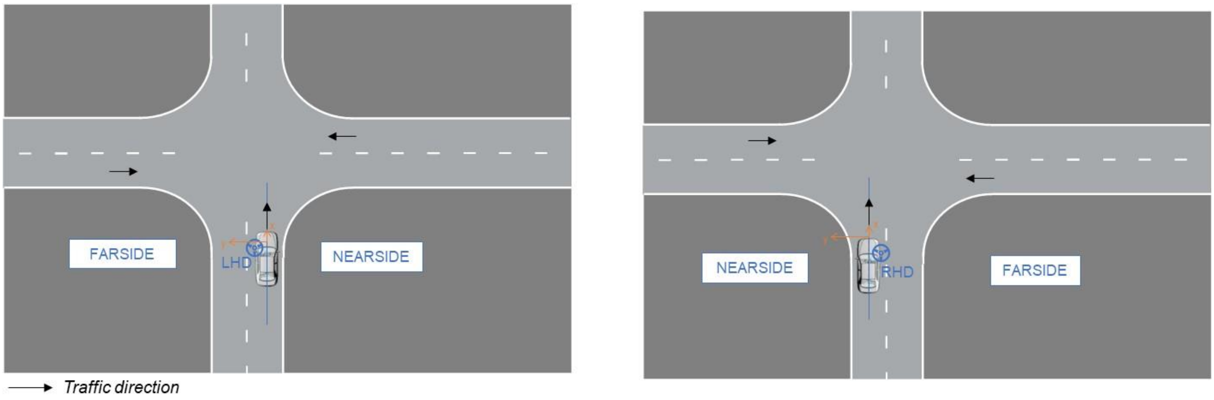


Figure 14: Farside and Nearside configuration for LHD (left figure) and RHD (right figure)

3.1.2.4 CMOncoming – Car-to-Motorcyclist Oncoming

The scenario represents the passenger car drifting into the lane of the motorcycle which is coming from the opposite direction. The test scenario is as below:

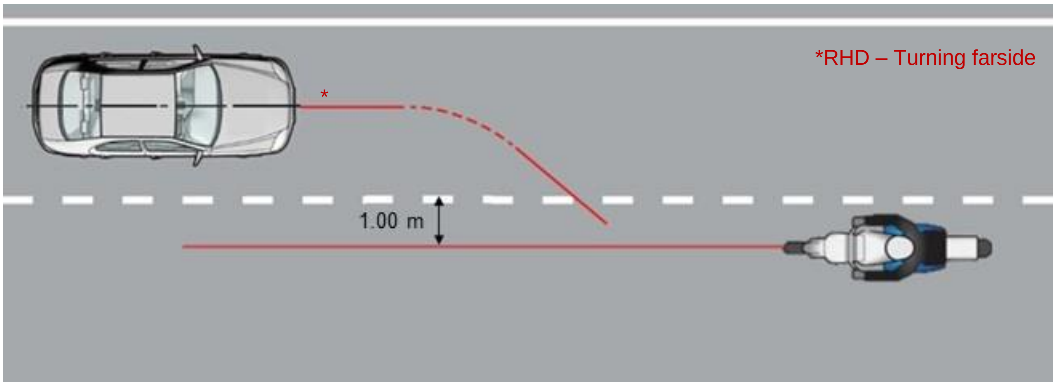


Figure 15: CM Oncoming 2026 scenario

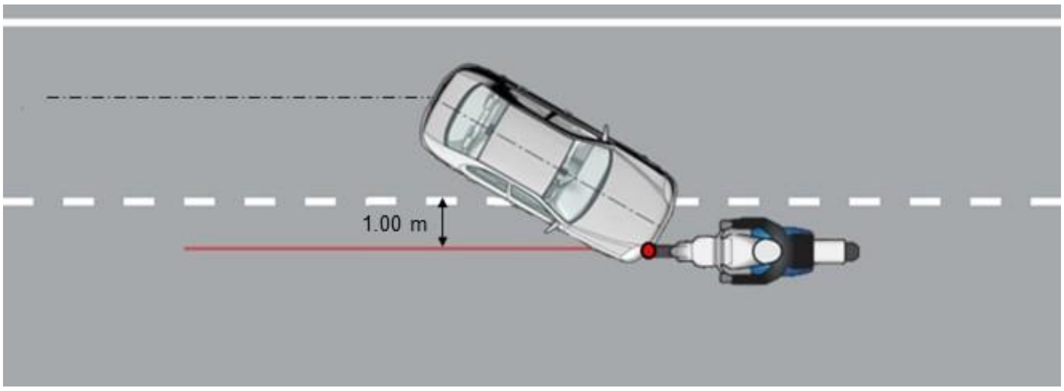


Figure 16: Impact point for CM Oncoming test scenario

The system to be assessed in that situation is a lane support system (LSS) as the vehicle is lead out of its lane with the motorcycle's. It was highlighted by the discussion that the heavy traffic and road condition may not allow a safe steering action from an ADAS system. Then the market may not be ready to integrate an active steering function. One requirement for the car is to have EPS (Electric Power Steering Control). In overall the system is not common on the market (only some OEMs) however it tends to increase in the market for the upcoming years.

Therefore, two options are suggested for the assessment. In case the technology for ELK action is realistic for 2026, the pass/fail criteria will be the collision with the target. Otherwise, an emergency warning could help in that situation to alert the driver that the vehicle drift over its travelling lane and a motorcycle is coming from the opposite direction. To assess the warning, the maximum intrusion (at the reference point) of the vehicle should be under 20 cm after the lane. The operator is authorized to take over the vehicle control when the maximum intrusion is 50 cm.

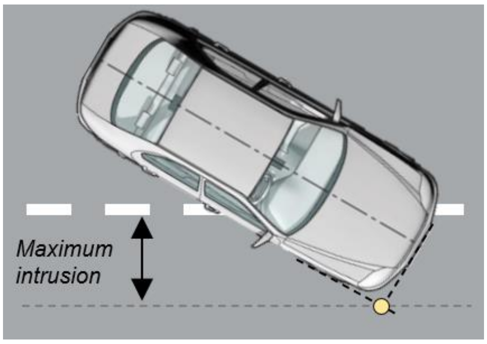


Figure 17: Maximum intrusion measure at VUT front bumper corner (RHD) for Oncoming scenario.

The warning can activate through different form, such as audible warning, haptic or input on the steering wheel, as long as it is proportional to the criticality of the situation. It should be an emergency warning. The objective is to avoid the impact therefore, the criteria of “no impact” should enable the maximum point in the assessment for this scenario.

The speed of the motorcycle has been defined at 60 km/h based on the mean value observed in the accident data study.

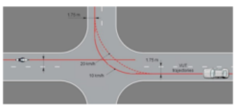
3.1.3 Conclusion

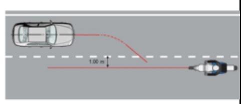
In conclusion, the test proposal for 2026 from the OASIM project is:

- 4 additional test scenarios to assessing AEB and LSS-ELK/LDW systems

Table 6 : Summary table of 2026 test scenarios and parameters

	CMRm		CMFtap	CMCrossing	CMOncoming
Paragraph	8.3.1		8.2.2	8.2.3	8.2.6
Type of test	AEB	FCW	AEB	AEB	LSS
VUT Speed [km/h]	40-60	40-80	(2026) 10,20	20-60	72
VUT direction	Forward		Farside turn	Farside and nearside	Farside
Target speed [km/h]	30,45,60		30,45,60	20	60
Impact location [%VUT width]	50	50 and 25	50	50 -50% motorcycle length	10
Lighting condition	Day		Day	Day	Day
Number of test	36 speed combinations (best case: 22 tests)		6 tests	9 speed combinations (best case: 5 tests)	4 – 5 tests





3.2 Test scenarios proposal for 2031

For the next update of the ASEAN NCAP assessment, the OASIM proposal would be to integrate three additional situations based on the most critical accident situations.

3.2.1 CMFtap - Car-to-Motorcycle Front Turn Across Path

The Car to Motorcycle front turn across path is partly assessed by the 2026 proposal. However, the accident data study shows that the vehicle speed is higher than 20 km/h. It would be relevant to add the 30km/h turn to cover 75% of the accident cases observed.

The first suggestion would be to add a higher VUT test speed: 30 km/h turning trajectory.

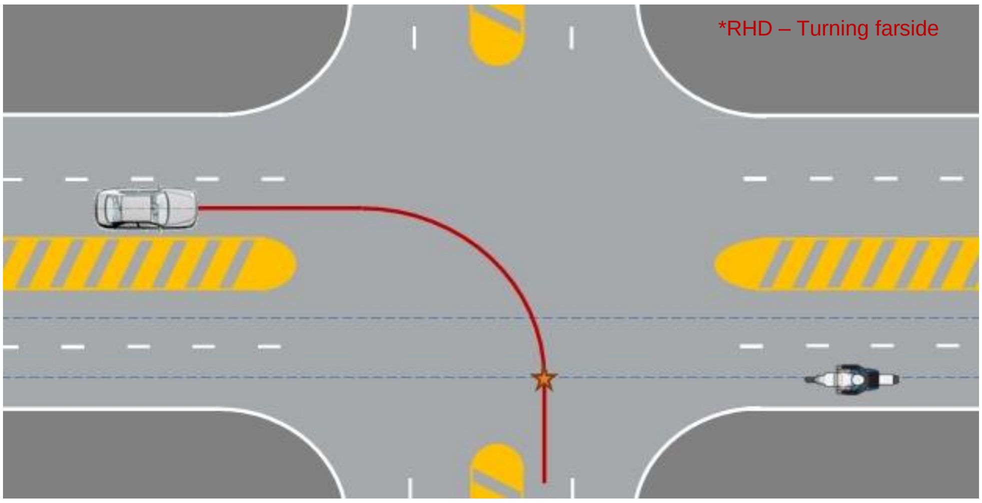
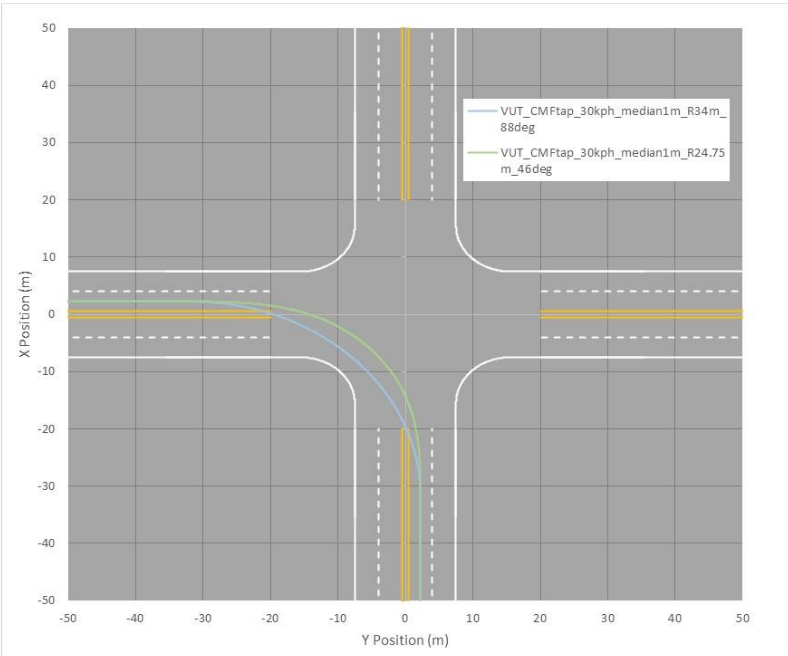


Figure 18: CMFtap 30km/h turn configuration

The 30km/h cannot be driven into the European type of intersection – 2 way – 2 lanes, limited by the lateral acceleration.



Test speed	Part 1 (clothoid)			Part 2 (cst radius)			Part 3 (clothoid)			
km/h	Start Radius R1 (m)	End Radius R2 (m)	Angle (deg)	Start Radius R2 (m)	End Radius R2 (m)	Angle (deg)	Start Radius R2 (m)	End Radius R1 (m)	Angle (deg)	Accel (Calculated)
10	1500	9	20.62	9	9	48.76	9	1500	20.62	0.86
15	1500	11.75	20.93	11.75	11.75	48.14	11.75	1500	20.93	1.48
20	1500	14.75	21.79	14.75	14.75	46.42	14.75	1500	21.79	2.09
30	1500	24.75	22	24.75	24.75	46	24.75	1500	22	2.81
30	1500	30.75	20	30.75	30.75	50	30.75	1500	20	2.26
30	1500	34	1	34	34	88	34	1500	1	2.04

Figure 19: Example of general parameters for the 30km/h trajectories.

For 30km/h, the value indicated are based on first step suggestion based on the test feasibility from the vehicle behaviour point of view with a maximum lateral acceleration as the main criteria, to be realistic. A natural driving study should be done to define a realistic complete trajectory for the test.

The point to be discuss relative to this speed are:

- The driver's naturalistic behaviour in that kind of intersection, to define a realistic trajectory
- The dimensions of the intersection and
- The motorcycle travelling lane

3.2.2 CMCrossing – Car-to-Motorcyclist Crossing

The Car to Motorcyclist Crossing test scenario proposal for 2026 allows to start addressing this accident situation with the current ADAS technology, around 40 % of the cases. However, the accident data study shows that most of the accidents happened in an intersection with obstructions. Therefore, to address this scenario is important to challenge the technological feasibility and integrate the scenarios with obstructions, represented by 60% of the cases.

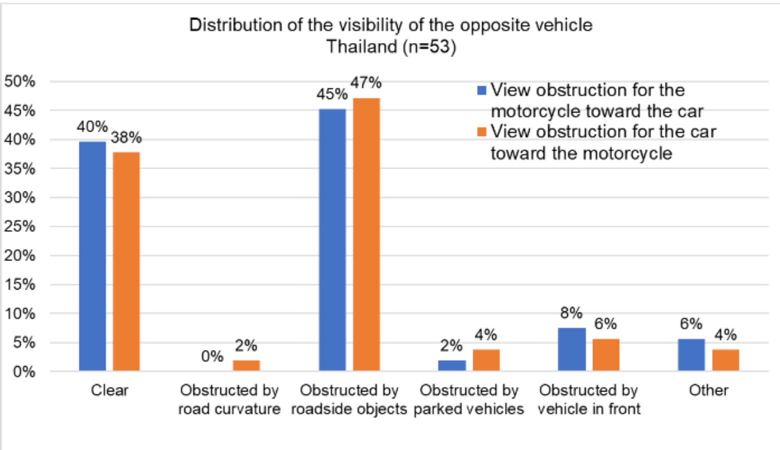


Figure 20: Distribution of the visibility and kind of obstruction for the Crossing scenario.

The obstructions observed are mostly roadside objects, such as walls, building, advertising post, and poll. The figures below show some example of accident scenes with obstructions.

Figure 21: Examples of obstruction on accident scene - walls and buildings.

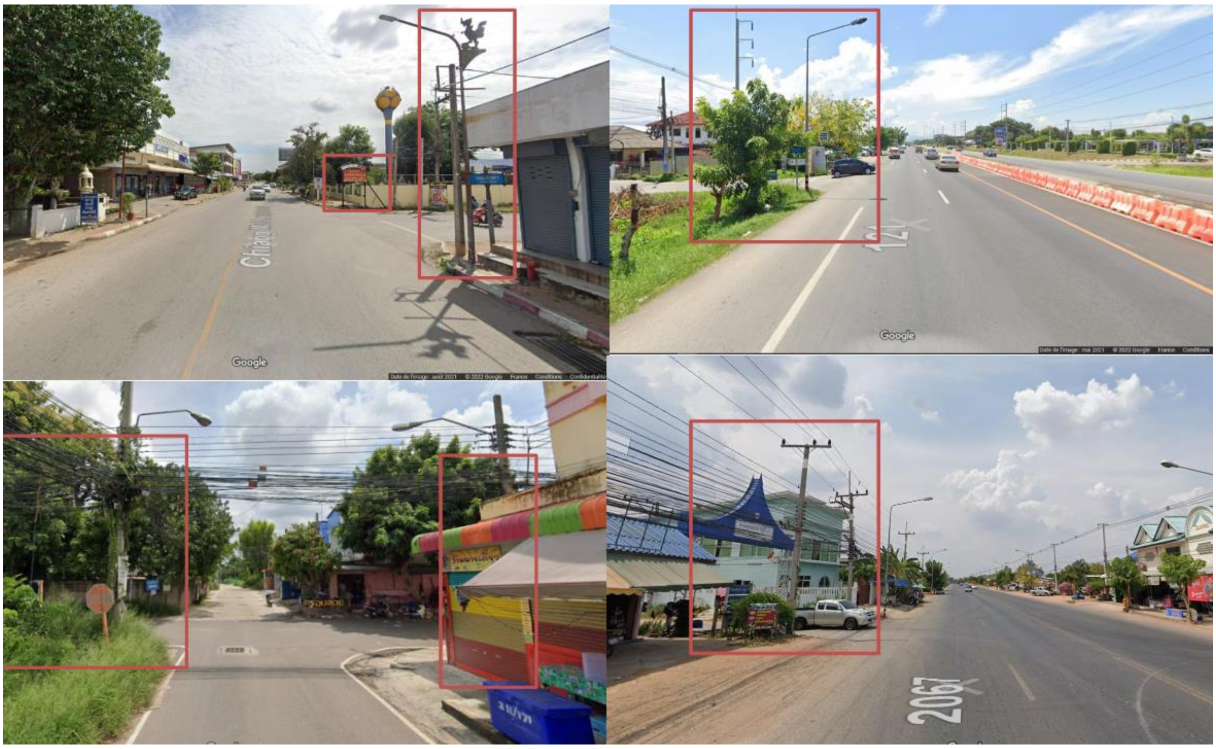


Figure 22: Examples of obstruction on accident scene - trees, post, poll.

3.2.3 CM Head-on – Car-to-Motorcyclist Head-on

The integration of the Car to Motorcycle Head-on scenario is mainly limited by the testing feasibility. The scenarios represent the car and the motorcycle coming from opposite directions and colliding front to front. The high speeds observed shows the criticality of the accident scenario and an emergency manoeuvre, such as an AEB system, would help reducing the consequences of the impact, by decreasing the relative impact velocity.

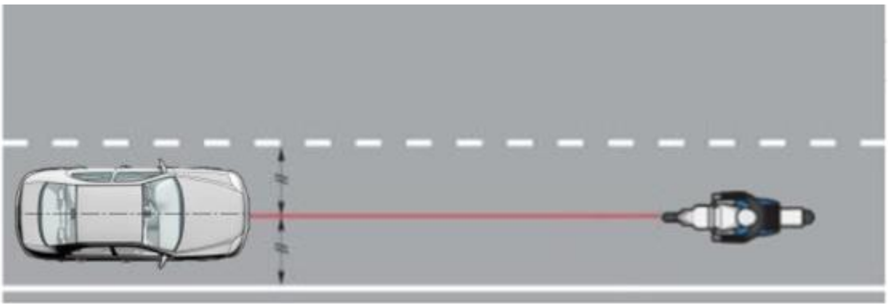


Figure 23: Car to Motorcycle Head-on scenario.

From the accident data study, the impact point is in most of the cases 100% overlap, meaning the front of the motorcycle impact the middle of the vehicle.

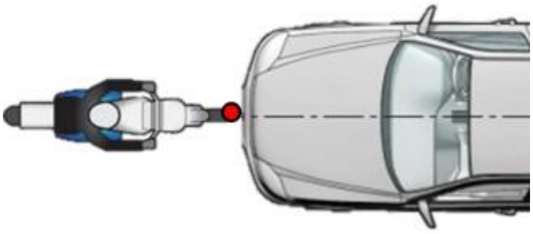


Figure 24: Impact point for CM Head-on scenario.

This scenario is leading to the collision of the vehicle whether the systems activate sufficiently or not, therefore the safety of the operator and the integrity of the vehicle and the target cannot be respective. The testing solution is to set up a limit when it agreed that the system cannot operate a sufficient reaction and that an avoidance manoeuvre can be carried out (for example 1.7 TTC).

As Euro NCAP integrated a similar situation within its Car-to-Car AEB Assessment, some testing experience should be taken within the upcoming year to be able to address it also for the ASEAN NCAP Motorcyclist Assessment.

From the accident data study, the speeds to consider as relevant for the vehicle are 55-60 km/h and for the target, 50-72 km/h. The impact point should be set-up on the front of the motorcycle to middle of the front bumper.

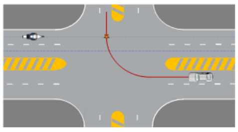
3.2.4 Conclusion

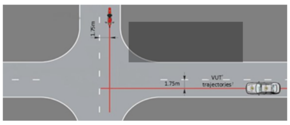
In conclusion, the test scenarios suggested to be introduced for the next update of the protocol are those 3 scenarios : updates on CMFtap and CMCrossing, and the addition of the Head-on scenario.
The items written in orange are the parameters to be defined with more inputs from additional accident data and naturalistic driving study, and test experiences.

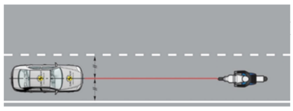
Table 7: Summary table of 2031 test scenarios and parameters

	CMFtap	CMCrossing	CM Head-on
Type of test	AEB	AEB	AEB / +
VUT Speed [km/h]	30	20-60	55-60
VUT direction	Farside turn	From farside and nearside	Forward
Target speed [km/h]	30,45,60	>20	50-72
Impact location [%VUT width]	50 Lane of the motorcycle	50 -50% motorcycle length	50
Lighting condition	Day	Day	Day
Obstruction	No	YES	No
Feasibility			
Comment	Investigate higher speed for VUT 30km/h and intersection configuration	Second step of the crossing scenario integration	Main issue is the test feasability High relative speed

Feasability	
	Feasible
	Complicated
	Highly complicated







The scenario feasible mean that it can be addressed by the ADAS systems with conventional sensors, however more information and study to set the CMFTap configuration at 30 km/h (with naturalistic driving study for example).
The complicated scenario mean that the scenario could be addressed with conventional sensors, used for ADAS systems however they are still very challenging for ADAS systems, or testing issues.

3.3 Upcoming assessment updates

Within the scenarios identified as not being addressable by the ADAS within the foreseen future, there are the 7 left scenarios out of the 12 most common one studied.

Some of them are similar to test scenarios introduced within the OASIM proposal for 2026 and the next update of the ASEAN NCAP Assessment. Therefore, these scenarios with more experiences and adapted technologies could be feasible integrated to the test for the ADAS systems to cover more accidents. Those cases should be under discussion for the test roadmap within the upcoming years. Two situations have been identified as such:

- The (#2) Turning scenario, Right Turn Into Path – Perpendicular Direction situation is similar to crossing and CMFTap. The vehicle is turning right and encounter the motorcycle coming perpendicularly at its right. Based on the accident data study, it would be relevant to test the situation with the 20 km/h VUT turn. The target speed should be included between 40 km/h and 70 km/h. Finally, the conduct of the test scenario should lead to an impact on the front right part of the vehicle, with a 20°-40° impact angle with the target. Test parameters should take those inputs into consideration.
- (#3) Turning scenario, Right/Left Turn Across Path – Same Direction, is also representing the vehicle turning right while the motorcycle tries to overtake it. In that case, the turning manoeuvre would be more representative of the accidents at 30 km/h and the motorcycle speed would high, between 50km/h and 70 km/h. The scenario is

challenging due to the speeds and also the fact that is happened mostly in city streets and intersections. This scenario is important to address as it represents in terms of KSI, the next more important accident after (#1), (#9) and (#4).

Their proportion of KSI is higher than their proportion in all the accidents.

Then, within the head-on situations observed, two additional situations could be discussed with the experience of the Car-to-Motorcycle Head-on test scenario. These scenarios could be complicated to assess with current ADAS system as the time for detection would be too short. It should be considered similar to Car-to-Motorcycle Head-on test scenario with obstruction.

- (#6) Head-on scenario, opposite direction -lane change motorcycle manoeuvre
- (#7) Head-on scenario, lane change vehicle manoeuvre-opposite direction

Finally, three situation seems highly difficult to cover with ADAS systems integrated in the vehicle, even within the upcoming years:

- (#10) Car-to-Motorcycle Cut-in scenario, representing the motorcycle doing a lane manoeuvre in front and within the lane of the vehicle.
  Motorcycle manoeuvre complicated to define. Moreover, based on the accident data study and looking at the impact point, it shows a last-minute lane change manoeuvre, and it would be really difficult for the system to react.

- (#8) Turning scenario, straight path-right turn across path–same direction
  This scenario would be rear-end scenario with an offset and motorcycle doing a last minute manoeuvre to turn right.

- #5 Head-on scenario, Straight Path –Opposite Direction (case: motorcycle enters car lane). The situation is similar to head-on scenario however the accident is due to the motorcyclist fault and is highly complicated to be addressed by the ADAS systems.

In conclusion, the seven scenarios defined as not being addressable by the ADAS systems with the next two updates of the ASEAN NCAP assessment and should be discuss within the years are:

Table 8: Summary table of the scenarios to be considered for >2031 updates of the ASEAN NCAP Assessment

	Turning scenario, Right Turn Into Path – Perpendicular Direction	Turning scenario, Right/Left Turn Across Path – Same Direction	Head-on scenario, opposite direction - lane change motorcycle manoeuver	Head-on scenario, lane change vehicle manoeuver - opposite direction
Type of test	AEB	AEB	AEB / FCW	AEB / FCW
VUT Speed [km/h]	20	30	60	60-90
VUT direction	From farside	From farside and nearside	From farside	From farside
Target speed [km/h]	40-70	50-70	60	50-60
Impact location [%VUT width]	Front right 20-40°	Side right (wheel) 0-20°	50	50 10°
Lighting condition	Day	Day	Day	Day
Obstruction	No	No	Yes	Yes
Feasability				
Comment	Similar to crossing (CMCrossing) and turning (CMFtap)	In complementary to BSD Similar to BSD and turning (CMFtap)	Half of the accident with obstruction / half clear	

*adapted to the timeline and expactations

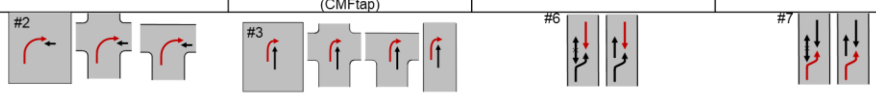
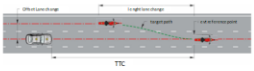
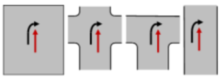
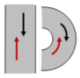


Table 9: Summary table of the accident scenarios too complicated to adress by the ADAS systems

	Car-to-Motorcycle Cut-in scenario	Turning scenario, straight path - right turn across path – same direction	Head-on scenario, (case: motorcycle enters car lane)
Type of test	AEB	AEB	AEB / +
VUT Speed [km/h]	70-80	10-40	55-60
VUT direction	Forward	From farside	Forward
Target speed [km/h]	40-60	50-70	50-72
Impact location [%VUT width]	Dépend of the manœuvre of the motorycle Front left of the VUT / right side of the M	Front Right side (wheel) 0-10° up to 60°	100%
Lighting condition	Day	Day	Day
Obstruction	No	No	No
Feasability			
Comment	Motorcycle manoeuvre complicated to define Impact point shows the last minute lane and it would be really difficult for the system to react.	Motorcyclist fault	Similar to head-on scenario but motorcyclist fault

Additional information about the feasibility scale here:

- « Feasible » in green entailed that the scenario could be addressed with conventional sensors, used for ADAS systems. However, it will need discussions and development.
- « Complicated » in orange mean that the scenario could be addressed with conventional sensors, used for ADAS systems however they are still very challenging for ADAS systems, or testing issues.
- « Highly complicated » in red, can be reviewed in case of new technologies however it doesn't seem addressable by ADAS systems with conventional sensors.

4 Test execution

4.1 Test equipment

To reproduce the accident scenarios, the test is defined with parameters such as the speeds and the trajectories of the vehicle. By its definition, the test must be representative of a real accident situation between the car and a motorcycle. Therefore, it is defined such as if the ADAS system from the vehicle doesn't react to the situation, the vehicles collide with each other. In this report, we refer to the VUT as the vehicle under test and the AMT as the motorcyclist target.

The target includes a dummy, representative of the most common motorcycles within the ASEAN countries market, and a platform as the propulsion system for the dummy. The target requirements are to be cashable and to respect some dynamic parameters to reproduce the test with accuracy. The target replicates the visual, the radar reflexion and LIDAR attribute of the real motorcycles. To have more details about the target, refer to *D2.1 – Target Specifications* [1].

Figure 25: AMT - ASEAN Motorcycle Target dummy

The vehicle is equipped with driving robot the reproduce with accuracy the test scenario and presented to all the vehicles assessed the similar and repeatable situation. For more details about the parameters defined and the tolerances to be respected to define the test as valid and accurate, refer to the paragraph 4.3 Test execution.

The target and the VUT are synchronised. To drive the vehicle within the right trajectories synchronised with the target, driving robots are installed controlling the accelerator pedal, the braking pedal, and the steering wheel.

See [1] with the data recording requirements from the equipment.

4.2 Test conditions

4.2.1 Track conditions

This part sum-up the research made on the road condition in the ASEAN region. The road configurations for each accident scenarios have been studied through the details from the accident data study and a literature review have been carried out to complete the information and represent most of the countries.

4.2.1.1 Highways

Highway classification have been studied from the United Nations Economic and Social Commission for Asia and the Pacific (https://www.unescap.org) databases, as well as the number of lane and the width of the roads.

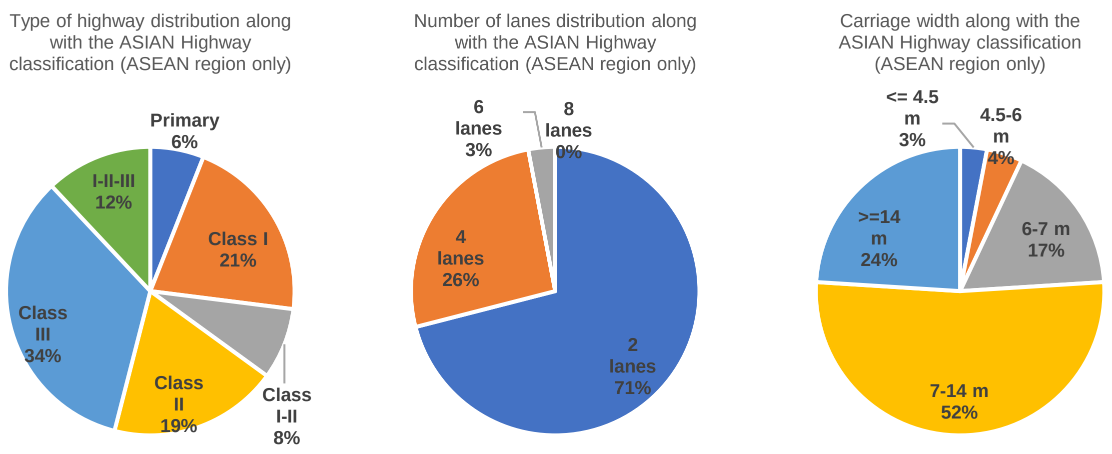


Figure 26: Road characteristics based on UNESCAP databases.

Then the lane markings have been studied based on the Guidelines for Geometric Design of Roads and on Traffic Control and Management device from Malaysia, and on Standard Drawings for Highway Design and Construction from Thailand. The documents list the different type of lane markings. The guidelines also described the dimensions of the roads and the lane width. It was compared to other studies from Cambodia and Malaysia. The width of the lane of 3.5 m is relevant with the actual road status.

As for the lane markings, a comparison with the European regulation and the Euro NCAP protocol indications, show that there no significant differences on the dimensions. However, a remarque is made on the fact that the centreline lane markings may be made with the yellow colour and not white, that could be more challenging for the systems.

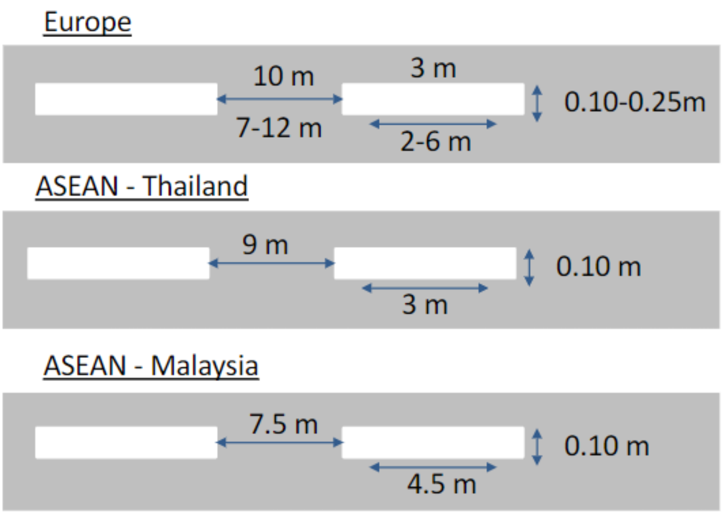


Figure 27: Lane marking dimensions comparison Europe, Thailand, and Malaysia.

4.2.1.2 Intersections

A focus has been done on the study of the intersection in ASEAN countries following the integration of higher speed for the vehicle doing a turning manoeuvre for the CMFtap scenario.

Referring to the real accident cases observed in the Thai database, this accident situation (#1) occurs mostly on urban and suburban roads, with more than half on city streets and a third on highway roads. Respectively the number of lanes observed for this configuration within this accident data study are 4-6 lanes and 2-4 lanes.

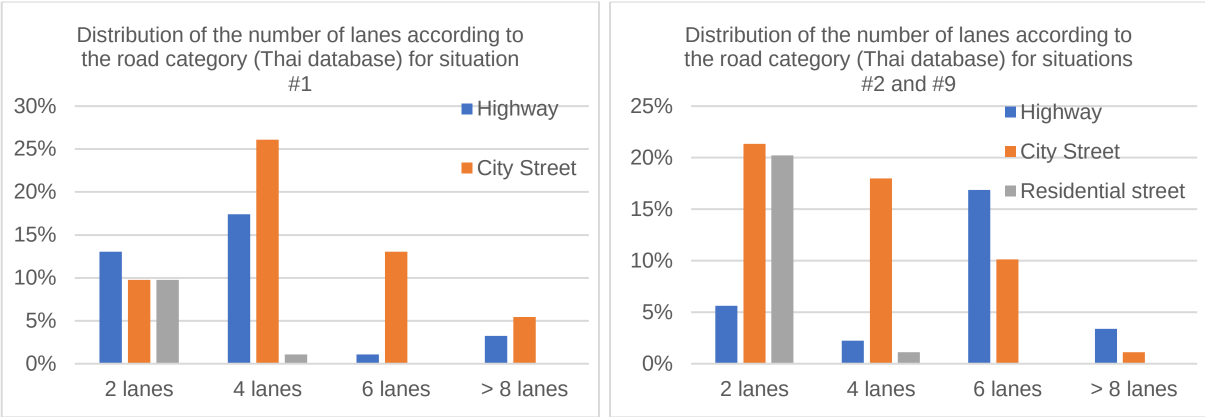


Figure 28: Distribution of the number of lanes for accidents situations #1,#2 and #9 (main accidents in intersections).

Looking at all the accidents occurring mainly in intersection within the 12 most common scenarios studied (#2 and #9), the configurations of the roads are distributed with the same proportion between 2 and 4 lanes.

The conclusion is that the 4-lane configuration has an impact on the conduct of the CMFtap scenario and would need a more details study on the state of the art on the road conditions and the road users behaviour in these kind of intersections.

4.2.2 Light conditions

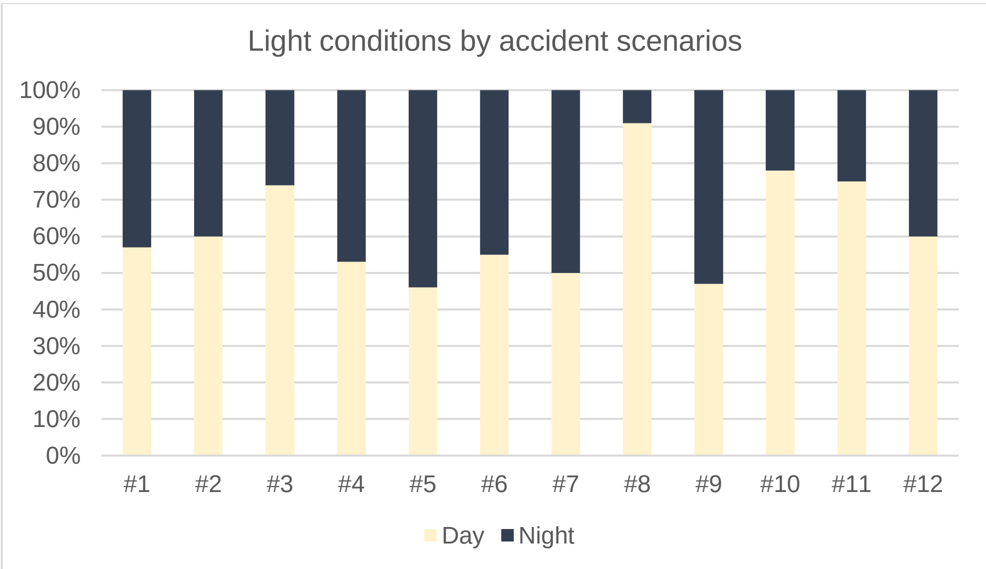


Figure 29: Light conditions, day or night, by accident situations.

For the first integration of the test scenarios with the 2026 test proposal, as most of the accidents happened during the day, the tests should be assessed within daylight.

As in the future updates of the protocol, some scenarios should be assessed with night condition tests. From the accidents observed, the main relevant scenarios are also the 2026 test scenarios (#1, #4, #5 and #9).

4.2.3 Weather conditions

More than 90% of the accident's cases studied happened with a clear weather on dry road surface. The assessment of the vehicles must be in similar conditions.

Boundaries should be defined to have the same situation for all the vehicles. Based on the other NCAPs protocol, the weather boundaries to carry out the tests are:

- Conduct tests in dry conditions with ambient temperature above 5°C and below 40°C.
- No precipitation shall be falling and horizontal visibility at ground level shall be greater than 1km. Wind speeds shall be below 10 m/s to minimize AMT and VUT disturbance.
- Natural ambient illumination must be homogenous in the test area and in excess of 2000 lux for daylight testing with no strong shadows cast across the test area other than those caused by the VUT or AMT. Ensure testing is not performed driving towards, or away from the sun when there is direct sunlight.

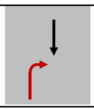
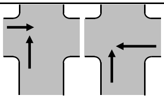
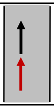
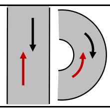
Therefore, the condition should assure a dry road surface, without rains and without wind that could disturb the sensors and the proper functioning of the testing tools such as the AMT platform.

4.3 Test execution

The OASIM project has written a proposal for the next assessment protocol. In order to support a better integration of the proposal and for standardization purposes, a procedure has been written respecting the previous ASEAN NCAP protocols.

5 Conclusion

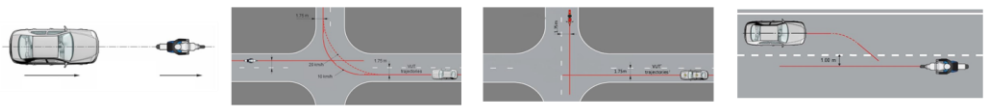
The accidents situations expected to be addressable by the ADAS systems by 2026 have been identified within the 12 most relevant accidents scenarios based on the accident data study (WP1). They have been defined in four test scenarios based on the details from the Malaysian and Thai databases. It allows to cover around 30% of the accidents between a motorcycle and a passenger car.

All accidents	14.6%	8.3%	3.6%	4.1%
KSI	14.8%	7.4%	5.3%	3.6%
Pictogram	 1	 2	 3	 4

Therefore, the test scenarios are:

- **Car to Motorcycle Front turn across path (CMFtap)**, representing the first accidents in terms of KSI, where the VUT is turning farside (right for Right-Handed driving) colliding with the AMT coming straight from the oncoming direction. The trajectories have been based on Euro NCAP TEST PROTOCOL - AEB/LSS VRU Systems Version 10.0.5, December 2021).
- **Car to Motorcycle Crossing scenario (CMCrossing)**, representing the VUT and the AMT coming from perpendicular direction and colliding in the middle of the VUT front bumper and middle length of the AMT.
- **Car to Motorcycle Rear-end Moving (CMRm),** representing the VUT and the AMT going into the same direction and the VUT impacting the rear of the motorcycle.
- **Car to Motorcycle Oncoming (CMOncoming)**, representing the VUT drifting into the lane of the AMT and colliding front to front. The trajectories of the VUT have been defined according to Euro NCAP TEST PROTOCOL - AEB/LSS VRU Systems Version 10.0.5, December 2021).

	CMRm 3		CMFtap 1	CMCrossing 2	CMOncoming 4
Paragraph	8.3.1		8.2.2	8.2.3	8.2.6
Type of test	AEB	FCW	AEB	AEB	LSS
VUT Speed [km/h]	40-60	40-80	(2026) 10,20	20-60	72
VUT direction	Forward		Farside turn	Farside and nearside	Farside
Target speed [km/h]	30,45,60		30,45,60	20	60
Impact location [%VUT width]	50	50 and 25	50	50 -50% motorcycle length	10
Lighting condition	Day		Day	Day	Day
Number of test	36 speed combinations (best case: 22 tests)		6 tests	9 speed combinations (best case: 5 tests)	4 – 5 tests



The main associated parameters improvement identified are based on two of these scenarios with aspects that could not be covered in 2026. Concerning the scenario CMFTap, the first proposal covers only 10 and 20 km/h vehicle speeds however the accidents observed shows that it would be relevant to test the 30km/h. It was also identified that part of the intersections in ASEAN region are wider with more than lane, and where higher speed could be done for the turning manoeuvre. A naturalistic driving study should be done to define a realistic trajectory of this speed. The study should be expanded to observe the motorcycle behaviour in that kind of intersection to identify the impact point. The second scenario related to the update suggestions is the CMCrossing. The 2026 cover lower speeds of the motorcycle due to technologies feasibilities however the accident data shows that it would be relevant to cover higher speeds than 20 km/h. As well, the configuration with obstruction should be included. For the scenarios to be included in second step, the head-on scenario is one of the most relevant situations in which AEB could help avoid and reduce the consequences of such accidents. However, this scenario is challenging and as introduce in Car to Car Euro NCAP protocol, the future experience will be necessary to include this scenario in second step.

Another recommendation based on the ASEAN NCAP existing protocol from 2021, would be to improve the current scope of the test with a vehicle manoeuvre during the overtaking test to also assess a steering action to keep the vehicle in its lane. In that case, the trajectories should be based on Euro NCAP trajectories adapted to the ASEAN countries specific road traffic with relevant studies if necessary.

Other axes of test improvement are the weather (with the rain and after rain conditions), the light conditions (night condition) and to consider the left turning accident situations.

In conclusion the proposal for 2026 ASEAN NCAP Assessment and the recommendation the oncoming updates can be sum-up within the following roadmap:

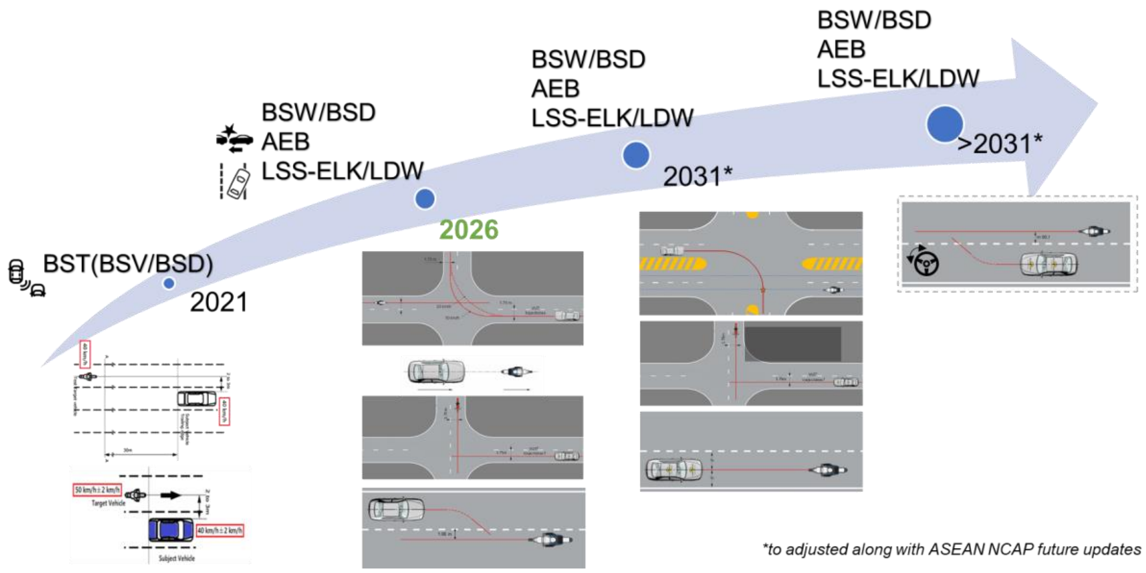


Figure 30: Final OASIM proposal Roadmap for ASEAN NCAP Motorcyclist Assessment.

6 Bibliography

[1] OASIM D2.1 Accident Parameters Description, 2023. [Online].

[2] Euro NCAP ASSESSMENT PROTOCOL – VULNERABLE ROAD USER PROTECTION, Version 10.0.5.

[3] Euro NCAP TEST PROTOCOL – AEB Car-to-Car systems, Version 3.0.3.

[4] Euro NCAP TEST PROTOCOL - AEB/LSS VRU Systems, Version 10.0.5.

[5] Euro NCAP TEST PROTOCOL – Lane Support Systems, Version 3.0.2.

[6] Euro NCAP TEST PROTOCOL – AEB Car-to-Car systems, Version 4.1.

[7] Euro NCAP TEST PROTOCOL – Lane Support Systems, Version 4.1.

[8] ASEAN NCAP OVERALL ASSESSMENT PROTOCOL, Version 2.1.

[9] ASEAN NCAP Assessment Protocol Safety Assist, Version 2.0.

[10] MIROS, *ASEAN NCAP ROADMAP 2021-2025,* 2018.

[11] ASEAN NCAP ASSESSMENT PROTOCOL - MOTORCYCLIST SAFETY, Version 1.2.

[12] Latin NCAP ASSESSMENT PROTOCOL – OVERALL RATING, Version 1.1.2.

[13] Latin NCAP ASSESSMENT PROTOCOL – SAFETY ASSIST, Version 1.1.2.

[14] Latin NCAP TESTING PROTOCOLS, Version 1.1.0.

[15] CATARC C-NCAP Management Regulation, 2018.

[16] UNESCAP INTERGOVERNMENTAL AGREEMENT ON THE ASIAN HIGHWAY NETWORK, 2004.

[17] A. Ahmed, A. F. M. Sadullah and A. S. Yahya, *Field study on the behavior of right-turning vehicles in Malaysia and their contribution on the safety of unsignalized intersections,* Pulau Pinang, Malaysia: Article in Transportation Research Part F Traffic Psychology and Behaviour, 2015.

[18] Kingdom of Thailand – Ministry of Transport Department of Highways, *Standard Drawing for Highway Design and construction,* 2015 Revision.

[19] Japan international cooperation agency Katahira & engineers international, *Preparatory survey for national road no. 5 improvement project (prek kdam- thlea ma'am section) in the Kingdom of Cambodia- final report,* Ministry of public works and transport (MPWT); The royal government of the kingdom of Cambodia, 2013.

[20] Road Engineering Association of Malaysia, *A Guide on Geometric Design of Roads,* 2000.

[21] Road Engineering Association of Malaysia, *Guidelines on Traffic Control and Management Devices – Part 4 Pavement Marking and Delineation,* 2004.

[22] U. Nations, *Addendum: 129: Regulation: 130,* 2013.

[23] OASIM D1.1 Accident Scenarios Description, 2021.

[24] OASIM D1.2 Accident Parameters Description, 2021.

7 Figures and tables