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The Role, Place, and Importance of Preventive-Defensive Driving in Avoiding Traffic Accidents

[1] Gheorghe Neamțu, [2] Marinela Ință

[1, 2] "Lucian Blaga" University of Sibiu, 10 Victoriei Street, Sibiu, Romania

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Corresponding Author: **Gheorghe Neamțu**

Abstract

Road traffic vigilance refers to a driver's ability to observe and remain constantly alert to everything happening around them throughout the entire journey. Preventing a traffic accident means adopting a preventive (or defensive) approach, that is, a driving style in which you anticipate dangerous situations, reduce risks, and increase safety on the road. This requires increased vigilance, respect for the rules, and the ability to respond appropriately to others' mistakes or adverse road conditions. This scientific article presents the authors' personal perspective on preventive-defensive driving of motor vehicles, interested readers can learn about: legislation and specialized literature in this field; the concept of "stop accidents, life has priority"; the role of defensive driving in preventive driving; some integrative concepts of preventive-defensive driving; the main rules of preventive-defensive driving; typical situations with a high risk of traffic accidents; traffic accidents and their classification; and certain aspects regarding the principles of preventive-defensive driving — 5 case studies analyzing important situations in the subject area. The conclusions regarding the topic are presented at the end of the scientific article. To conduct this scientific research, experts in defensive driving were consulted, videos were watched, books, websites, and specialized journals were reviewed.

Keywords: Vigilance, Behavior, Preventive, Defensive, Rules, Legislation, Motor vehicle, Accident

1. Introduction

Preventive driving is the active and responsible behavior of road users, based on anticipating dangerous situations and adjusting speed to weather and road conditions. Its purpose is to prevent accidents by anticipating the mistakes of other road users (pedestrians, drivers) and maintaining constant vigilance, and it applies both while driving and when stopped [1]. *Defensive* driving is a set of techniques and a proactive approach behind the wheel designed to reduce the risk of accidents by anticipating hazards, regardless of traffic conditions or the mistakes of other drivers. It involves caution, respect for the rules, and managing difficult situations to avoid traffic conflicts. Therefore, the two concepts are often used interchangeably, with the common goal of preventing traffic accidents by anticipating risks [1]. They incorporate a set of techniques, strategies, and attitudes based on safety, responsibility, and adaptability. Preventive-defensive driving is essential because it transforms driving from a reactive activity into a proactive one, with the primary goal of minimizing the risk of accidents, even in unforeseen situations or those caused by the mistakes of others. This implies **anticipating** hazards, continuously adapting to traffic conditions, and respecting traffic rules. Avoiding a traffic accident essentially means adopting a preventive-defensive driving style and remaining vigilant, anticipating potential traffic hazards and obeying traffic rules, through the full dedication of each driver to a combination of responsibility, divided attention, and a balanced mental state.

2. Legislation and literature review

2.1 European legislation on preventive driving

European legislation on preventive driving is not a single code, but is incorporated into various directives and regulations that promote road safety and reduce accidents through anticipation and responsible behavior.

The main European legislative and regulatory aspects are:

- **Assessment under the Driving Licenses Directive:** Directive 2006/126/EC [2] on driving licenses requires examiners to pay particular attention to defensive and courteous driving behavior. This driving style must demonstrate the driver's ability to anticipate risks and react calmly;

- **Preventive versus defensive driving:** In the European context, preventive driving refers to behavior that ensures accidents are avoided by anticipating the incorrect actions of others. This requires continuous theoretical and practical training and differs from defensive driving (which focuses more on avoiding collisions);
- **Common road safety rules:** Although there is no single European traffic code, the EU enforces standardized rules, such as the use of safety belts, speed limits, and strict regulations on alcohol at the wheel, all of which contribute to a preventive approach to risk;
- **Key elements imposed:** European legislation encourages a driving style that includes regular vehicle inspections, adjusting speed to road conditions, and maintaining a safe following distance—all considered pillars of defensive driving.

2.2 European legislation on defensive driving

After researching the relevant European legislation, we found that defensive (or preventive) driving is not regulated by a single European law, but rather consists of a set of road safety principles incorporated into the national laws of Member States, which are aligned with European Union directives on road safety and driver training.

The EU sets high standards for obtaining a driver's license, which include an assessment of defensive driving skills. The goal is to reduce the number of accidents by promoting responsible behavior. If you are a new driver in another country, it is essential to familiarize yourself with the specific rules of each member state, as these may vary.

2.3 Romanian legislation on preventive driving

Emergency Ordinance No. 195 of 2002 [3] establishes clear principles for preventing traffic accidents, and the Road Traffic Code emphasizes responsible driver behavior.

Here are some relevant legal stipulations:

A. Adapting speed to road and traffic conditions

According to Article 121 of Government Emergency Ordinance 195/2002, drivers must adjust their speed based on:

- Weather conditions (rain, snow, fog);
- Road conditions (slippery roads, ice, snow);
- Reduced visibility (at night or in unenlightened areas).

Even if the legal speed limit is not exceeded, driving at a speed that is not appropriate for the actual conditions may be penalized.

B. Maintain a safe distance

According to Article 51, paragraph 4, of the Road Traffic Code, maintaining a sufficient distance from the vehicle ahead is mandatory. This helps prevent collisions in the event of sudden braking.

C. Respect for the rules regarding yielding the right of way

Pedestrians, cyclists, and other vehicles have clear rights on the road, and drivers are required to yield the right of way, according to the Road Traffic Code. Failure to follow these rules is one of the main causes of traffic accidents in Romania.

D. Avoiding aggressive behavior on the road

Recent updates to the Road Traffic Code impose severe penalties on drivers who engage in aggressive behavior. This includes:

- Sudden acceleration, unnecessary braking, and cutting off other vehicles;
- Excessive or intimidating use of the horn;
- Intentionally ignoring the signals of other road users.

2.4 Romanian legislation on defensive driving

Romanian legislation on defensive driving has been consolidated through the official incorporation of the concept into traffic laws, defining it as special training for drivers aimed at preventing traffic accidents.

The purpose of this regulation is to amend Government Emergency Ordinance No. 195/2002, for the purpose of establishing an obligation for certain categories of drivers to complete a training course aimed at providing specialized training in road accident prevention (defensive driving), as well as for establishing tax incentives to encourage all categories of drivers to take such courses.

Defensive driving is defined by law as special training for drivers aimed at preventing traffic accidents. According to the law, drivers may take a training course to receive special instruction in defensive driving.

The rules governing the authorization of driving schools and driving instructors in the field of defensive driving, the rules governing the certification of traffic law instructors and driving instructors in the field of defensive driving, as well as the examination and training procedures in the field of defensive driving, shall be established by order of the Minister of Transport and Infrastructure.

The traffic police of the Ministry of Internal Affairs maintains a registry of drivers who have completed defensive driving courses and annually evaluates the effectiveness of these courses based on the extent to which graduates are involved in traffic accidents. The procedures for maintaining records and evaluating effectiveness are established by order of the Ministry of Internal Affairs.

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Expenses incurred for completing a training course in defensive driving by drivers aged 18 to 26 who are still in school and have no income are deductible from the income tax payable by the persons referred to in Article 499 of the Civil Code," the law further states. The law further provides that drivers of special vehicles as defined in Article 32(2) of Government Emergency Ordinance No. 195/2002, who are engaged in such activities as of the effective date of this law, shall comply with the requirement set forth in Article 24(1)(5) (5) of Government Emergency Ordinance No. 195/2002 within 12 months of the entry into force of the order of the Minister of Transport and Infrastructure adopting the examination and training procedure in the field of defensive driving.

Key legislative provisions and regulations:

- **Defensive driving courses:** The Romanian government has introduced specialized courses, the cost of which may be tax-deductible under certain conditions;
- **Accreditation:** The law requires the accreditation of defensive driving schools and the certification of

instructors specializing in this field;
- **Objective:** The legislation aims to improve road safety by training drivers to anticipate the mistakes of other road users and to adapt their speed and driving style to road conditions.

2.5 Literature review
- **Official Definition:** *Defensive driving* is special training for drivers aimed at preventing traffic accidents, with the goal of anticipating risky situations and avoiding collisions.
- **Official Definition:** *Preventive driving* refers to the behavior of road users (drivers, pedestrians, etc.) that ensures the prevention of accidents by anticipating and avoiding dangerous situations, adapting behavior to traffic conditions, and making decisions that protect safety, even in the event of errors committed by other road users.
- **Official Definition:** *Reducing speed to the point where any danger can be avoided* is a legal obligation for drivers to adjust their speed so that they can stop safely at any time. This does not imply a fixed numerical value, but rather adapting to conditions such as reduced visibility, heavy traffic, uncontrolled intersections, bridges, or hazardous areas.

The main situations that call for this measure include:
- **Visibility less than 100 meters:** Fog, torrential rain, or abundant snow;
- **Intersections:** Especially uncontrolled ones;
- **Dangerous locations:** Sharp curves, bridges, railroad crossings, crosswalks;
- **Specific traffic signals:** Flashing yellow light at traffic lights.

This rule is a general safety guideline set forth in traffic laws to prevent accidents when road conditions do not allow driving at the maximum legal speed limit.

In simple terms, this means slowing down enough to be able to stop immediately or maneuver safely if an obstacle appears. There is no fixed figure (such as 30 km/h); rather, it is a speed adapted to the situation.

Here is what it actually means to reduce your speed to the point where you can avoid any danger:
- **Total control:** Being able to stop the car within the distance you can see ahead (visibility);
- **Anticipation:** If you're passing a bus stopped at a station or driving through an area with many children, your speed must be low enough that, if someone runs out in front of the car, you can avoid a collision;
- **Difficult conditions:** On icy road, in dense fog, or torrential rain, the "threshold for avoiding any danger" can be as low as 10–20 km/h.

According to the explanatory dictionary of the Romanian language, we define the terms [4]:
- ***Preventive****—aimed at averting harm, preventing the onset or spread of a disease, the commission of a crime, etc.;*
- ***Defensive****—intended for defense, serving a defensive purpose, or providing protection.*

3. The concept "Stop Accidents, Life has Priority"
The concept of ***prioritizing human life*** [5] in road accidents is not just an ethical slogan, but a fundamental principle that guides legislation, infrastructure design, and emergency response.

In traffic accidents, life always takes priority because it is a fundamental, inalienable right that supersedes any material damage or traffic-related interests. Road safety aims to protect the physical well-being of road users by preventing deaths and serious injuries, which entail immense human and social costs.

Here are the main reasons why life takes priority:

A) **The irreversible nature of death:** Unlike vehicles or infrastructure that can be repaired or replaced, the loss of a human life is irreversible. This is the central message of the road safety campaigns carried out by the Romanian police;

B) **Road safety as a national priority:** Institutions such as the Ministry of Internal Affairs and the Traffic Police promote campaigns whose primary goal is to save lives by combating speeding and failure to yield;

C) **Protection of vulnerable road users:** Traffic accidents are dangerous for pedestrians, cyclists, and drivers, which is why traffic rules are designed to prevent fatal collisions;

D) **The "Vision Zero" Strategy** [6]**:** Many countries, including Romania, are moving toward adopting the European Vision Zero concept. This strategy is based on the premise that no loss of life on the roads is ethically acceptable;

E) **Human error:** It is acknowledged that people make mistakes, but the traffic system must be designed so that mistakes do not result in fatalities;

F) **Common responsibility:** Dsigners, road builders, and automakers share responsibility with road users for ensuring survival in the event of a collision;

G) **Massive socioeconomic impact:** Beyond the human tragedy, serious traffic accidents impose enormous costs on society, as documented in technical reports such as those published by AGIR (the General Association of Engineers in Romania):
   - **Medical costs:** Surgery, hospitalization, and long-term rehabilitation;
   - **Loss of productivity:** People who have died or become disabled can no longer contribute to the economy;
   - **Psychological trauma:** The impact on families and witnesses requires extensive psychological support.

H) **Legal priority in emergencies:** The law imposes strict rules for protecting life in the event of an accident:
   - **Providing first aid:** It is a moral and legal obligation that takes precedence over moving the vehicles involved in the accident in order to clear the road;
   - **Priority for emergency vehicles:** Emergency medical services and firefighters have absolute priority because every second counts when it comes to survival.

I) **Road safety as a national priority:** Institutions such as the Ministry of the Internal Affairs treat road safety as a matter of national security, investing in monitoring technologies and infrastructure designed to mitigate driver errors.In the event of a car accident, saving lives is always crucial, *as the first few minutes* are often the difference between survival and death, and a swift and proper response can prevent injuries from worsening or fatal complications from arising before medical personnel arrive.

The main reasons why saving lives in these situations is vital:

- **Reducing mortality during the "golden hour":** Many deaths occur immediately after an accident or shortly thereafter. Providing first aid (stopping bleeding, clearing the airway) in the first few minutes increases the chances of survival, and many deaths can be prevented;
- **Preventing serious complications:** Proper first aid can prevent paralysis (through correct neck/spine handling), post-traumatic shock, or infections;
- **The enormous impact of accidents:** Traffic accidents are a leading cause of death worldwide, especially among young people (ages 15–29);
- **Specific critical situations:** Head injuries or massive blood loss are common causes of death that can be managed through immediate on-site interventions;
- **Saving lives through simple actions:** Using safe belts, keeping a first-aid kit in the car, and knowing first-aid procedures can save thousands of lives annually.

4. The role of defensive driving in preventive driving

Defensive driving is a fundamental part of preventive driving, acting as a practical and strategic tool through which a driver not only follows the rules but also anticipates and actively avoids dangerous situations, reducing the risk of accidents. While preventive driving represents a general mindset of caution, defensive driving is the set of techniques and behaviors applied to maintain vehicle control and safety on the road.

In Romania, defensive driving has began to be chosen by an increasing number of commercial fleet owners for their employees. At the same time, the number of drivers who recognize the importance of driving courses that go beyond what is taught in driving school is also on the rise. In this regard, Law No. 20 was enacted on January 13, 2022 [7], amending Government Emergency Ordinance No. 195/2002 on traffic on public roads by introducing defensive driving and first aid courses as requirements for obtaining a driver's license or for lifting a license suspension.

5. Integrative concepts of preventive-defensive driving

Preventive-defensive driving (or preventive-defensive driving conduct) of a motor vehicle in traffic is a driving style focused on anticipating and avoiding dangerous situations before they cause an accident.

This concept combines two essential components for safety:

- **Preventive (proactive) driving:** Involves adjusting speed and driving style according to road conditions, visibility, and heavy traffic, with the aim of preventing critical situations;
- **Defensive driving (reactive):** Involves anticipating the mistakes of other road users (pedestrians, other drivers) and taking precautions to avoid an accident, even if others violate the rules.

The main integrative concepts of preventive-defensive driving are:

- **Anticipating hazards:** This is the core of preventive driving, involving the driver's ability to foresee dangerous situations (the behavior of other road users, weather conditions, or road conditions) before they turn into accidents;
- **Adapting speed and distance:** Continuously adjusting speed according to road conditions (rain, fog, heavy traffic) and maintaining an appropriate safe distance from the vehicle ahead;
- **Constant vigilance:** Paying close attention to the surrounding environment to react proactively, not reactively;
- **Knowledge of the law:** The foundation of defensive driving is a thorough understanding of traffic rules and safety regulations;
- **Courtesy and discipline:** Calm and disciplined behavior in traffic helps avoid tense situations;
- **Adapting to the environment:** Adjusting speed to weather conditions, road conditions, and traffic density;
- **Safety first:** The focus is on road safety, not on speed;
- **Avoiding surprises:** Maintaining a safe following distance, using mirrors, and signaling in advance;
- **Active observation and situational awareness:** Constantly scanning the surroundings (using mirrors, checking blind spots) to stay aware of everything happening in traffic;
- **Responsibility and defensive driving:** Driving calmly and responsibly, acknowledging that other road users may make mistakes, and adapting to compensate for these errors;
- **Risk minimization:** Adopting strategies that minimize the likelihood of being involved in an accident, including knowing and obeying traffic rules;
- **Vehicle maintenance:** Keeping the vehicle in good mechanical condition and ensuring the driver's mental alertness, avoiding fatigue or distraction;
- **Continuous training:** Drivers are encouraged to stay informed about changes in legislation and to have a solid theoretical and practical foundation;
- **Following basic rules:** This includes maintaining a safe following distance, signaling intentions, and observing speed limits;
- **Proper driving position:** Adjusting the seat, mirrors, and headrest for maximum visibility and control;
- **"See and be seen":** Using signals and ensuring maximum visibility.

6. Basic rules for defensive driving

In defensive driving courses, drivers who wish to improve their abilities are introduced to a whole range of new ways to approach their vehicle and the driving process. Some of the principles of defensive driving are not found in the traffic rules, but they complement them naturally.

These include recommendations such as the following:

A. The two-second rule (Fig 1): This implies maintaining a distance equivalent to the distance the car in front of you would travel in two seconds. To ensure you're applying the rule correctly, choose a fixed reference point and count the two seconds in your head after the car in front of you passes the object. You can choose a pole, a tree, or a vehicle parked on the side of the road;

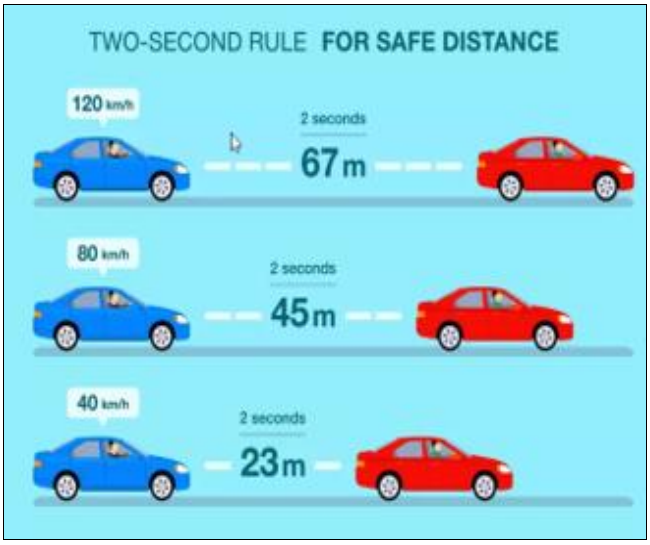

Fig 1: The two-second rule in preventive/defensive driving for safe distance

B. The zipper rule (Fig 2): In situations where two lanes join into one or where there is a busy intersection marked with a "Yield" sign, the solution is not always for only vehicles with the right of way to proceed. To ensure the entire process runs smoothly, one vehicle from each side must enter the intersection at a time;

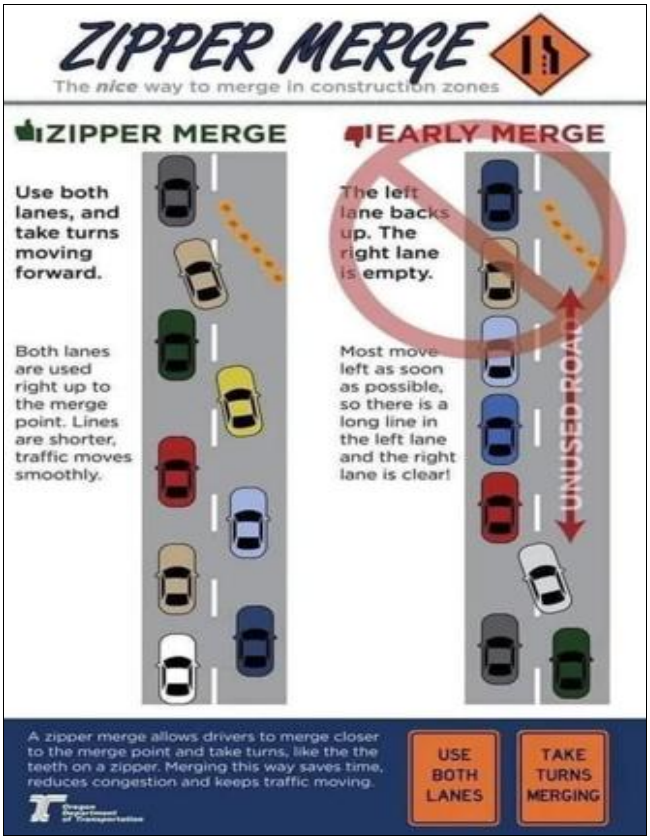

Fig 2: The Zipper rulle

C. Avoiding the "herd effect" on the highway (Fig 3): Just as on any other section of road, the two-second rule must be followed on the highway as well, but here we face a specific risk. When driving alongside a vehicle whose speed is not much higher, we tend to accelerate. This tendency, exhibited by every road user, causes drivers to push each other and unnaturally shorten the distance between vehicles;

Fig 3: "The herd effect" on the highway

D. Controlling a vehicle in a skid (Fig 4): Understeer occurs when the front end slides out, while oversteer involves the rear end sliding out. In each of these situations, different actions are recommended. *Understeer* should be countered by gradually reducing speed, taking care not to lock the wheels, so that the front axle can regain traction. *Oversteer* will require the opposite action: accelerating and keeping the wheels in the direction of travel;

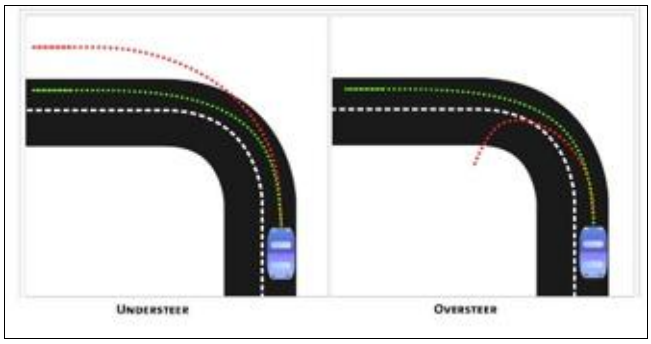

Fig 4: The phenomenon of understeer and oversteer of a motor vehicle

E. Driving on snow (Fig 5): Balance the front and rear of the vehicle—this is the safest way to pull away from a snow-covered parking spot. Accelerating and spinning the wheels will only cause ice to form under the tires. It is important not to reduce speed if the car starts to skid, but to carefully modulate the throttle and maintain the car's trajectory. The car's windows, headlights, and taillights must be thoroughly cleaned, and the fuel tank should always be full, in case of getting stuck in the snow;

Fig 5: Driving in the snow conditions

F. Attention on the road: Both European and Romanian traffic laws sanction the use of mobile phones by drivers while driving. In this situation, hands-free communication systems are permitted. A heated conversation can distract

you from other cars or traffic signs. It is also very dangerous to eat or drink while driving.

7. Basic rules for preventive driving

There are multiple rules of defensive driving that can be used to increase awareness and proactivity on the road. However, when it comes to a "code" of defensive driving, the ***Smith System*** is the most popular. The Smith System for preventive driving provides a solid and effective framework for developing the abilities needed to anticipate and manage traffic situations [8].

It is based on five principles [8]:

A. **Aim High in Steering:** This principle underlines the importance of observing the driver's entire environment. You shouldn't just focus on the car in front of you, but maintain a comprehensive view of the traffic around you and up to three cars ahead. This allows you to anticipate changes and react accordingly. Look 15–20 seconds ahead of your vehicle to anticipate obstacles, not just the car in front of you;

B. **Keep the overall image in mind (get the big picture):** This principle constantly paying attention to how you drive, but also to your surroundings. You can do this by frequently checking your rearview mirrors and maintaining a distance between yourself and other drivers equal to half your driving speed in meters. Keep an eye on the traffic (mirrors, peripheral vision) to stay aware of the cars around you.;

C. **Stay alert (keep your eyes moving):** This principle remaining alert while driving, even in situations or on routes you're used to. Avoid staring straight ahead; keep scanning the traffic to prevent eye strain and stay aware of everything that's happening;

D. **Make sure you have an escape route (leave yourself an out):** This principle involves maintaining an adequate following distance, along with other ways to avoid potential accidents. You can also add maintaining a safe distance between your car and the ones in front of and behind you, which allows you to avoid rear-end collisions when the driver in front of you brakes suddenly;

E. **Make yourself visible (make sure they see you):** In other words, avoid ending up in the blind spot of other road users. You can't rely entirely on other drivers when it comes to your safety, so make sure you're visible to other road users, especially when performing maneuvers such as passing or pulling out of a parking space. Use your turn signals, horn, or headlights to let other drivers know you're there.

These are the central rules of defensive driving, but that doesn't mean they're the only ones you can follow to improve your safety and that of other road users.

Here are some other rules that will help you better handle traffic situations:

- **Take all the safety precautions available to you:** Wear your seatbelt and use any other safety features available in your car;
- **Be aware of blind spots:** Just as you expect to be seen, you must ensure that you are aware of all other road users and all elements of your surroundings, even if they are in a blind spot;
- **Check all mirrors:** It is recommended that you constantly check all mirrors, from the side mirrors to the rearview mirror, even if you are not performing a maneuver. Therefore, it would be ideal to develop this habit to avoid causing yourself unnecessary stress;
- **Be careful of all traffic signs:** Even if your surroundings seem safe, there may be unexpected risks, which are indicated by traffic signs and signals;
- **Make sure your car is completely safe and in good working order:** Before hitting the road, ensure that all parts of your vehicle are functioning properly, from lights and signals to tire pressure;
- **Take breaks when you feel you need them:** Driving for long periods can tire you out without you noticing any change. You may also end up driving on autopilot, reducing your attention. Try to take as many breaks as possible and don't push yourself too hard, even if it might seem like it could shorten your travel time.

8. Typical situations involving a high risk of traffic accidents

The rules discussed so far apply in all situations. However, under certain environmental conditions, you will need to take additional measures to reduce the risk of a traffic accident.

Here are some of the most dangerous situations in which driving carefully can help you:

A. Driving in the rain (Fig 6):

Fig 6: Driving in the rainy conditions

- When visibility is less than 100 meters, drive at a speed of 30 km/h in built-up areas and 50 km/h outside built-up areas;
- Keep a greater distance than usual from the vehicles ahead;
- Avoid sudden acceleration and puddles, as these can cause hydroplaning;
- Turn on your low beams even during the day;
- Avoid sudden braking or sharp turns. Slow, steady maneuvers are safer in rainy conditions;
- Reduce your speed to the point where you can avoid any danger. This reduces the risk of an accident and increases safety.

B. Driving in foggy conditions (Fig 7):

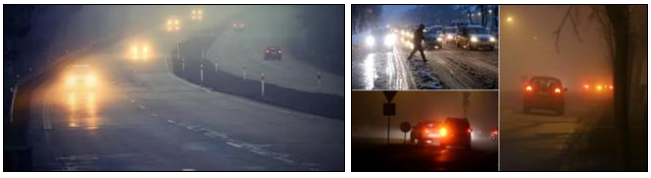

Fig 7: Driving in foggy conditions

- Use your fog lights;
- Turn on the ventilation system to keep the windows clear and improve visibility;
- Pay attention to both the road and the shoulder to spot pedestrians preparing to cross the street or parked, unmarked vehicles;
- Maintain a safe following distance between vehicles and reduce your speed to avoid a potential front-end or rear-end collision;

- Avoid dangerous maneuvers, adjust your speed to a comfortable level or to the point where you can safely avoid any danger, and do not attempt risky passing maneuvers;
- Avoid stopping on the side of the road. Instead, look for a more secluded spot, such as a gas station or parking lot, and park with your fog lights on.

9. Traffic accidents and their classification

According to the specialized literature, a traffic accident is an event resulting from a failure to comply with traffic regulations, involving one or more motor vehicles traveling on a public road, resulting in injury, bodily harm, or even the death of one or more passengers, or causing various types of property damage.

Traffic accidents are classified as follows [9]:

- ***Minor accidents*—**these are accidents that result in injury to one or more people, leading to an inability to work for up to 30 days, or property damage of up to 60% of the vehicle's value;
- ***Serious accidents*—**these are accidents that result in one or more of the following consequences:
  - Persons who have been fatally injured;
  - Persons who have been permanently disabled;
  - Injury to one or more persons resulting in an inability to work for more than 30 days;
  - Property damage exceeding 60% of the vehicle's value.

Depending on the circumstances in which the accident occurred, the type of accident, and the number of people involved, accidents are classified into the following categories [9]:

Accident involving vehicles and pedestrians:

- Hitting pedestrians who were walking on either the left or right side of the road;
- Hitting pedestrians who were in areas designated for their use, such as sidewalks;
- Hitting pedestrians who were crossing the road illegally or standing on the roadway.

Accidents involving a single vehicle, for example:

- Reversing;
- Colliding with an obstacle on or off the roadway;
- Colliding with an obstacle as a result of skidding;
- Colliding with a cyclist or an animal;
- Accidents that occurred while getting in or out of a moving vehicle.

Traffic accidents with multiple vehicles involved:

- Rear-end collision;
- Collision with a parked vehicle;
- Head-on collision—vehicles traveling in opposite directions;
- Side collision;
- Tangential collision—resulting from failure to maintain a safe lateral distance;
- Consecutive collisions in a line of vehicles.

The main road safety measures that help prevent traffic accidents are:

- ***Respect the rules and principles of road traffic in adverse weather conditions:*** During the cold season, there are weather phenomena such as snow, sleet, or rain, and these can affect traffic safety. Therefore, you should drive more cautiously, observing speed limits, so as not to skid off the road in unforeseen situations;
- ***Compliance with traffic rules and principles:*** Adhering to traffic rules has proven to be an effective measure for preventing accidents. Therefore, observing speed limits, maintaining a safe following distance from the vehicle ahead, and obeying traffic signs will help you prevent an unwanted accident;
- ***Checking the vehicle's technical condition:*** Most traffic accidents are caused by a vehicle's technical malfunction. For this reason, we recommend periodically checking the vehicle's condition to avoid any unwanted incidents.

10. Some aspects of the principles of preventive-defensive driving: Case studies

10.1 Driver distraction caused by using a cell phone or other devices without a hands-free device, and preventive-defensive driving

Using a mobile phone while holding it in your hand while driving is strictly prohibited on public roads in Romania. Penalties include fines and, in certain situations, a 30-day license suspension if other rules are also violated. The use of a hands-free device is permitted, but distraction remains a major hazard.

Key aspects of mobile phone use while driving:

- **Prohibition:** It is prohibited to use a phone or any device capable of recording or playing text, photos, or video if held in the hand while the vehicle is in motion;
- **Penalties:** Both in Europe and in Romania, the fines for using mobile phones or other gadgets without a hands-free device are substantial. Your driver's license may be suspended for 30 days if using a phone is combined with other violations, such as failing to yield the right of way or running a red light;
- **Exceptions:** Using a phone is permitted only if the vehicle is legally stopped (for example, at a traffic light or in heavy traffic);
- **Safe alternatives:** It is recommended to use hands-free systems, headsets, or connect your phone via Bluetooth to the car's system to keep both hands on the wheel and your attention on the road;
- **Risks:** Using a phone distracts visual, cognitive, and manual attention, exponentially increasing the risk of accidents.

Using a cell phone while driving isn't dangerous because you have to operate it with one hand while steering with the other; rather, it's dangerous because it distracts you from the road (Fig 8). The biggest mistake we make when driving a vehicle in traffic is associating risk solely with the physical aspect. The right thing to do is not to text on your cell phone, use hands-free, keep both hands on the wheel, pay attention to the road, and everything will be safe.

Fig 8: Distracted driving caused by using a cell phone without a hands-free device at the wheel

In reality, the main problem is not visual or physical distraction (vehicle handling), but cognitive distraction from driving. The human brain cannot process two complex tasks

simultaneously. It cannot simultaneously coordinate the act of driving a vehicle with that of carrying on a coherent conversation or writing and sending messages on a cell phone, all at the same level of performance. What actually happens is rapid switching between them—that is, "task switching"—but in this process, the human brain misses essential information from the traffic. For example: we may be looking directly at a vehicle braking in front of us and yet, in our capacity as drivers, fail to react in time. This happens not because we didn't see it, but because our mind was engaged in another process.

This is the phenomenon known as "inattentional blindness"—that is, we see but do not process. Scientific research in this area shows that the reaction time of a driver engaged in conversation can increase significantly, sometimes to a degree comparable to that of a person under the influence of alcohol or hallucinogenic substances. In this case, the most dangerous illusion arises: the feeling that we have total control over the vehicle, because unlike other risks, the cell phone does not give us clear signals that we have lost our attention. We don't feel that we're slower, we don't feel that we've involuntarily reduced the vehicle's speed, and we don't feel that we're processing information less effectively. The reality is that we filter less information from our surroundings, react later, and make poorer or incorrect decisions.

Think about a simpler situation: we're driving down a familiar road at a steady pace and talking on our cell phone. At some point, we realize that we've driven several hundred meters without remembering exactly what happened around us. The car kept moving, but we weren't fully present. Now let's imagine that an unexpected event occurred during that exact interval. In this case, we didn't react more slowly because we lacked reflexes, but because the information reached the brain too late. For this reason, in our opinion, even hands-free devices used while driving are not a real solution. They eliminate part of the problem but leave the core issue intact: cognitive distraction, and multitasking remains a dangerous myth in preventive-defensive driving.

Justification: we can't do two things well at the same time, and if we try, we end up stumbling from one mistake to the next. The same thing can happen when we use a tablet, fiddle with the dashboard, or operate the car radio.

Immediate conclusions: Preventive-defensive driving requires total focus—the ability to observe, understand, and anticipate in real time. Any activity that draws our attention away from this process reduces our control, even if we don't notice it in the moment. Cell phones or other gadgets aren't just a distraction; they directly reduce our ability to drive a vehicle safely, and the problem isn't how much we use them, but that we use them when we need our full attention.

10.2 Overtaking by pressing the accelerator pedal halfway and knowing when to abandon the overtaking maneuver in preventive-defensive driving

Overtaking is the maneuver by which a vehicle passes in front of another vehicle or around an obstacle traveling in the same direction by changing direction and moving out of the lane or line of traffic in which it was initially traveling [10].

Safe passing relies on the proper management of three fundamental factors: *power reserve, space reserve*, and *time reserve*. These constitute the *"safety margin"* needed to compensate for human error, unforeseen road conditions, or the aggressive behavior of other road users.

Here is the significance of each one:

A. Power Reserve

- **Rapid acceleration:** A power reserve (the engine's ability to accelerate further) allows for a shorter time spent in the oncoming lane;
- **Quick completion of the maneuver:** This is crucial for returning to the original lane as quickly as possible, especially in emergency situations (such as an oncoming vehicle);
- **Safe overtaking:** If the vehicle lacks sufficient power, overtaking can become extremely risky or impossible.

B. Space reserve

- **Safe following distance:** Before beginning to pass, there must be a safe following distance from the vehicle ahead that allows for early acceleration without the need for sudden braking;
- **Re-entry space:** There must be sufficient space between the vehicle being passed and oncoming traffic to safely return to your lane;
- **Lateral distance:** Maintaining a sufficient lateral distance from the vehicle being passed (or obstacles) is essential, especially when passing bicycles, mopeds, or large vehicles, to avoid the risk of contact.

C. Time reserve

- **Anticipation and planning:** Allowing enough time means not rushing and properly assessing the situation before beginning to pass (visibility, speed of other vehicles);
- **Avoiding time crisis:** Overtaking in a hurry (time pressure) exponentially increases the risk of accidents;
- **Accurate calculation:** An accurate estimate of the time needed to complete the maneuver, taking into account the relative speed of the vehicle being overtaken and the oncoming vehicle, is a key element of defensive driving.

In road traffic, we don't lose control when danger appears, but rather a few seconds before it does—we just aren't aware of it. One of the most important principles of defensive driving is to never use the vehicle's full capacity when passing another vehicle. Many drivers, when passing other vehicles in traffic, press the accelerator pedal to the floor (Fig 9), drive as fast as the road allows, and get as close as the distance permits. In practice, they drive at the limit without leaving themselves a safety margin.

Fig 9: Pressing the accelerator pedal too hard (to the floor)

The problem is that in road traffic, certain conditions can change in a fraction of a second at high speeds, and if we're already pushing the limits, we have no margin for error. That's why we must always leave ourselves a margin of safety. The first of these is the engine's power reserve.

Example: Proper overtaking is not achieved by flooring the accelerator pedal, but rather by applying it gently—pressing it halfway—so that you still have power reserves available if the situation takes a turn for the worse while you are driving.

The second problem is space reserve. It is important not to drive too close to the vehicle in front of you and not to get "stuck" between other vehicles, because space means real options, not just comfort.

The third problem is time reserve. In this regard, it is important not to drive too fast, so that any unexpected situation does not catch us off guard without a solution. When we eliminate these margins, we essentially limit our own ability to influence the outcome of a situation. We no longer drive proactively, but instead rely on last-minute reactions that are often insufficient or inappropriate.

A prudent driver does not push their vehicle to the absolute limit in terms of the three issues mentioned above, but manages their resources in such a way as to always have a backup plan. It is precisely this seemingly unnecessary reserve that always proves decisive when things do not go according to plan.

As for the decision to abandon overtaking when we feel we no longer have enough time to perform a safe and proper maneuver, that decision rests with each of us, in our capacity as drivers.

In traffic, the feeling that we don't have enough time to overtake another moving vehicle is not an illusion. It is a real signal that the speed, distance, or context in which we find ourselves no longer provides us with sufficient reaction time. Most drivers completely ignore this signal and "cover it up" with haste, overconfidence, or the idea that they "can manage.

At that very moment, he began to force an overtaking maneuver, executing a close call, a quick entry into an intersection, or late braking. The problem is that in preventive-defensive driving, time is not something you can compromise on. If we don't have it, we can't make up for it with reflexes or experience.

Most of the time, the feeling of running out of time arises before a critical, delicate situation. This is how the human brain signals that you've entered a zone where there's no longer enough control.

A prepared and experienced driver doesn't ignore this signal and respects it.

Example: When we're getting ready to overtake another vehicle in traffic and the questions pops into our minds: do we have enough time? We assume we already know the answer. If we have to ask ourselves, it means we aren't confident enough, and in that case, what's the point of attempting the pass? To gain 5–6 seconds by risking our lives?

When we feel we don't have enough time to complete an overtaking maneuver, the correct response is not to accelerate or force the situation, but to create time by slowing down, increasing the distance, or abandoning the maneuver altogether.

Time in traffic is not gained by rushing but by making the right decisions early enough.

In this case, preventive-defensive driving means constantly building up this time buffer so that we do not end up in situations where we are forced to react under pressure, and when we do find ourselves in such a situation, the most important thing is to recognize the warning sign: if we feel we don't have enough time, it's not just a feeling—it's the reality of that moment—and that is exactly when we must slow down, not rush the maneuver.

Immediate conclusions: Preventive-defensive driving does not mean avoiding risk solely through rules, but rather constantly creating the necessary room for maneuver—both physically and mentally—to make the right decisions when situations arise. In this case, the real difference isn't made when everything is going according to the rules, but when extreme situations arise. Only then can we see if we've maintained control, or if we've lost it without realizing it, just a few seconds earlier. In traffic, a lack of time is the first step toward losing control.

10.3 Frequent monitoring of the vehicle's rearview mirrors while driving and preventive-defensive driving

The first appearance of a rearview mirror, surprisingly enough, was in a book published in 1906. Dorothy Levitt and her book "The Woman and the Car" introduced readers to the concept of the rearview mirror. Eight years later, it was adopted by automobile manufacturers. No one expected just how important these exterior car parts would become. With the constant use of rearview mirrors, cyclists, motorcyclists, and pedestrians became protected from accidents. Rearview mirrors are mounted on cars and other vehicles, designed to allow the driver to see behind, to the side, or through the rear window of the vehicle.

Thus, by analogy, we have Fig 10 [11]:

- The left-side mirror allows you to see vehicles that may be passing the car you are in;
- The right-side mirror allows you to see vehicles you have already passed;
- The rearview mirror (center mirror) allows you to see vehicles behind your car, those that are in the blind spot of the side mirrors.

Fig 10: Interior and exterior rearview mirrors [11]

When practicing preventive-defensive driving, you should not look in your rearview mirrors for more than 2–3 seconds, in order to minimize the risk of an accident or sudden braking. These glances should be brief and repeated every 6–8 seconds. This constant awareness helps you stay informed about both the vehicles behind you and those beside you, thereby avoiding unexpected hazards.

Most drivers check their rearview mirrors only when making a maneuver: before changing lanes, before turning—sometimes too late, and others never at all.

It's important to remember that the traffic around us is constantly changing, even if we're driving straight and not making any special maneuvers. Vehicles behind us are accelerating, others are braking or changing lanes, motorcycles can suddenly appear from blind spots, and a driver might become aggressive or inattentive without us realizing it. For this reason, if we don't constantly check our

rearview mirrors, we lose this big-picture view. Essentially, we're driving without knowing what's happening around us.
A simple principle of preventive-defensive driving is to check the rearview mirrors of the vehicle we are driving every 6–8 seconds—not mechanically, but consciously, so that we understand what is happening around us. This way, we create a mental map of the traffic, knowing who is behind us, who is approaching, or who might become an imminent risk, and when an unexpected situation arises, we are no longer surprised because we already have the information.
Example: if we suddenly have to avoid an obstacle, we already know (since we're aware of the situation in advance) whether there's enough space to the left or right of the road, so we don't need to check again when avoiding the obstacle because we've already checked.
Immediate conclusions: Preventive-defensive driving isn't just about reacting to what's happening right in front of us. It means being constantly aware of everything happening around us. A vehicle's rearview mirrors aren't for maneuvering; they're for anticipating. It is important to make it a habit to check them constantly every 6–8 seconds, and we will have more control over traffic situations. When we know what is happening around us, our reactions become faster and safer.

10.4 The Influence of air fresheners and odors in the vehicle cabin on drivers and preventive-defensive driving

The air freshener in a vehicle's cabin significantly affects indoor air quality and, consequently, the health of passengers, potentially causing adverse effects ranging from minor discomfort to allergic reactions and respiratory problems.
The main ways in which air fresheners affect the car's interior:
Health impact:

- **Allergies and irritation:** Oil-based products can cause skin allergies and respiratory irritation;
- **Respiratory problems and headaches:** Air fresheners or other commercial air fresheners can lead to headaches and respiratory problems;
- **Toxic substances:** Many air fresheners contain hazardous chemicals, such as benzene (known to be linked to leukemia) and formaldehyde (associated with upper respiratory tract cancer);
- **Cardiovascular system:** Propane, present in some products, can affect the heart and kidneys.

Factors affecting intensity:

- **Heating system:** Air fresheners are used up more quickly and release a greater amount of substances during the cold season, when heating is frequently used;
- **Evaporation:** Evaporation-based air fresheners (such as pine-scented ones) are less consistent in releasing their fragrance.

Recommendations:

- **Eliminating the source of the odor:** It is more effective to identify and eliminate the cause of the unpleasant odor rather than mask it with an air freshener.
- **Ventilation:** The best way to freshen the air is to open a car window.

Although no one would have thought that the car air freshener—which most drivers hang from the rearview mirror—could have any effect, researchers in the field have shown that certain scents can, to some extent, alter our level of alertness.
On long drives, especially at night, the car's interior becomes our environment—the space where we breathe—and this environment directly influences our state of mind.
There are scents that keep us more alert: mint, citrus, and eucalyptus. These are fresh scents that stimulate attention and keep us more connected to everything happening around us.
A research team in China studied how olfactory stimulation with the scent of mint affects driver fatigue and alertness. The scientists analyzed both subjective and objective variables using a group of 34 volunteers, some of whom were tested while exposed to mint, while others were exposed to plain air. The researchers found that drivers who inhaled the mint scent reported lower levels of fatigue compared to drivers who inhaled only air. Reaction time indicators and eye movement variables also supported the finding that drivers' alertness increased during exposure to the scent of mint, but not during exposure to air [12].
There are, however, scents that have the opposite effect: lavender, vanilla, sweet or floral scents. These don't put us to sleep instantly, but they do help us relax; the problem isn't the scent itself. The problem is when we use it. If we're on a long, monotonous drive at night and feeling tired, a relaxing scent only pulls us further into that comfort zone and we start to lose alertness without realizing it (Fig 11). It's not sudden; it's subtle. We feel like everything is fine, under control, but our reactions are no longer the same.

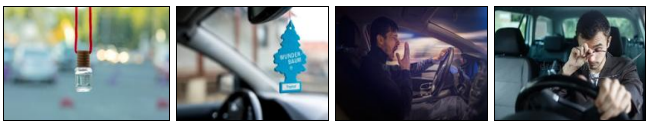

Fig 11: Car air fresheners and their effect on drivers

Immediate conclusion: Preventive-defensive driving means staying in control of even the smallest details around us—including the smell inside the vehicle we're driving—because if it smells like a spa, that's not the time to start relaxing ourselves.

10.5 GPS, travel time for a route, and preventive-defensive driving

GPS *(Global Positioning System)* it calculates the travel time for a route using a complex combination of real-time data, historical information, and advanced algorithms to estimate the ETA **(Estimated Time of Arrival)** (Fig 12). It does not rely solely on distance divided by the maximum legal speed, but takes into account a multitude of dynamic factors.

Fig 12: ETA – (Estimated Time of Arrival) from GPS system

Here's how the process works:

A. Factors taken into account when calculating the time:

- **Real-time data (crowdsourcing):** Apps like Google Maps or Waze analyze the speed at which other users are traveling on the same route. If thousands of phones report slow traffic, the GPS will increase the estimated travel time;
- **Historical data:** The system analyzes typical traffic on a specific road segment at a specific time and day of the week, taking into account rush hours or public holidays;
- **Speed limits:** The algorithms take into account the legal speed limits on each road segment;
- **Traffic conditions:** This includes traffic jams, accidents, or work on the road;
- **Road type and intersections:** The average wait time at traffic lights or roundabouts is added to the total travel time.

B. Routing algorithms:

The GPS uses algorithms: Such as Dijkstra's or A* to evaluate millions of possible routes between two points and select the fastest one (not necessarily the shortest).

C. Arrival time dynamics:

- **Continuous updating:** The estimate is not static. As you drive, the device recalculates the route based on new traffic information;
- **"Learning" behavior:** The GPS observes whether, on a certain road, even though the speed is lower, people arrive faster than on a parallel road, likely due to more right turns (which are faster) than left turns.D.

Key components:

- **Ground speed:** The GPS calculates the vehicle's actual speed by measuring the time it takes to change position relative to the satellites;
- **Departure/Arrival time:** Users can set a desired arrival time, and the app calculates when they need to leave, taking into account the estimated traffic conditions at that time.

Many drivers want to beat their estimated time of arrival (ETA), without realizing that "estimated" does not mean "guaranteed" it is merely an approximation. They drive not according to traffic conditions, but according to a number displayed on a screen. They see the arrival time and, without realizing it, start making decisions to beat it. These decisions are wrong and dangerous. In doing so, they accelerate harder, brake later, exceed the speed limit, and force their way through an intersection all just because they want to arrive 20–30 minutes earlier than the app indicates.

The problem is that the estimated time doesn't account for risks; it doesn't know how tired we are, it doesn't know how congested the traffic or the road actually is, it doesn't anticipate the intentions or mistakes of other road users, and it certainly doesn't take responsibility for the consequences of a wrong decision. It is merely an estimate, not a target to be met.

The moment we start driving with the idea that we need to make up for lost time, our driving style changes without us even realizing it. We become more rushed, more impulsive, and more willing to take small risks that, when added up, can create a more complicated situation.

Preventive-defensive driving means exactly the opposite; it means adapting our decisions based on the reality of traffic, not on certain algorithms. If the road is congested, we must accept the pace, density, volume, and intensity of the traffic. If a risk arises, it is important to slow down. If visibility is poor, we must not force these elements, because the goal is not to arrive faster than the GPS app estimates. The goal is to reach our destination safely.

Immediate conclusions: Arriving at our destination two minutes early won't change our lives, but a hasty, wrong decision can completely change our lives. We can use GPS apps as a navigation tool, not as a standard for how we should drive. We must be in control of the vehicle, not the app's estimated time. The decision is ours.

11. Conclusions

Preventive-defensive driving is a proactive driving behavior that minimizes the likelihood of being involved in an accident.

Preventive driving is practiced at all times and is essential for road safety and reducing the risk of being involved in unpleasant traffic incidents.

Defensive driving is considered, in a broader sense, an advanced form of defensive driving, focusing not only on avoiding one's own mistakes but also on neutralizing the dangers created by others. It serves as the "antidote" to aggressive driving, focusing on safety, fuel economy, and the protection of all road users.

Defensive driving is a requirement assessed at the European level for obtaining a driver's license and a driving style promoted to enhance safety.

European legislation encourages proactive and responsible behavior behind the wheel, where defensive driving means preventing accidents through anticipation and adaptation.

Defensive (or preventive) driving involves, according to the best practices promoted by legislation, maintaining a safe following distance, anticipating hazards, actively observing the environment, and constantly adapting one's behavior to traffic conditions.

By adopting a defensive driving style, drivers reduce aggression on the road and protect both their health and the condition of their vehicle. Although not mandatory, defensive driving courses are encouraged in Romania, and the government allows income tax deductions for the costs of completing them.

Driving a vehicle under conditions where avoiding danger is paramount is, in practice, defined by the legal obligation of every driver not to drive "blindly," relying solely on right-of-way, but to be prepared for any unforeseen event.

Traffic regulations and the responses of emergency services in the event of an accident always prioritize the rescue and protection of those involved.

Prompt and organized action at the scene of an accident securing the area, calling 112, and providing first aid not only saves lives but can also significantly reduce the degree of disability among victims.

Ignoring any of these three factors (power, space, time) turns overtaking from a routine maneuver into a major accident risk. The basic rule is: *"if in doubt, do not attempt to overtake."*

Travel time is dynamic and based on a combination of speed limits, historical data, and real-time traffic information provided by other drivers.

A safe speed is one that gives you total control over the vehicle you are driving at all times, regardless of what the speed limit sign indicates.

The safety margin is the difference between a driver who merely "drives" and one who "anticipates." It transforms panicked reactions into calm, controlled actions.

Before setting out, check that your seatbelt locks properly by giving it a sharp tug.

Proper safety belts adjustment ensures that force is distributed evenly in the event of a collision, keeping occupants securely in their seats and reducing the risk of injury.

Vigilance on the road means staying constantly aware of traffic and not letting your attention wander, regardless of road conditions.

Essentially, defensive driving means being aware of traffic risks and taking early action to avoid them. This saves lives and prevents property damage resulting from the destruction of vehicles, goods, cargo, street furniture, infrastructure, and the environment.

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