Powered Light Vehicles:
Challenges and Opportunities for Low Carbon L-Category Vehicles in the UK

Module Four: Powered Light Vehicle Safety

Final Report
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Micro Vehicles Chapter Four

LowCVP Project Manager
Jonathan Murray,
Policy and Operations Director, LowCVP

Primary Module Contributor(s)
Christophe Bastien & Huw Davies
- Coventry University

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Cover Image source: still from 2014 Renault Twizy 80 Crash Test Video by Euro NCAP

Project Brief:

The L-Category vehicle sector has been identified as offering economic, environmental and societal benefits. However, the UK currently lags behind other countries in exploiting the advantages of this transport sector. Following a LowCVP seminar and workshop on the subject, it was agreed that further work would be worthwhile, to explore L-Category vehicles' potential in greater detail. The primary focus was to be around the larger three and four-wheeled L-Category vehicles, dubbed **Powered Light Vehicles (PLVs)**, as Powered Two-Wheelers (PTWs), such as motorbikes and mopeds, are already established markets in the UK.

A consortium of specialists from seven UK universities have come together to produce a series of reports, pro bono, in conjunction with the LowCVP's Innovation Working Group and including input from stakeholders to ensure relevance.

These reports are not intended as an end in themselves, but instead to act as a spur to action: to build the UK's capability in ultra-light automotive engineering and to provide conditions which support the market for micro vehicle uptake.

For more information about the LowCVP and the Partnership's work on Powered Light Vehicles visit:

LowCVP.org.uk/PLV

All L-category vehicles must meet functional safety requirements (*European Union, 2013*), but crash safety is not covered. This module proposes a set of crash test assessment criteria which are appropriate for ‘car-like’ L-category powered light vehicles.

Defining ‘car-like’ can be problematic (*TRL, 2008*). On one hand, many L7e quadricycles are obviously ‘car-like’ and so could be assumed to be essentially small M1 cars by consumers. On the other hand, L-category also encompasses a wide variety of extremely lightweight three- and four-wheeled designs, including those which have more in common with motorcycles or even pedal cycles. Such vehicles can be safer alternatives to conventional motorbikes or bicycles but imposing ‘car-like’ crash requirements on them would be inappropriate.

The intention in the near to medium term is that the protocols proposed in this module enable the creation of a market for safety, rather than mandate a set of legal requirements. ‘Car-like’ vehicles which pass the test(s) can be promoted and labelled accordingly.

4.1 Landscape of vehicle safety (1970 – 2016)

Motor vehicle safety on the roads has greatly improved in the past 40 years. Statistics have shown that the number of fatalities per billion kilometres travelled has reduced by around 80% since 1970 (*International Transport Forum, 2013*), as illustrated in Figure 4.1.

These improvements in the safety statistics have been achieved thanks to concurrent and complementary engineering approaches:

1. The enhancement of the vehicle structure strength to reduce the level of intrusion into the occupant safety space.
2. The management of decelerations and forces exerted on the occupant.
3. The enhancement of the vehicle structure stiffness for ride and comfort handling.

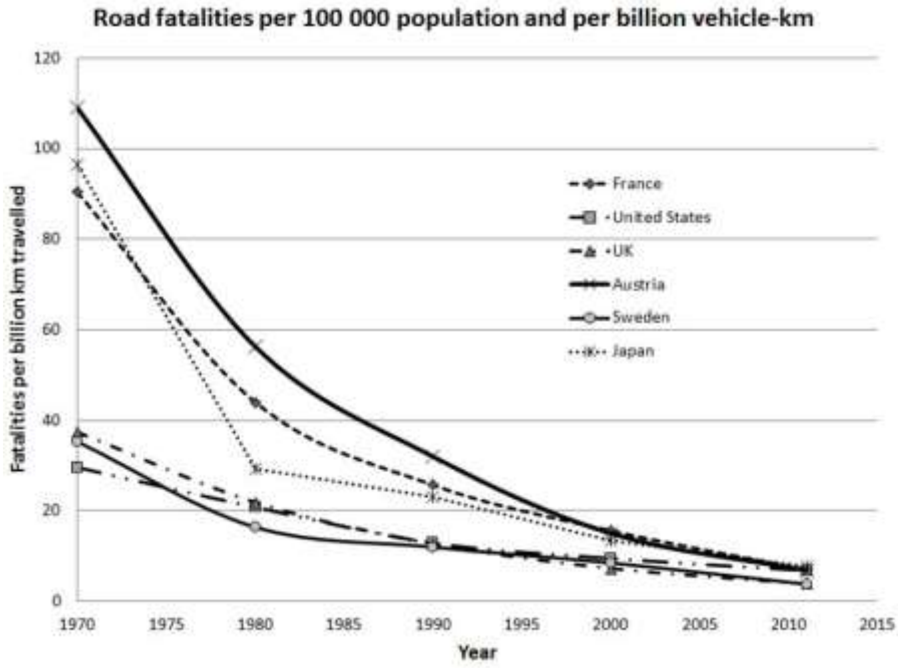

FIGURE 4.1: ROAD FATALITIES (1970 – 2010)

These improvements have been influenced by the introduction of better passive safety measures, which limit structural intrusions in the occupant compartment, as well as improved coupling of the occupant with the seat which has the effect of enabling a better engagement with the airbag system (*Stubbs, 2013*), (*NHTSA, 1998*) as well as mitigating occupant ejection (*Crandall, 2013; Neal-Sturgess, 2013; NHTSA, 2013a*). It is also suggested that speed management and effective drinking and driving policies have reduced fatalities by nearly half between 2000 and 2010 (International Transport Forum, 2013). It is therefore proven that engineering, speed management, drinking and policing approaches can have a positive outcome in the reduction of occupant injuries.

In meeting public policy objectives to reduce road traffic injury and fatalities, the focus has been primarily on M-category passenger cars, which currently dominate the market. This is based on the results of accident analysis that show impacts involving these vehicles account for the majority of injury accidents (excluding vulnerable road users). As a result, M-category vehicles are now subject to a suite of crash tests to assess occupant protection. This has accelerated the roll out and up take of a variety of engineering led technical features – airbags, pre-tensioner for seat belts, crumple zones, higher strength structural steels, etc.

L-category powered light vehicles are not subject to the same regulatory regime. EU Regulation 168/2013 stipulates requirements for functional safety, but crash testing is not required. PLVs often have few safety features, consequently drivers of such vehicles could be at a higher risk within the current fleet of vehicles present on the road.

The main aim of this module is to select the necessary engineering protocols which would provide PLVs with an appropriate level of occupant safety whilst considering engineering cost, retail price, production volumes and functionality. The Gantt chart in the appendix of this module (*figure 4.7*) suggests a timeline for realisation.

4.2 Initial Proposal for the Assessment of L-category Vehicles

4.2.1 ACCIDENT STATISTICS

By considering the collision types and frequencies recorded in the US Fatality Analysis Reporting System database (FARS), GIDAS (*German In-Depth Accident Study)* and STATS19 (UK accident, casualties and vehicle tables from the Department for Transport), it can be observed that most fatalities are present in frontal impact, followed by side, as depicted in Figure 4.2. It can be noted that in the US, rollover is more common that in Europe while rear impacts occur more frequently in Europe.

Consequently, for the introduction of PLVs, the focus on safety must be based on the most frequent accident modes. It is proposed to include frontal and lateral as the core modes of safety design requirements, while rear and rollover should be initially monitored and reviewed for potential future safety implementations.

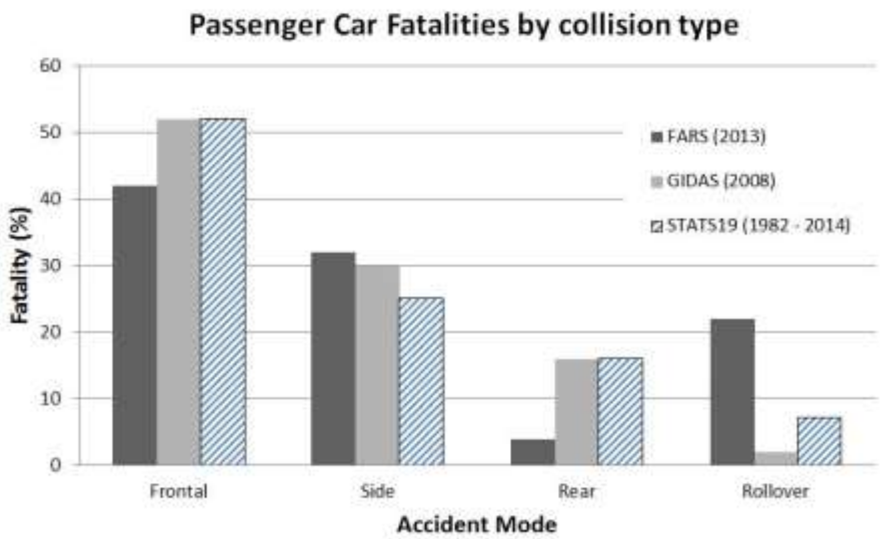

FIGURE 4.2: PASSENGER CAR FATALITIES BY COLLISION TYPE (PERCENTAGE)

There is very little information about the safety performance of L-category powered light vehicles. Renault's Twizy performed fairly well in consumer frontal and lateral impact tests (EuroNCAP, 2014); however, Renault is a major OEM and has considerable engineering resources compared to small L-category vehicle manufacturers. It is also not yet known whether the tests performed by EuroNCAP are representative of the accident scenarios that PLVs will encounter in the real world.

What is certain is that in the short to medium term, even if there was significant growth in the PLV sector, they would represent only a small proportion of the overall vehicle fleet. This would infer that in an accident the smaller PLV would impact vehicles which are larger and heavier. Whilst additional research will be needed to investigate the accident patterns of L-category powered light vehicles in the future, initially a balanced approach of vehicle assessment is proposed, first to address vehicle intrusions as a key parameter to maximise the chances of occupant survival in case of accident with a heavier and bigger opponent.

These intrusion levels will be assessed for the following 2 load cases referenced in Figure 4.2:

- Frontal impact
- Side impact

Rear impact is the 3rd most common mode of accident in Europe, hence as the proposal will aim to address some levels of safety in this accident scenario. There are to date no legal safety requirements for rear high-speed impact, as well as consumer requirements, consequently efforts in protecting the occupant in whiplash is necessary, because of the frequency of rear impact which do occur (16%), as depicted in Figure 4.2.

4.2.2 Frontal impact and compatibility

The PLV must have some frontal impact energy dissipation capabilities. The impact energy is based on the impact speed of the vehicle, hence the kinetic energy which is the mass of the vehicle multiplied by the square of the vehicle velocity.

Consequently, L-category powered light vehicles could be subjected to the UNECE 94 front crash test (*UNECE94, 2016*), which uses a 40% offset deformable barrier (ODB), impacting at 66km/h. Some research has now shown that a 20% overlap was causing structural load in the ‘A’ pillar and was a more severe structural integrity test than standard legal and EuroNCAP (*IIHS, 2012a*). As a result, more research is necessary on PLV future accidents to confirm whether any change of overlap from the standard testing is necessary.

The problem of performing such a frontal test is that the PLV architecture will only be able to absorb its own level of kinetic energy. As it will be driving amongst heavier vehicles, its impact energy capability will be inadequate (*IIHS, 2014*). In order to address the lighter mass between the L-category vehicles compared to the current M-category vehicle fleet, a new testing regime is necessary. It is proposed to perform a compatibility test. This compatibility test would be performed by colliding the ‘L’ category vehicle against a 960kg deformable barrier at a closing speed of 66km/h (as per UNECE R94). This 960kg deformable barrier would be the standard side impact crash test barrier used in side impact test, as per on UNECE R96. Should ‘L’ category vehicles pass this test, then their front-end structure will have stiffness and strength capabilities to withstand collisions with standard vehicles.

As a compatibility vehicle, it is proposed to utilise the moving side impact barrier from UNECE96 (*UNECE96, 2016*). This has some major advantages:

- The barrier already exists and will add no extra cost of development for an L-category barrier
- The barrier instrumentation exists and is well understood
- The impact range will change from 60km/h to 66km/h, which is within the range of the crash test barrier

This proposed method allows a quick implementation to test L-category powered light vehicles.

As the focus of the test is based on the vehicle structural integrity, the crash test dummy in the PLV will not be instrumented: only its inertial properties are used.

Use of the seatbelt

Current L-category legislation does not mandate the fitment of a seatbelt, except for L6e-B and some L7e vehicles. Restraint systems play a major role in the safety of occupants (Stubbs, 2013) and are fundamental to the reduction on impact energy between the occupant and the vehicle interior, especially thorax to steering wheel and column (seatbelt) and head to steering wheel and windscreen (airbag). Not wearing the seatbelt, in general, can be tragic, as recorded in the Global Status Report On Road Safety 2016 report (WHO 2016), where "*Seat-belts … are extremely effective at saving the lives of car occupants in the event of a crash. Ensuring that vehicle manufacturers fit seat-belts … is therefore critical to reducing road traffic fatalities*". It has also well documented (NHTSA 2007) that the use of the seat belt at the time of the crash make a difference in the need for hospitalization, as people not wearing their seat belt at the time of the crash were more likely to be hospitalized compared to those wearing it (32% vs. 19%).

It is proposed that in the future, where suitable, L-category powered light vehicles should be fitted with 3-point seatbelts, where practical.

Following crash tests performed by EuroNCAP on heavy quadricycles, it was shown that for the Ligier IXO JS LINE 4 Places that "*The vehicle has 3-point seatbelts but, in the frontal impact, the upper connection of this belt to the door pillar pulled out of the structure. The dummy was effectively unrestrained from that point on and the scoring of all body regions was penalised owing to the increased risk of injury*" (*EuroNCAP, 2016*). A similar comment was made for the Tazzari Zero where "*The vehicle has a 3-point seatbelt but, in the frontal impact, this broke at the point where it is attached to the door pillar*" (*EuroNCAP, 2016*). These 2 vehicles had poor driver frontal protection, consequently it is recommended that L-category PLVs must pass the seatbelt anchorage regulatory test to be performed as per ECE R14 (*UNECE 14, 2016*).

The proposed metrics to certify the structural frontal crashworthiness of PLVs can be based on:

- Floor pan intrusion: evidence has shown that floor pan intrusion above 30mm could cause lower leg injuries compatible with an AIS2 (NHTSA, 2003).
- Steering wheel intrusions should not exceed 12.7cm (intrusion stipulated by UNECE 12) but at frontal impact speed of 66km/h (and not 48km/h stipulated by UNECE 21)
- Steering column impact level with occupant chest must not exceed 80g per 3ms limit (*UNECE 12, 2016*). This is a component test which is affordable.
- Occupant is belted, and seatbelt anchorage passes ECE R14 (*UNECE 14, 2016*).

4.2.3 Lateral impact

Considering accident statistics from Figure 4.2, it is proposed that PLVs must be subjected to part of the UNECE 96 side impact test scenario (*UNECE96, 2016*), which is using a deformable barrier (ODB) of 960kg, impacting at 60km/h.

Consequently, it is proposed that the focus of the safety of such vehicles should be based on their structural integrity over occupants' legislative injury requirements and more particularly (UNECE 96, 2016):

- *"No door shall open during the test.*
- *After the impact, it shall be possible without the use of tools to open a sufficient number of doors provided for normal entry and exit of passengers to allow evacuation of all occupants*
- *no interior device or component shall become detached in such a way as noticeably to increase the risk of injury from sharp projections or jagged edges; ruptures, resulting from permanent deformation are acceptable, provided these do not increase the risk of injury".*

The UNECE test setup would be completed with the addition of the IIHS side impact structural requirement, stating that the B pillar, or barrier if no B pillar present, should be no less than 126mm (Figure 4.3) from the driver seat pan centreline (IIHS, 2006). IIHS use a 1360kg barrier, nevertheless, it is proposed to use the same levels of intrusions as a pass/ fail criterion.

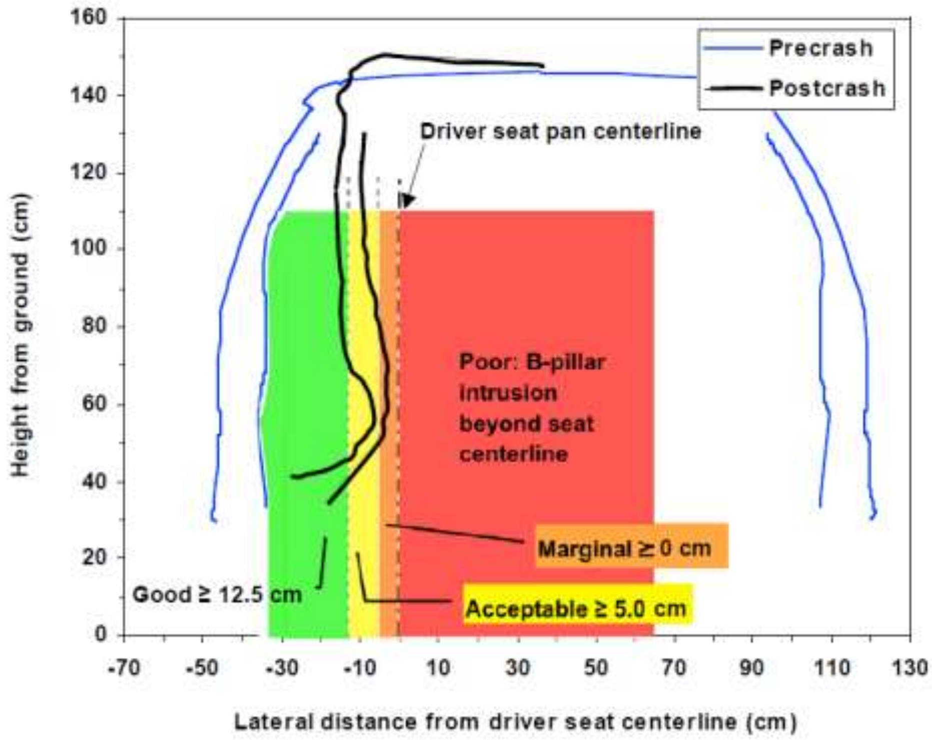

FIGURE 4.3: IIHS SIDE IMPACT TEST INTRUSION RECOMMENDATIONS (IIHS, 2013A)

4.3 Rollover

Due to the fact that an L-category powered light vehicle's centre of gravity will be different to that of N1/M1 vehicles, such lighter vehicles may have the tendency to rollover during impact. More statistics are needed, and this mode of accidents should be further researched.

As the rollover accident mode is low in the European Union, it is proposed to monitor them and to propose, if required, a structural safety cage strength test, based on the FMVSS 216 protocol (*FMVSS216, 2016*), which would subject PLVs to a quasi-static plenum, which would exert a force equal to 2.6 times the GVW.

4.4 Vehicle Interior Head Protection

During an accident, in spite of the wear of the seatbelt, the occupant's head could contact the vehicle interior trim, dashboard, roof etc. It is proposed to include the UNECE21 (*UNECE 21, 1986*) vehicle interior regulation within the safety requirements of the future L-category vehicles. UNECE 21 relates to the protrusion and radii of curvature of the interior fittings as well as their stiffness when subjected to a ram test aiming to replicate a head impact. This regulation will verify that the vehicle interior design is compliant enough so that head injuries are mitigated.

Whiplash

Whiplash is a complex phenomenon, which is very difficult to compute dynamically and is very much seat design dependant. As the PLV will have basic and lightweight seat technology, meeting dynamic whiplash using the BioRid crash test dummy, would change the purpose for which these vehicles are made. Consequently, performing a static whiplash test, as depicted in Figure 4, would be a mandatory requirement (*RCAR, 2016*). More evidence and research will be needed to certify the need of a dynamics whiplash test.

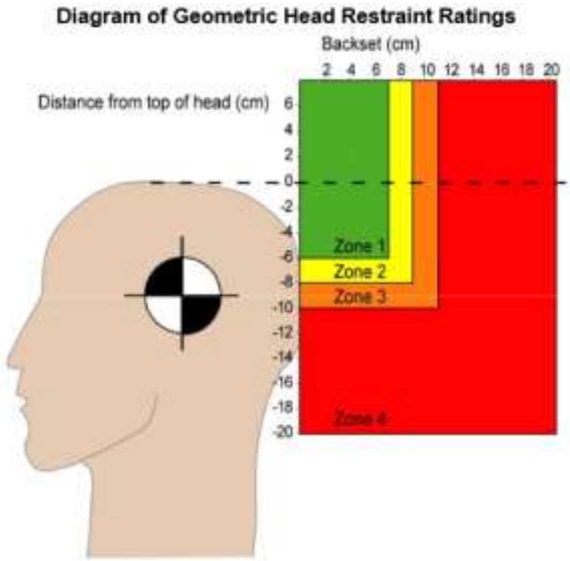

FIGURE 4.4: STATIC WHIPLASH ASSESSMENT TEST (RCAR, 2016)

4.5 Pedestrian Protection

PLVs will be driven in cities and will be in the vicinity of pedestrians. More research is needed to investigate the frequency and the mode of pedestrian accidents with such vehicles. It is too early to advocate that PLVs should be compliant with protocol UN ECE127, which protects pedestrians (*UNECE, 2009*). Pedestrian protection has a huge influence on the vehicle styling, hence can have some negative influence should the PLV's frontend be designed for a specific purpose. The frequency of head impacts on powered light vehicles' bonnet and specific locations would need to be investigated to review the implementation of the pedestrian protocol in the future.

4.6 The future safety implementations on L-category powered light vehicles

In order to mitigate vehicle intrusions, it is recommended that prior to a collision, in case of an accident, the vehicle speed should be reduced as much as possible (*Berg 2012; Grover 2012*). Some research was commissioned by the advanced Forward-looking Safety Systems working group (vFSS), led by DEKRA, which is promoting the market penetration of front protection systems designed to avoid accidents and to lessen the consequences of accidents into the volume-model segment and to further improve road safety. By evaluating the corresponding pre-crash braking behaviours, it was discovered that, based on the GIDAS database, in 24% of the 1,492 cases studied, the car drivers did not brake at all. This high number relates to the EuroNCAP research findings that 90% of road accidents are caused by drivers who are distracted or inattentive (EuroNCAP 2013e). In a further 23% (Figure 4.5) of cases the data contained no information on the braking behaviour. In all other cases the cars were braked before the impact. Of the latter, the deceleration was over 6 m/s² in 28% of the cases (*Berg 2012*).

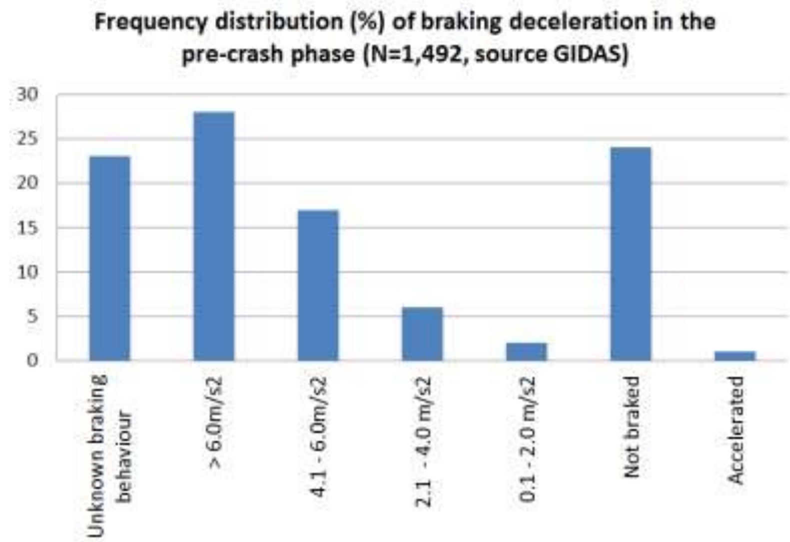

FIGURE 4.5: FREQUENCY DISTRIBUTION OF BRAKING DECELERATION IN THE PRE-CRASH PHASE (BERG 2012)

These statistics are showing clearly that the driver can have an important input in the collisions process. If 24% of the drivers have not braked, this could be classified as a driver error, as the collision has not been mitigated and could have been. It can also be concluded that there would be a potentially significant benefit to assist the driver in performing an emergency braking and suggesting maybe that this could be made automatic. Consequently, two new systems could be introduced in future vehicles: Autonomous Emergency Braking (AEB) and Forward Collision Warning (FCW), which are very distinctive safety systems. Whereas AEB performs automated braking, FCW only warns the driver of a potential collision and pre-pressures the braking system, relying on the driver to act (*Thatcham 2012*). Various technologies already exist, and some, like the stereo-camera systems appear to be the most efficient to avoid accidents, as depicted in Figure 4.6.

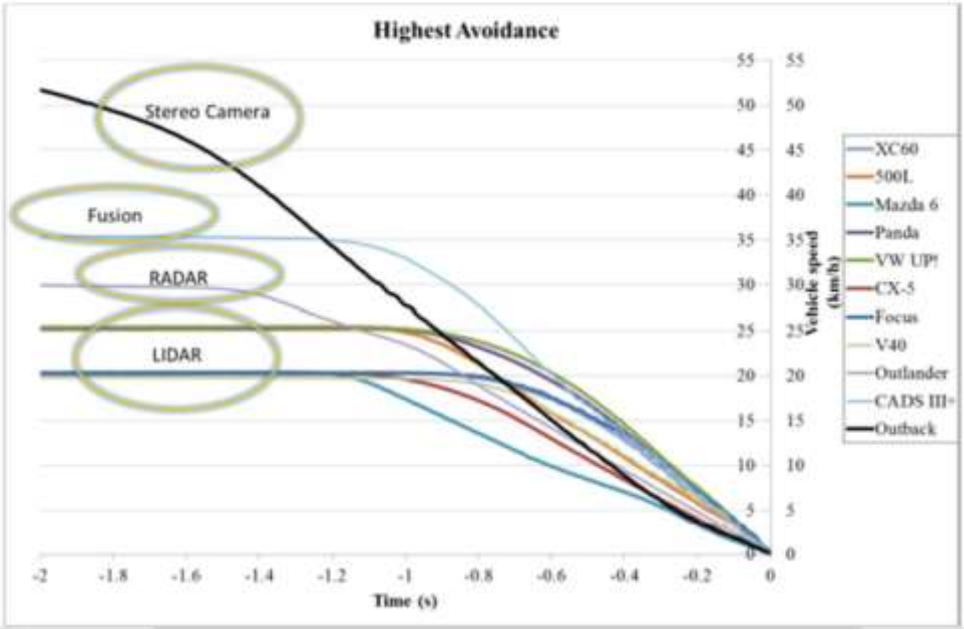

FIGURE 4.6: STATE OF THE ART OF AEB TECHNOLOGY AVOIDANCE TECHNOLOGY (HULSHOF 2013)

Similar findings from the Highway Loss Data Institute (*IIHS 2012b*) have concluded that Forward collision avoidance systems, particularly those that can brake autonomously, along with adaptive headlights, which shift direction as the driver steers, show the biggest crash reductions.

IIHS has already reported some AEB technologies success stories in its literature, endorsing the benefits of active safety and even divulging the vehicle brand names, like the Volvo XC60, to incite other OEMs to follow suit (*IIHS 2012c; IIHS 2013b*).

The GIDAS database also concurs with the FARS database, as about 60% of the seriously injured and about 40% of the killed vehicle occupants result from a frontal collision. In about 60% of cases the opponent in the accident was another vehicle (GIDAS) and of these cases a total of 40% were front-rear collisions. Considering this evidence, it can be suggested that frontal impact mitigation needs to be designed for in order of priority.

More evidence has shown that in 8483 crashes used for analysing AEB effects, only 12% of the drivers performed a steering manoeuvre compared to 88% providing no steering input (Edwards 2013). Another report published by NHTSA, entitled "A Test Track Protocol For Assessing Forward Collision Warning Driver-Vehicle Interface Effectiveness", has revealed that a distracted driver takes 1.2s to 1.7s to react to a crash, while a 'warned' one could react between 0.3s to 1.0s (NHTSA 2011), based on " the instant the driver returns their attention to the forward facing viewing position". The study has shown that FCW on its own was not sufficient to avoid the accident, as only 26.4% of possible accidents have been avoided using FCW alone. In the intent to identify which alert modalities most effectively assist distracted drivers in forward collision and lane departure crash scenarios, it was suggested that haptic seatbelts, based on 32 volunteers, offered better crash avoidance effectiveness than the other individual modalities (auditory, visual and combination of both).

Thatcham Research has studied generic accident scenarios which would benefit from active safety (Thatcham 2014) and has estimated that active safety, and especially Autonomous Emergency Braking (AEB), could reduce annually in Europe:

- Within 3 years: save 60 lives and result in 760 fewer serious casualties
- Over 10 years: save 1,220 lives and nearly 136,000 serious casualties

The benefits of such technology have been discussed in the "Motoring of the Future" report (*House of Commons Transport Committee, 2016*) with Thatcham who have estimated that the UK would gain significant safety benefits if AEB systems were implemented throughout the UK vehicle fleet. Thatcham recommended that the Government should intervene to make that happen. It proposed a legislative requirement to fit AEB systems to new cars, a regulatory programme to implement emerging technologies beyond AEB and a vehicle scrappage or tax incentive scheme to promote automated systems which improve safety. The report confirmed that road safety was of paramount importance to the Government and that the Government preferred to "*nudge people rather than mandate*" but said that it would intervene if there were market failure relating to certain types of technology or safety issues. Should the evidence and cost-benefits be clear, the Government would "*mandate the introduction of safety requirements"*.

The cost of implementing such technology has reduced greatly from a decade ago (£3,600), as Lidar hardware would now cost around £600 (*Ross, 2016*). Thatcham claim that an AEB system can cost as low as £200 per vehicle (*Fleet World, 2016*), including the hardware cost as well as software development costs - quoted for the implementation of very large volume of vehicles (Ford Fiesta and Ford Focus).

In the case of PLVs, SMEs could purchase the hardware, but the initial software cost would be high, as the implementation will be different than with a standard vehicle. Consequently, in order to permit the implementation of such safety beneficial technology, a government grant (Innovate UK or others) could be used to give a boost to this vehicle market.

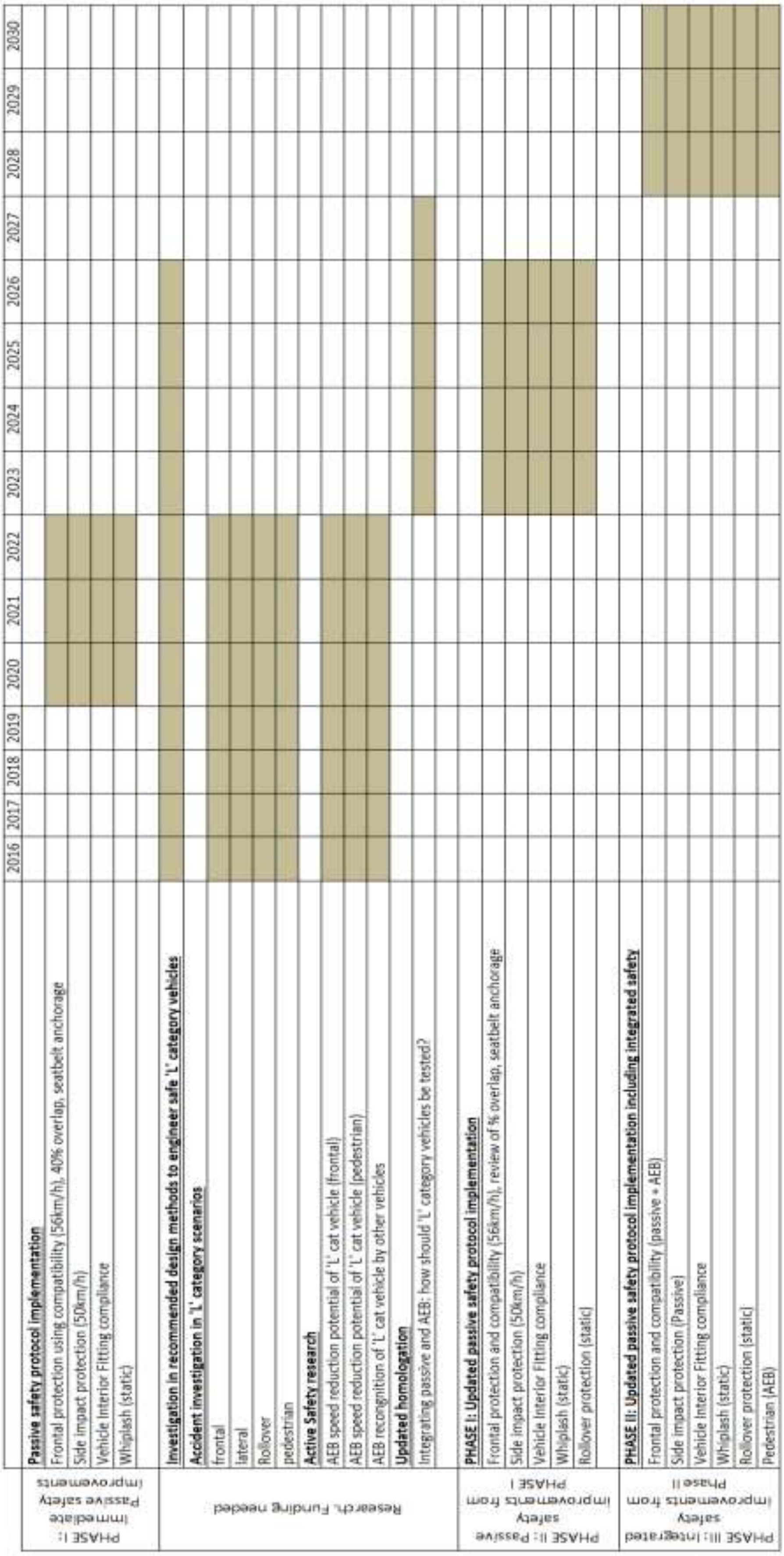

FIGURE 4.7: PROPOSED IMPLEMENTATION PHASES AND RESEARCH FUNDING

4.7 Conclusions and Recommendations for the development of safety in L-category powered light vehicles

From the evidence gathered in this report it can proposed that:

1. Seatbelts should be fitted as standard in PLVs (where possible) and made mandatory to wear.
2. In frontal tests, the seatbelt anchorage must remain intact as per UNECE 14.
3. In frontal safety crash test assessments, L-category powered light vehicles must be tested in compatibility mode against a dynamic 960kg barrier at 66km/h (based on the side impact barrier in UNECE 96) and be assessed for floor intrusions which must be less than 30mm.
4. When the steering control is struck by an impactor, it shall not exceed 80g cumulative for more than 3ms (UNECE 12).
5. In lateral safety crash test assessments, intrusions (B pillar or barrier) must not be less than 126mm from the seat centreline when the vehicle is impacted with a 960kg barrier at 60km/h (UNECE 96).
6. Static whiplash requirement is included (adjustable headrest).
7. Vehicle Interior fitting legislative requirement (UNECE 21) must be implemented in future L-category PLVs.
8. Funded research would be needed to investigate recommended design guidelines for the safety design of L-category powered light vehicles.
9. Funded accident research is performed on PLVs in order to review and amend the initial test proposed for the frontal and lateral load cases.
10. Funded accident research is performed on PLVs to review and amend the initial test proposed for rollover load-cases.
11. Funded accident research is performed on PLVs to understand the types of pedestrian accidents encountered by these vehicles.
12. Funded research is performed to ensure that future vehicles, non- L-category, can detect PLVs in their AEB sensing algorithms.
13. Funded research in the development of AEB, city, inter-city and pedestrian safety.
14. Funded research into the implementation of an integrated safety test protocol of PLVs.

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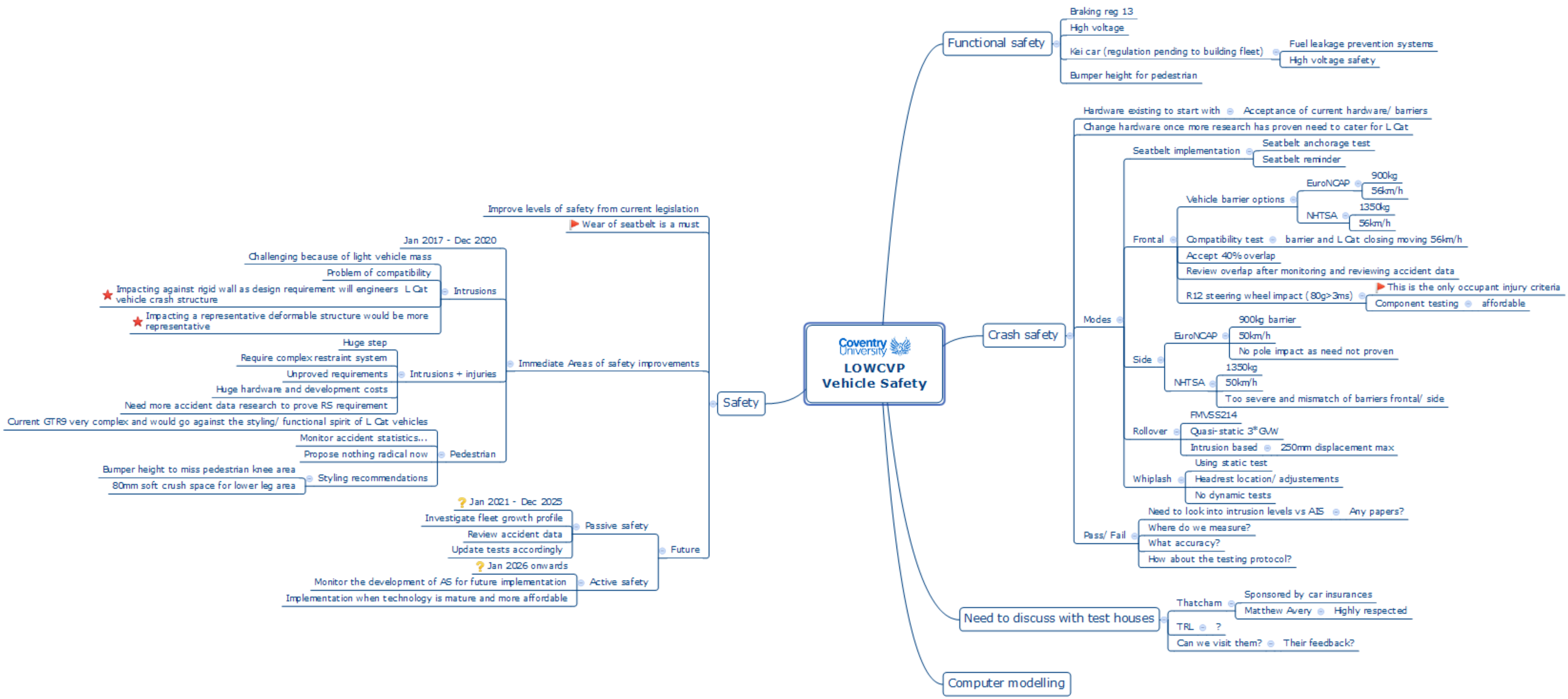
Appendix:

		2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
PHASE I: Immediate Passive safety improvements	**Passive safety protocol implementation**															
	Frontal protection using compatibility (56km/h), 40% overlap, seatbelt anchorage															
	Side impact protection (50km/h)															
	Vehicle Interior Fitting compliance															
	Whiplash (static)															
Research. Funding needed	**Investigation in recommended design methods to engineer safe 'L' category vehicles**															
	Accident investigation in 'L' category scenarios															
	frontal															
	lateral															
	Rollover															
	pedestrian															
	Active Safety research															
	AEB speed reduction potential of 'L' cat vehicle (frontal)															
	AEB speed reduction potential of 'L' cat vehicle (pedestrian)															
	AEB recongnition of 'L' cat vehicle by other vehicles															
	Updated homologation															
	Integrating passive and AEB: how should 'L' category vehicles be tested?															
PHASE II: Passive safety improvements from PHASE I	**PHASE I: Updated passive safety protocol implementation**															
	Frontal protection and compatibility (56km/h), review of % overlap, seatbelt anchorage															
	Side impact protection (50km/h)															
	Vehicle Interior Fitting compliance															
	Whiplash (static)															
	Rollover protection (static)															
PHASE III: Integrated safety improvements from Phase II	**PHASE II: Updated passive safety protocol implementation including integrated safety**															
	Frontal protection and compatibility (passive + AEB)															
	Side impact protection (Passive)															
	Vehicle Interior Fitting compliance															
	Whiplash (static)															
	Rollover protection (static)															
	Pedestrian (AEB)															

FIGURE 4.8: PROPOSED IMPLEMENTATION PHASES AND RESEARCH FUNDING


Coventry University
LOWCVP
Vehicle Safety
Functional safety
Braking reg 13
High voltage
Kei car (regulation pending to building fleet)
Fuel leakage prevention systems
High voltage safety
Bumper height for pedestrian
Crash safety
Hardware existing to start with
Acceptance of current hardware/ barriers
Change hardware once more research has proven need to cater for L Cat
Seatbelt implementation
Seatbelt anchorage test
Seatbelt reminder
Vehicle barrier options
EuroNCAP
900kg
56km/h
NHTSA
1350kg
56km/h
Frontal
Compatibility test
barrier and L Cat closing moving 56km/h
Accept 40% overlap
Review overlap after monitoring and reviewing accident data
R12 steering wheel impact (80g>3ms)
This is the only occupant injury criteria
Component testing
affordable
Modes
900kg barrier
EuroNCAP
50km/h
No pole impact as need not proven
Side
1350kg
NHTSA
50km/h
Too severe and mismatch of barriers frontal/ side
FMVSS214
Rollover
Quasi-static 3*GVW
Intrusion based
250mm displacement max
Using static test
Whiplash
Headrest location/ adjustements
No dynamic tests
Need to look into intrusion levels vs AIS
Any papers?
Pass/ Fail
Where do we measure?
What accuracy?
How about the testing protocol?
Need to discuss with test houses
Thatcham
Sponsored by car insurances
Matthew Avery
Highly respected
TRL
?
Can we visit them?
Their feedback?
Computer modelling
Safety
Improve levels of safety from current legislation
Wear of seatbelt is a must
Jan 2017 - Dec 2020
Challenging because of light vehicle mass
Problem of compatibility
Intrusions
Impacting against rigid wall as design requirement will engineers L Cat vehicle crash structure
Impacting a representative deformable structure would be more representative
Huge step
Require complex restraint system
Unproved requirements
Intrusions + injuries
Huge hardware and development costs
Need more accident data research to prove RS requirement
Immediate Areas of safety improvements
Current GTR9 very complex and would go against the styling/ functional spirit of L Cat vehicles
Monitor accident statistics...
Propose nothing radical now
Pedestrian
Bumper height to miss pedestrian knee area
80mm soft crush space for lower leg area
Styling recommendations
Jan 2021 - Dec 2025
Investigate fleet growth profile
Passive safety
Review accident data
Update tests accordingly
Future
Jan 2026 onwards
Monitor the development of AS for future implementation
Active safety
Implementation when technology is mature and more affordable

Low Carbon Vehicle Partnership

Connect
Collaborate
Influence

Low Carbon Vehicle Partnership
3 Birdcage Walk
London
SW1H 9JJ

+44 (0) 20 7304 6880
secretariat@lowcvp.org.uk
www.lowcvp.org.uk