VEHICLE RESCUE SHEETS: OPPORTUNITIES AND BARRIERS IN THE SOUTH AFRICAN CONTEXT

M VANDERSCHUREN[1*], O VACULÍN[2] and A NEWLANDS[1]

[1]Centre for Transport Studies, University of Cape Town, Department of Civil Engineering, 1 Madiba Circle, Upper Campus, UCT, Rondebosch 7701, South Africa;
Tel: 021 650 2593; *Email: marianne.vanderschuren@uct.ac.za
[2]CARISSMA – Institute of Safety in Future Mobility, Technische Hochshule Ingolstadt, Esplanade 10, Germany; Tel: +49 841 9348-3803; Email: Ondrej.Vaculin@thi.de

ABSTRACT

Motor vehicle crashes are a major cause of road related human suffering. The latest WHO statistics (2023) quote 1.19 million fatalities and between 20 and 50 million injuries, globally, each year. While the Safe Systems Approach (WHO and UN, 2021) focusses on five pillars (users that may make mistakes, multimodal transport and land-use planning, road and roadsides, vehicle and speeds, as well as post-crash care), attention to each pillar differs significantly, not only in research, but also in practice. Research regarding entrapment in vehicles after road crashes is quite limited, even internationally. According to Nutbeam et al. (2021), up to 40% of road crash related hospital patients were trapped in their vehicles, prior to trauma transport and hospitalisation.

There is a phenomenon in trauma care known as the ‘Golden Hour’, which is commonly used to characterise the urgent need for the care of trauma patients. This term implies that morbidity and mortality are affected if care is not instituted within the first hour which occurs immediately after injury (Lerner and Moscati, 2001; Vanderschuren and McKune, 2015). Hence, patients who are trapped have worse outcomes than those who are not trapped, due to prolonged times at the scene.

In some countries, such as Germany and Spain, rescue sheets have been introduced to speed up the extraction process of trapped road crash victims. Rescue sheets provide information about vehicle safety functions, such as disconnecting the high voltage and other potential risk components in the crashed vehicle, such as batteries, fuel/gas tanks, airbags, gas generators, gas struts, as well as vehicle structure reinforcements. This information is provided by the manufacturers to speed-up the rescue process. Their aim is to help the first and second responders to make their rescue steps easier and quicker.

Since their introduction in the 2000’s, with the support of automobile clubs in some European countries, the rescue sheets are standardised, since 2015 (ISO 17840), and offered in a form of a free mobile App called Euro Rescue, launched in collaboration with CTIF and Euro NCAP. This paper provides an indication of the entrapment risk, as well as opportunities and barriers to the introduction of rescue sheets, in the South African context.

Keywords: Road safety, Rescue sheet, Golden hour, Vehicle entrapments, South Africa.

1. BACKGROUND

This paper is drafted by members of the TRANS-SAFE consortium[1]. The EU-Funded TRANS-SAFE project aims to identify and implement road safety interventions on the African continent. Various solutions are confirmed and tested, by bringing road safety agencies and experts from Europe and Africa together to drive an action agenda. The consortium members are highly experienced and knowledgeable in Africa-related research. Together, they drive forward effective approaches for road safety improvements.

The TRANS-SAFE consortium models its approach on solutions described in the most recent Safe Systems Approach description, as introduced in the 2021 report, drafted in collaboration between the United Nations (UN) and the World Health Organisation (WHO). In fact, the TRANS-SAFE consortium has reimagined the Safe Systems Approach, accommodating a multi-facetted proposition (for further information on this, see: Reimagining the Safe Systems Approach: From pillars to a framework).

While the TRANS-SAFE consortium aims to improve road safety on the African continent, four demonstration cities were identified to trial and demonstrate interventions. These cities are Cape Town (South Africa), Kigali (Rwanda), Kumasi (Ghana) and Lusaka (Zambia). In each city multiple demonstrations took place. The planning and roll-out of rescue sheets, the topic of this paper, is happening in South Africa and Rwanda. This paper reports on early results in the South African context.

2. RATIONALE

Road traffic fatalities claim 1.19 million lives every year (WHO, 2023) and remain a significant global crisis. Although the number of deaths, due to road traffic crashes, has decreased slightly since 2016, on average over 3 200 people still succumb on the global roads every day, costing countries around 3% of their gross domestic product (WHO, 2023). This reinforces the labelling of road traffic fatalities as a global pandemic (BMJ, 1973).

In its latest 'Global Road Safety Report' (2023), the World Health Organisation (WHO) reports that road fatalities have decreased by a mere 5% since 2010. This is nowhere near the target of a 50% reduction that originally was set for 2020 (WHO, 2013). The period from 2010-2020 was identified as the 'Decade of Action for Road Safety' (WHO, 2013).

In order to achieve the 50% reduction by 2020, the UN identified five pillars for road safety, namely road safety management, safer roads and mobility, safer vehicles, safer road users, and post-crash care (UN, 2020). These pillars form the basis of the 'Safe Systems Approach'. Very few countries managed to achieve a 50% reduction, leading to the launch of the second Decade of Action for Road Safety (2021 – 2030), with slightly adapted pillars (Vanderschuren and Mwaura, 2023).

While several countries that applied the Safe Systems Approach in a holistic manner made significant progress in reducing fatalities, showcasing the opportunities available, many did not manage significant reductions (WHO, 2023). Overall, 66 of the countries analysed by the WHO (2023) have seen an increase in road fatalities. Some 28 of these countries are on the African continent. Overall, Africa has seen a 17% increase in road fatalities (WHO, 2023).

[1] https://www.trans-safe.org/

Low- and lower middle-income countries are disproportionately affected by the road safety pandemic, bearing 57% of the global road traffic fatality burden, despite owning only 35% of the world's vehicles (WHO, 2023).

While the road fatality rate in South Africa has been steadily decreasing in absolute and percentage terms (RTMC, 2023) over the past several years, there is still substantial progress that needs to be made to meet the National Road Safety Strategy's goal of halving road traffic fatalities from 2010-2030. In the last thirteen years, there has been a 15% reduction in absolute fatalities, which shows that a lot of work still needs to be done (RTMC, 2023).

That said, the fatalities per 100 000 inhabitants in South Africa have reduced from 24.1 deaths per 100 000 population in 2010 (WHO, 2013) to 19 deaths per 100 000 population in 2021 (WHO, 2023). This, compared to the global estimate of 15 fatalities per 100 000 population and seven deaths per 100 000 population in Europe.

Africa, and more specifically South Africa, clearly still has a long way to go before road fatalities are meeting WHO (2013 and 2023) targets. To continue making improvements in road safety, it is essential that South Africa continues to follow international best practices as set out in the United Nations' second 'Decade of Action for Road Safety'. The introduction of rescue sheets is one of the best practices internationally identified, related to vehicles and post-crash care, in terms of the Safe Systems Approach. Furthermore, first responders call for more information on the scene (see Section 3).

3. RESCUE SHEETS

This paper assesses the opportunities and barriers to the implementation of rescue sheets in the South African context.

After a traffic accident, it is often necessary to extricate occupants from damaged vehicles. Although door opening is a typical evaluation criterion in standardised crash tests, it is not guaranteed for all real-life accidents, due to the different initial conditions, such as impact speed, barrier type, impact angle, etc.

The extrication process may involve actions ranging from the removal of a door to the complete dismantling of the vehicle, which can be time consuming. In order to start medical treatment as soon as possible, it is essential to minimise the extrication time. Since some parts of the vehicle structure are made of reinforced steel, vehicles are equipped with hazardous components, such as airbag gas generators or high-pressure gas springs, or have alternative propulsion systems, such as LPG, CNG or H_2 gas or high-voltage systems in addition to conventional petrol and diesel engines, simply cutting vehicle parts without prior knowledge of their location can be time-consuming and even dangerous for first responders and occupants. As new energy vehicles, including Electric Vehicles (EVs) are introduced to the market, unfamiliarity and the energy source itself may increase the risks.

"Rescuers come to me many times and ask: Dave, what is the biggest challenge out there in vehicle extrication? Others speak about alternative fuels, which really still boils down to hybrids, electrics and some hydrogen… The biggest challenge faced by rescuers in the realm of vehicle rescue is twofold. First off is dealing with the ever-increasing strength and the variety of combination of materials being used as vehicle structure reinforcements. Some can be cut, others not… The solutions are not always straightforward or easy to accomplish…The second is education on vehicle rescue. We need good, timely, pertinent information", indicates David Darymple, AIETecRI, who is a firefighter/EMT/ rescue technician for Clinton (NJ) EMS/Rescue, with 34 years of experience (https://www.fireengineering.com/technical-rescue/pillars-of-vehicle-rescue-2/).

It is extremely important to perform the extrication efficiently and safely based on detailed vehicle knowledge to protect both the occupants and the first responders. The first step in obtaining vehicle information is to identify the manufacturer, type and year of the automobile. However, even this task can be difficult, due to the large number of models and different powertrains for one model.

A rescue sheet is a document that contains information about the structure of the vehicle, including the location of cabin reinforcements, fuel tank, low voltage battery, high voltage traction battery, airbags, gas generators, control units, etc. It serves as a manual for first responders on how to access occupants who may be trapped inside the vehicle and indicates suitable cutting points.

Rescue sheets are supplied by vehicle manufacturers. The information is adapted for each brand and model. The rescue sheets allow the first responders to make quick and safe decisions on the scene of a crash, in order to get victims emergency medical care as fast as possible. A test carried out by FIA (Eicher, 2010) found that a rescue team with access to a rescue sheet completed their total rescue operation 30% faster than the team without a rescue sheet, showing the effectiveness of this tool in reducing time to remove entrapped victims. An example of the contents of a rescue sheet is provided in Figure 1.

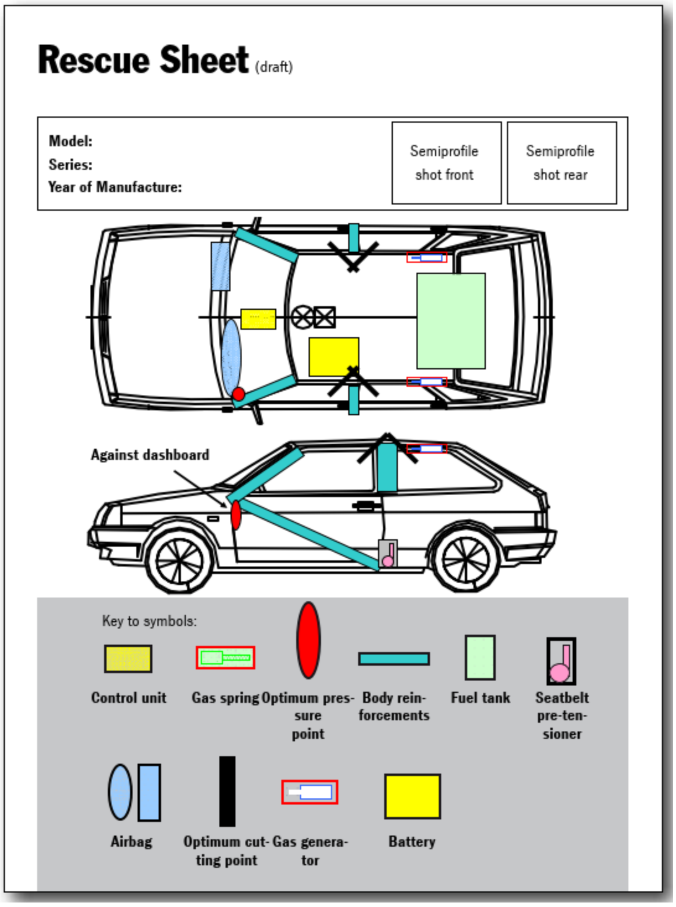

Figure 1: Standardised rescue sheet from ADAC (ADAC, n.d.a; FIA, 2010)

The fast identification of the vehicle brands and model are of high importance to first responders. Two approaches have been implemented in practice. The older approach is based on installation of the printed rescue sheet in behind the sun visor and indicating this information for the first responders by a sticker behind the wind shield as indicated in Figure 2. The stickers are distributed by national automobile clubs in some European countries. The newer approach is the use of an QR-code combined with an App for mobile devices and desktops.

The QR-codes can be purchased[2] and installed by the vehicle owner behind the windshield, on a B-pillar and in the tank cover. In the case of plug-in hybrid vehicles, the additional sticker is installed on the charging connector cover. The main issue of self-ordered stickers is the correct identification of the vehicle by its owner. Since each vehicle obtains and unique Vehicle Identification Number (VIN). The VIN is a 17-character long code, which contains also the information on the vehicle model and production year. The optimal way will be to derive the proper vehicle model by entering the first ten letters of VIN; however, this function is currently not implemented in the e-shop.

Figure 2: German version sticker informing about a rescue sheet on board (Eicher, 2010)

Some manufacturers equip their newer models with a standard QR-code. For example, QR-codes are installed in Mercedes vehicles manufactured since 2013. Another Original Equipment Manufacturer (OEM) installing QR-codes to the vehicles is Renault, which began with this activity for all passenger vehicles in 2020[3]. Some OEMs enable the generation of QR-code stickers for older models, allowing vehicle owners to order these stickers. Mercedes enables the ordering of QR-code stickers for models manufactured since 1990[4].

When a first responder arrives at a crashed vehicle, (s)he can scan the QR-code with an App. The App, which also enables off-line use for all rescue sheets, will open the respective page. Thus, first responders have real-time information on the vehicle involved in a crash.

The adoption of rescue sheets has been spearheaded by the ADAC, FIA, Euro NCAP (European New Car Assessment Programme), and the International Organisation for Standardization (ISO). Euro NCAP is a European vehicle safety rating system backed by

[2] E.g. https://www.res-qr.de; https://shop.rescuesheet.net/
[3] https://www.renault.de/safety/qrescue.html
[4] https://rk.mb-qr.com

the European Union, which introduced rescue sheet guidelines in 2020, in line with the ISO 17840 standard (2015) on rescue information (Euro NCAP, 2020a). The adoption of rescue sheets has been mostly prevalent in European countries, due to incentives given to vehicle manufacturers (Euro NCAP, 2020b). During the literature review for this paper, little information about the use of rescue sheets in other parts of the world was found.

As mentioned, rescue sheets were originally physical copies that were stored in the vehicle (usually behind the driver's sun visor, for example), easily accessible by rescuers (Unger and Sandner, 2010). However, in some crashes, it is not guaranteed that the rescue teams will be able to access a physical rescue sheet.

This new App approach is more comprehensive and covers the most common European models. However, the authors did not find some vehicle models or types, even if they are less than 15 years old. As a result, first responders lose valuable time searching for the proper vehicle model and type information. Another drawback is that the rescue sheets are in different languages. The app allows QR-codes to be scanned, providing the language required in respective European countries, which has been successfully tested on Mercedes vehicles.

In Europe, since 2018, vehicles are equipped with an eCall system that can transmit the VIN of a vehicle involved in a serious collision to the emergency services. This also helps first responders to identify the correct rescue sheet.

The future of the rescue sheets can be in 3D digital, as proposed in Deserno et al. (2021), as well as Sobotta and Deserno (2024). This approach shows the vehicle in 3D to help identify the critical rescue components. Further development, according to the authors of this paper, may lead to an augmented reality where the first responder has the information projected into his glasses to inform him in a virtual view, where the rescue critical components are located.

4. POST-CRASH CARE

As mentioned, post-crash care is one of the key elements of the Safe Systems Approach. The other four pillars of the approach aim to prevent road crashes from occurring in the first place, but in the unfortunate case a crash does occur, it is essential to have fast, effective post-crash care in order to reduce the negative impact of the crash (Vanderschuren and Mwaura, 2023). Emergency medical care immediately after a crash is extremely time-sensitive, and any delay can mean the difference between life and death (WHO, 2023).

Research has shown that over 30% of crashes result in extrication of people from vehicles (Weninger and Hertz, 2007; Dias et al., 2011). In order to reduce the likelihood of major injury or death, it is essential that trapped vehicle occupants are removed as quickly as possible in order to receive emergency medical care. Medical studies have shown that entrapped victims of road crashes are more likely to lose their life as a result of the crash or sustain more serious injuries than those not entrapped (Dias et al., 2011; Nutbeam et al., 2021). Additionally, the time it takes to extricate a victim from their vehicle has been found to be a good predictor of victim fatality or need for trauma care, highlighting the need for fast and efficient extrication methods (Palanca et al., 2003; Lerner et al., 2011). The 'Golden Hour' is a term that defines this reality – the term implies that mortality and injury severity are negatively affected if emergency care is not instituted within the first hour after a crash occurs (Vanderschuren and McKune, 2015).

In the study by Vanderschuren and McKune (2015) the average overall time from the moment a crash occurred to the moment that a patient receives medical attention in the hospital was calculated to be 60 minutes, based on provincial Emergency Medical Service (EMS) data. The different events and delays that occur in an EMS event are depicted in Figure 3. The 60 minutes mentioned above are based on the blue blocks provided in the figure. The worrying fact is that Vanderschuren and McKune (2015) established that 70% of the roads in the Western Cape Province are outside the 60-minute 'Golden Hour'.

Extrication of victims from vehicles is an extremely time-sensitive operation – every second counts when rescuing entrapped people after a road crash. Compared to the study by Vanderschuren and McKune (2015), extraction is an additional event. From Figure 3, it is clear that the provision of rescue sheets reduces the extraction time.

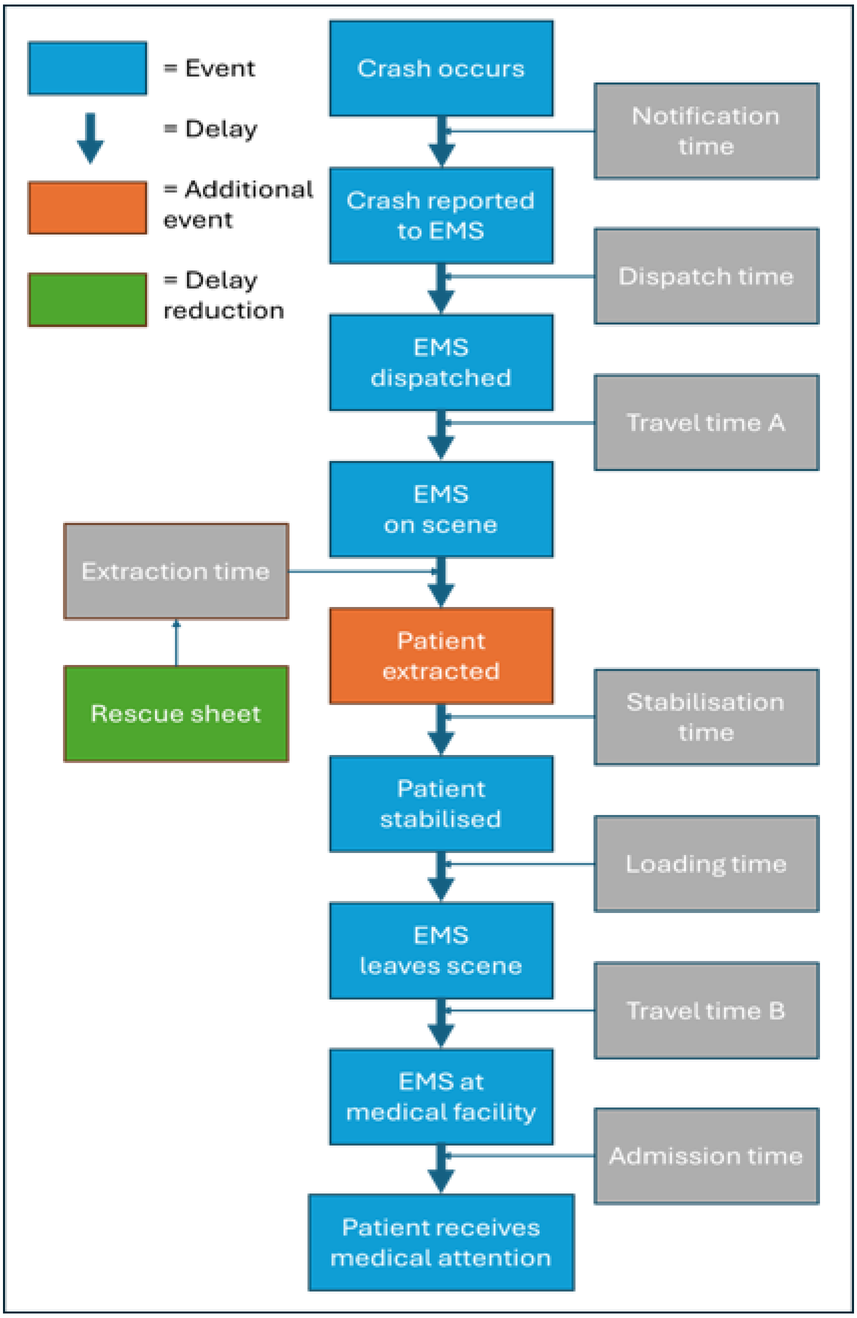

Figure 3: Post-crash event sequence (adapted from Vanderschuren & McKune, 2015)

While the increasingly safe design of vehicles has resulted in less entrapment of occupants, when entrapment does occur, extrication is more difficult. As can be seen in Figure 4, as the year of manufacture of a vehicle increases, so does the length of time taken to rescue occupants (ADAC, n.d.b). This is due to improved vehicle structural integrity, high-strength steel, and body reinforcement, which makes cutting through the vehicle a significant challenge for rescuers (FIA, 2010; Euro NCAP, 2023).

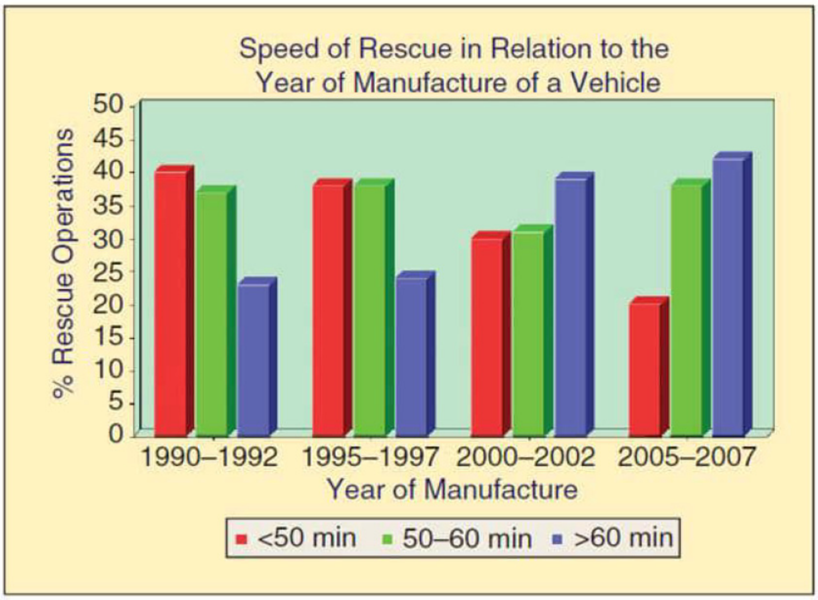

Figure 4: Impact vehicle manufacture year in relation to rescue speed (ADAC, n.d.b)

Additionally, components such as the fuel tank, control units, battery, airbags, and gas cylinders pose a threat to both the rescue team and occupants of the vehicles during a rescue operation (Unger and Sandner, 2010). Figure 5 shows the main challenges experienced at crash sites, with localising/disconnecting the battery making up nearly a quarter of the on-site rescue problems (ADAC, n.d.b). With an increasing number of electric vehicles on the road, this may become an even greater concern in the near future.

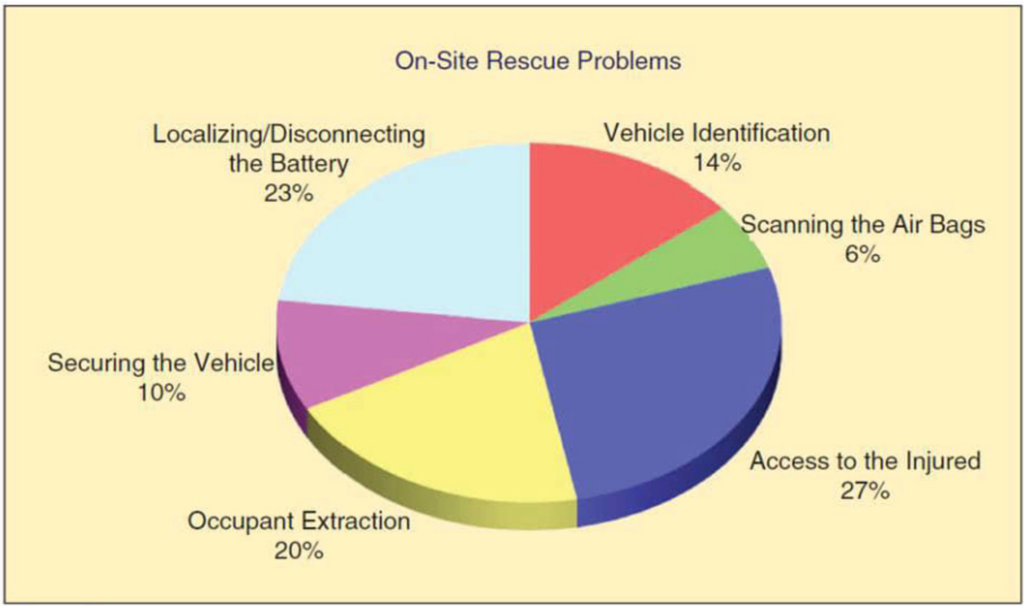

Figure 5: Main rescue problems at a crash site (ADAC, n.d.b)

5. WAY FORWARD

After almost 150 years of automobile industry based on the Internal Combustion Engine (ICE), global and local markets are changing. By 2050, South Africa's Green Transport Strategy (GTS, 2018-2050), released by the Department of Transportation (DOT, 2018), aims to cut greenhouse gas emissions by 50%. This will require a move towards EVs and other green energy adaptations, increasing unfamiliarity amongst emergency personnel and potentially high-risk energy sources. Hence, this move may increase the patient extraction risks, as described previously. Lane-Visser and Vanderschuren (2023) have estimated that meeting the DOT's goals will require a significant move towards EVs and other clean vehicle technologies by 2050.

In their 'Learning by Doing: Just Transition' scenario that meets the 2050 environmental aims, all rail and bus transport will need to be electric, as well as at least 42.5% of all passenger cars, and even part of trucking (short distances) will be electric (Lane-Visser and Vanderschuren, 2023). Just transition in this scenario assumes that all inhabitants benefit from new technologies and related economic opportunities.

As mentioned before, technology advantages have increased the complexity of vehicles, leading to a growth in rescue times (ADAC, n.d.b). A move towards EVs and other green energy sources will increase vehicle complexity even further. In turn, the rescue times may rise even further. Furthermore, battery technology embedded in EVs come with additional risks for trapped vehicle occupants and the rescue personal, due to its flammability, amongst others.

Based on this, it is clear that this is an opportune moment to introduce rescue sheets in the South African context. The first discussions with stakeholders have stated, namely:

- The University of Cape Town leases one electric vehicle for research purposes. This vehicle is shared by multiple users and investigators. The custodian of the vehicle is committed to trialling the rescue sheet for this vehicle.
- The Government Motor Transport (GMT) in the Western Cape has been experimenting with electric vehicles for a few years now. At the moment of writing this paper, 5 electric vehicles are included in the provinces fleet. GMT will be including rescue sheets in the EVs and will assist in liaising with rescue services in the province, so as to identify training needs.
- Golden Arrow Bus Services (GABS) has ordered 120 electric buses, which will be arriving in Cape Town during the course of 2025. The first electric buses will be providing transport services from February this year. GABS will be including rescue sheets in the electric buses. These drivers of these buses will receive training regarding rescue requirements. There is consideration to also include the training of provincial rescue personnel.
- The Tshwane Automotive Special Economic Zone (TASEZ) is identifying training opportunities for the automobile industry. In a discussion, training around rescue sheets was identified as one of the opportunities for advancing knowledge and skills in the industry. This will go hand in hand with encouraging their industrial counterparts to incorporate rescue sheets into their vehicles. TASEZ is committed to collaborate with the University of Cape Town and the TRANS-SAFE consortium. The rescue sheets will be the first step in this collaboration.
- The National Department of Transport has also been informed of the project, and will be provided feedback on the outcome of the pilot studies in the South African context. Development of national training programs could then also be considered based on the outcomes.

Within the South African context, the abovementioned stakeholders agree that the traditional way of introducing rescue sheets, i.e. a paper copy somewhere in the vehicle, is not preferred. Within the country a QR-code implementation will be trialled. All electric buses and private cars described will display their specific QR-code in multiple places behind the window. The TRANS-SAFE consortium looks forward to sharing results from the pilot in the near future.

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