Virtual ITS European Congress, 9-10 November 2020

Paper number ITS-SP2042

Stakeholder requirements for aftermarket eCall systems in Europe

Dr. Fatih M. Özel

OECON Products and Services GmbH, Germany, oezel@oecon-line.de

Abstract

All new types of M1 (cars) and N1 (light commercial vehicles) vehicle categories registered in the European Union from 31 March 2018 are required to have eCall functionality. Hence, more than 300 million vehicles that are already on European roads cannot benefit from the deployment of eCall. To define the standards and specifications and pave the way for deployment of aftermarket eCall systems, Project sAFE co-funded through the 2018 call of the Connecting Europe Facility was launched. As a part of the project, stakeholder requirements for aftermarket eCall systems were investigated with semi-structured in-depth interviews. It was found that although some requirements for aftermarket systems are same as regulated eCall systems, some requirements (i.e. installation and triggering) do not exist and/or different, and they need to be determined throughout sAFE Project for ensuring the full functionality, compatibility, interoperability, continuity and conformity of aftermarket devices across Europe.

Keywords:

Project sAFE, aftermarket eCall, stakeholder requirements

1. Introduction

With the unparalleled growth of motor vehicles, traffic accidents causing injuries and fatalities are one of the most serious issues in the world. Although the number of road deaths in the European Union (EU) decreased by 52% between 2001 and 2015, and the EU has the lowest fatality rate of any region in the world; approximately 70 people die on European roads and 370 people suffer serious road traffic injuries every day [1].

Automated car accident detection, or eCall is an emergency call that can be generated either manually by vehicle passengers or automatically via activation of in-vehicle sensors when a serious road accident occurs. When activated, the in-vehicle eCall system establishes a 112-voice connection directly with the relevant Public Safety Answering Point (PSAP). Even if no passenger can speak, for instance owing to injuries, a “Minimum Set of Data” (MSD) is sent to the PSAP to allow emergency responders to reach passengers as soon as possible [2].

In literature, it was proved that the consequences of traffic accidents regarding injuries and fatalities depend strongly on the response time of the emergency services. The response time can be defined as the time that takes place between the occurrence of the accident and the arrival of services to the site [3]. In that context, eCall saves lives or decreases the seriousness of injuries by relaying crucial information to emergency responders faster and, thereby, reducing their response time significantly. In fact, previous studies found that the response time can be reduced by 50% in rural and 40% in urban areas [4]. Therefore, all new types of M1 (cars) and N1 (light commercial vehicles) vehicle categories

registered in the EU from 31 March 2018 are required to have eCall functionality.

However, there are already more than 300 million vehicles on European roads and these vehicles cannot benefit from the deployment of eCall, as eCall currently only applies to new vehicles where eCall device is integrated as a part of the vehicle assembly process. Project "sAFE - Aftermarket eCall For Europe" [5] was therefore launched to create, and in the future deploy, an effective and affordable eCall solution for different vehicle categories including cars, light commercial vehicles, coaches and buses, agricultural vehicles, large goods vehicles (LGVs), tricycles and quadricycles through the deployment of standards, operating procedures, testing and certification. In this paper, stakeholder requirements for aftermarket eCall are investigated by conducing in-depth and semi-structured interviews with individuals representing organisations in the eCall aftermarket service chain.

2. Methodology

The methodology was based on the seven stages of an interview investigation [6]. The first stage was formulating the aim of the study (stage 1 – thematizing). Then, in-depth and semi-structured interviews were selected, and interview questions were prepared in order to answer the research question (stage 2 – designing). Next, the interviews were conducted based on the interview guide and on a one-to-one basis with experts in different domains (stage 3 – interviewing). Post interview, the recorded interviews were transcribed for analysis (stage 4 – transcribing). Qualitative analysis of the interview transcripts was then undertaken to seek patterns, themes, and meanings explaining expert answers (stage 5 – analysing). The results of the qualitative analysis were provided with exemplars from the interview transcripts and key themes. The results were compared with the aims and objectives of the study (stage 6 – verifying). The results of the study were then communicated with reports (stage 7 – reporting).

3. Thematizing

Road safety is one of the major elements of the EU's transport policy. eCall saves lives or decreases the seriousness of injuries by relaying crucial information to emergency responders and reducing their response time significantly. To support the harmonised implementation of an interoperable eCall service in the, all new types of M1 (cars) and N1 (light commercial vehicles) vehicle categories registered in the EU from 31 March 2018 are required to have eCall functionality as a standard feature. However, since the legislation requires that eCall in-vehicle system (IVS) will be controlled by the vehicle "Type Approval" process, only new model vehicles are equipped with eCall. This means that the benefits of eCall will only be realised by new vehicle models and those benefits are expected to be ubiquitous after 2030s. Since some Member States have much slower vehicle replacement cycles, a slower market penetration is expected in those countries. It should also be noted that these countries have higher accident rates which mean that they require more urgent solutions such as eCall to reduce the accident rates.

By equipping vehicles with aftermarket eCall devices, market penetration of eCall devices might be significantly increased. Nevertheless, such solution requires its own challenges especially by considering that vehicle categories that are not covered by the eCall regulation will also be equipped with such devices. Some challenges include false calls overloading PSAPs and wasting scarce

resources as well as the provision of non-standard information that is incoherent to the PSAP. Such situation would have significant negative impacts on costs and privacy as well as road safety.

In order to address these issues, it is very significant to understand stakeholder requirements and use this information as a basis to determine minimum requirements for aftermarket eCall devices and to test both those minimum requirements in practice, and to provide draft normalisation deliverables (draft Standards) to which any regulation can reference, for the safe and satisfactory operation and reliability of such devices. With this approach, it is aimed to guarantee the full functionality, compatibility, interoperability, continuity and conformity of aftermarket devices for different vehicle categories across Europe.

4. Designing and interviewing

The type of interview used involved an in-depth and semi-structured (that is qualitative / informal conversational / guided) approach. In-depth interviewing seeks to achieve the same level of knowledge and understanding possessed by the respondent and to understand personal experiences and perceptions within a contextualized, social framework [7]. In-depth interviews are conducted on a one-to-one basis. These interviews typically last from 30 minutes to more than an hour. They attempt to uncover underlying motives, prejudices, or attitudes towards sensitive issues. The goal is to get the deepest possible understanding of the setting being studied. This requires identifying expert participants who can provide information about the particular topic and setting being studied. For example, interviews are arranged with a predetermined number of people from different categories (e.g. by job title or rank). This type of interview was chosen as it was seen as a useful tool for enabling comparison of views of respondents from different backgrounds or if you have different people asking the questions. The first of these was a factor in this investigation.

The selected approach was conducting a number of semi-structured interviews with individuals representing organisations in the potential eCall aftermarket service chain. The interviewees were chosen intentionally from the organisations which were engaged in eCall related activities with the specific intention of providing different requirements for eCall aftermarket devices. Interview candidates meeting those criteria were identified by using Project sAFE database. The interviews were conducted based on an interview guide. The identification and interviewing process continued until the theoretical saturation (main requirements for aftermarket eCall) was achieved. In that context, a total of seven interviews were conducted. In terms of interviewed data, the emphasis was on quality rather than on quantity.

5. Transcribing and analysing

Post interview, the material was prepared for analysis. Qualitative (thematic) analysis of the interview transcripts was then undertaken to seek patterns, themes, and meanings that generate in-depth understanding of the phenomenon of interest. Qualitative analysis is approached as a critical, reflective, and iterative process that cycle between data and an overarching research framework that keeps the big picture in mind. The analysis is inherently a process of interpretation. We should not be afraid to ask questions of the data. These questions can be informed by theory or our own observations, hypotheses or hunches. If the analysis is rigorous and transparent then the data should be able to

support or not support these. This is the important part - the data should support or refute our ideas; we should not fit the data into the story we want to tell.

There were two parts to analysing the data, as given below:

- *"Content analysis" steps:* Read transcripts > Highlight quotes and note why they are important > Code quotes according to margin notes.
- *"Exploration analysis" steps:* Sort quotes into coded groups (themes) > Interpret patterns in quotes > Describe these patterns.

In this context, codes are tags or labels for assigning units of meaning to descriptive or inferential information. Coding is the process of organising the data into "chunks" that are alike, moving from words and sentences to "incidents". The results of the thematic analysis are given in the following sub-sections.

5.1. Installation

For aftermarket eCall systems, three types of installation can be distinguished:

- *Permanently attached aftermarket eCall system:* This device is affixed in such a manner that it is attached to the framework of the vehicle, and the IVS, apart from any activation buttons and warnings, is concealed within the vehicle.
- *Semi-permanently attached aftermarket eCall system:* It is very similar to the permanently attached systems although it can be detached from the vehicle by a specialist if required.
- *Itinerant eCall system:* This system might be plugged into a vehicle power supply and it is capable of being detached and/or moved to a different vehicle, or is an application operating from a communications device such as a mobile phone.

Hence, the question to experts was which type of installation would be appropriate for different vehicle categories and how they would overcome installation challenges. Some exemplars are given below:

"I clearly prefer an installation by a specialist in the workshop. However, if devices such as eCall Dash cams come on the market, their installation will be very easy and include eCall. It is then essential to check the entered data (mainly the VIN) online for validity. A SIM card and a GSM modem for online access is available due to eCall"

"Installation should be done very carefully by a dealer. We should not leave it up to the end users. Of course, the installation location is also important. You should not put the device under your seat. How will you then manually activate it?"

Permanent fixing in a service place is desired. End user installs it on its own without any technical supervision might be a very big problem. Biggest problem is VIN number. Very significant for PSAPs"

The desired solution was therefore permanent or semi-permanent fixing at an authorised service place by a certified and approved installer that configures the IVS appropriately prior to or immediately after fitment. The rationale behind this statement is to ensure that these devices do not become detached in a collision or incident and not become a danger to the occupants of the vehicle as well as operate reliably after the accident. To achieve that installation location should also be selected in a way that it minimises potential for accidental damage as well as the risk of injury to vehicle occupants in the

event of a crash or during the day-to-day use of the vehicle.

Different vehicle categories such as P2W might also require different installation types and procedures. Moreover, the integration of eCall into the existing and emerging devices such as dash cams and navigation systems might support the deployment of itinerant systems and, therefore, self-installations. Nevertheless, as this is a very sensitive issue, the feasibility of such solution will be further explored in Project sAFE.

5.2. Audio quality of IVS

The existing eCall regulation assumes transmission of voice via the vehicle audio system although it does not specifically require that. Nowadays, many modern vehicles provide a USB input port to the vehicle audio system, and such a port could be used both to provide power to an aftermarket eCall system and a voice connection link via the audio system of the vehicle (similar to a USB connected smartphone). However, since the location of the USB port varies greatly from one vehicle model to another, it presents more complex anchorage/fixing of the eCall system equipment. Moreover, older vehicles do not provide a USB input port to the vehicle audio system.

Another significant issue might be the transmission of minimum set of data (MSD). According to the standard (EN 16062) underpinning regulated eCall, the vehicle audio is disconnected during the period that the MSD is transmitted.

Against this background, the question to interviewees was what audio connection requirements aftermarket systems should provide. Some exemplars from the interview data are given below:

"They should provide their own microphone and speakers. Microphone and speakers should also be tested and certified. They should be installed to the specific places, not next to the engine. There might also be considerations regarding noise algorithms to mitigate noises"

"*PSAPs must have audio connection. We need to know what is happening. We always think about the worst-case scenario. Even if the driver cannot talk, we want to hear the environment. Best solution is using the systems connected to the vehicle audio system. Coaches and motorcycles do not have on-board entertainment. eCall devices for these vehicles should have their own microphones"*

"For me, retrofit systems are black boxes. They should have all the functions on board. In contrast to commercially available hands-free systems, eCall microphones should not hide the background noise. If the people are unconscious and unable to speak, the background noise can provide valuable information (such as fire sounds)."

It was therefore clear that the responses of the interviewees varied, possibly owing to two main reasons. Firstly, different installation types as discussed in the previous section might require different audio requirements. For example, permanent and semi-permanent type installations might require connection to the vehicle audio system while some devices with itinerant type installations might require connecting to additional speakers and microphones fitted specifically for eCall. Secondly, different vehicle categories such as buses and coaches as well as P2W might require different audio connection requirements.

5.3. Power supply to IVS

As discussed in the previous section, there are several power supply architectures that could be

envisaged for aftermarket eCall. However, it is an increasing trend that the power supply of a vehicle is disconnected/disabled after a significant crash. Since an eCall system requires power after a crash, whilst the system may rely on the vehicle power supply to recharge its own power sources during normal times, post triggering, it cannot rely solely on the vehicle power supply to maintain an eCall session. In fact, EN 16062 requires that

"Following call clear-down by the PSAP the IVS NAD shall remain registered on the serving network and available to receive calls from the PSAP and rescue workers for a minimum period of one hour as defined in EN 16072"

An aftermarket eCall system should therefore be able to maintain a voice call for up to 60 minutes or receive a call-back from a PSAP at any time up to 60 minutes from the successful send of the MSD. The significance of the extra power supply was also recognised by the interview study. Some exemplars are given below:

"They should have their own battery to ensure that they have power after a serious accident"

"For me, retrofit systems are black boxes. They should have all the functions on board and also be equipped with a backup battery in order to be able to trigger eCalls even when the vehicle electrical system is no longer available"

5.4. Communication with PSAPs

Impact of retrofit and aftermarket eCall systems regarding PSAPs are discussed in the following sub-sections.

5.4.1. Retrofit eCall systems

The manufacturers of M1/N1 category vehicles are, by the Regulation (EU) 2015/758 [8], required to equip all new M1/N1 vehicles with 112-eCall either as the main eCall system, or the fallback, at vehicle owners' discretion, or failure of, an additionally fitted EN1602 third party eCall system/service. A retrofit system installed into a previously type approved vehicle by the manufacturer of the vehicle (or its agent) will operate by using sensors in the vehicle in accordance with the Standards referenced in the Regulations.

However, for PSAPs, a 112-eCall from a retrofit system is identical in all aspects to a 112-eCall from a system fitted into a vehicle under the Regulation. Therefore, no additional provisions are required for such retrofit systems in respect of the interface/transaction with the PSAP, or the way that the PSAP handles such calls, and such systems can be tested under EN 16454.

5.4.2. Aftermarket eCall systems

Aftermarket systems might be analysed under different categories. The first division is that there are systems that are direct calling 112-eCall systems, and systems that operate via a third-party service provider (TPS-eCall).

5.4.2.1. Aftermarket TPS eCall

While the formal position of the European Commission is that TPS eCall systems are tolerated, but not specified other than they must be conformant to EN 16102, and the required fallback from, at vehicle owners' discretion, or failure of, an additionally fitted EN 16102 third party eCall system/service, to 112-eCall. This fallback is desirable for aftermarket systems, but it is not required (as it is working

outside of the regulation).

In a TPS-eCall scenario, when an eCall is triggered, the vehicle makes contact with the TPSP, the TPSP validates the need to contact the PSAP, and, conformant to EN 16102, it is the TPSP, using a landline, who contacts the PSAP, provides the MSD equivalent, and if requested attempts to make voice contact between the PSAP and the occupants of the vehicle. In order to be compliant to EN 16102, there must be the capability at least for the TPSP to talk with the occupants of the vehicle. However, the initial contact by the TPSP with the PSAP is identical for aftermarket TPS-eCall to that with a manufacturer installed TPS-eCall system.

The interview data disclosed that the experts also think similarly with the above-mentioned requirement. Some exemplars are given below:

"TPS provider can sign a contract to directly contact with the PSAP. It is up to TPSP to put the contract in place, and there is a standard for it"

"Direct voice communication is recommended especially for the cases requiring instant solutions, meaning real emergency. Therefore, it would be sensible to distinguish emergency situations by categorising them real emergency and secondary"

"I think a voice link between the vehicle and PSAP would be useful"

"TPS and direct communication is not possible. They cannot be used in the same sentence"

In brief, for TPS-eCall systems, the only requirement regarding the interface with the PSAP is that it should be in accordance with EN 16102. Accordingly, for a PSAP, if the system is compliant to EN 16102, then a TPS-eCall from an aftermarket TPS-eCall system is identical in all aspects to a TPS-eCall from a system fitted into a vehicle covered by the Regulation. No additional provisions are therefore required for such retrofit systems regarding the interface/transaction with the PSAP, or the way that the PSAP handles such calls, and can be tested under EN 16454.

5.4.2.2. Aftermarket 112 eCall

For this type of systems, there should normally always be a voice link as specified in EN 16062/EN 16072. These standards do not directly have minimum requirements for the quality of the voice communication between the PSAP and the occupants of the vehicle. But the regulation 2015/758 [8] carries the caveat:

"(18) The 112-based eCall in-vehicle system, as an emergency system, requires the highest possible level of reliability. The accuracy of the minimum set of data and of the voice transmission, and quality, should be ensured, and a uniform testing regime should be developed."

5.5. Workload on PSAPs

One fact regarding eCall systems is that they do not increase the number of incidents. The eCall system simply notifies the PSAP more rapidly about an incident. Similarly, equipping vehicles with aftermarket eCall does not increase the number of incidents, just changes the timing when the PSAP received notification of an incident.

Against this background, the interview study aimed to learn the experts´ opinions regarding impacts of aftermarket systems on PSAP workload. Some exemplars from the interview data are given below:

"When fully equipped with eCall in an accident involving two vehicles, there are also at least two

eCalls - where just one call in the PSAP was sufficient. One should also not underestimate that third parties passing the accident also press the eCall button to report the accident. This can lead to a higher volume of calls"

"The biggest risk is posed by manual eCalls - calls that are an "emergency call" to the driver ("no gas", "engine defect"), but are not relevant to the PSAP"

"It will increase the number of false calls to PSAPs, especially owing to the manual triggering. To avoid that some warnings should be given: i.e. this button should be pressed only in case of an emergency"

Therefore, although, theoretically, workload on PSAPs should not be increased, in practice, the number of calls to PSAPs is expected to be increased owing to the manual false calls or not PSAP relevant eCalls or automatic eCalls generated by different vehicles involved in the same accident.

5.6. MSD

Contents of the MSD are complex, including detail of the vehicle identification number (VIN) and United Nations Economic Commission for Europe (UNECE) vehicle classification. However, these complex data fields are very significant for PSAPs to save lives. The risks of error in the MSD data content should therefore be avoided. If the data is unreliable, then it is of significantly less use to the PSAP. In that context, possible impacts of aftermarket systems on MSD are discussed in the following sub-sections.

5.6.1. Retrofit 112-eCall systems

Since retrofit 112-eCall systems are installed by the vehicle manufacturer or its agent, it would seem, and should be a reasonable requirement that the MSD is as defined in EN 15722.

5.6.2. Aftermarket 112-eCall systems

As discussed before, the interviews disclosed that the desired installation solution is the permanent and semi-permanent installations made by authorised, certified and approved installers. In such a scenario, the system is installed in accordance with the relevant procedures, standards and legislations. To ensure that system operates appropriately with correct VIN number and do not interfere with other vehicle systems, the installed system is also tested. Thus, MSD fields would be correct after the installation. However, for itinerant systems that eCall is integrated into the existing and emerging devices such as dash cams and navigation systems that might be self-installed would be more problematic. This is especially in the case of the VIN number.

The question was therefore how the interviewed experts would identify the MSD requirements. Some of the answers are given below:

"PSAPs need to know if an accident has happened. MSD has been tested for passenger vehicles and do not require changes. For LGVs, there has been lots of work going during the last 8 years. There is a link PSAPs can get the load information"

"For, LGVs, we want to know what is transported. These categories of vehicles should be dealt with very carefully. Crucial info should be sent to the emergency services. But eCall can only be a part of this information"

"A field for additional vehicle types already exists in the MSD and should be used. Additional data

can be accommodated in the OSD - but you should avoid that in my opinion. Additional data also requires new decoders in every (!) PSAP. Therefore, it would be best to limit yourself to the already defined MSD and to allow additional data (e.g., dangerous goods), but to flag as optional in the standard"

It was therefore clear that no change on the MSD was required. However, the significance of optional data fields, i.e. load type for LGVs carrying dangerous goods, was highlighted by the experts. Since a field for additional vehicle type also exists, the new vehicle categories can be accommodated in the MSD. Such conclusions stem from the expectation that most installations will be made by an authorised, certified and approved installer. However, for itinerant systems that are self-installed, this might be problematic. Solutions for these systems should be found by Project sAFE partners.

5.7. Triggering parameters

Triggering parameters are crucial to minimise the risk for false calls to PSAPs. In that context, the interview study explored expert opinions regarding triggering requirements for different vehicle categories. The following statements were given by the interviewees:

"For motorcycles, falling does not necessarily mean an emergency. Acceleration and deceleration are also important. There should be threshold values. What is the threshold value? Is it a hard brake? How shard should I break? Or, can hard brake and motorcycle falling be an emergency accident? Trucks are a completely different story. For example, a truck´s load is CNG. We can measure pressure. If it suddenly reduces, it means there is a leak. It can be an emergency situation. Or similarly temperature reduces or increases suddenly. We can monitor the load and its dangerous characteristics. If eCall triggered manually, it is a different story. Any vehicle that is rolled over might be having problems but it does not mean an emergency"

"In my opinion, the trigger in M1-like vehicles should be the same as in the previous eCall standard. There, the negative acceleration that also triggers an airbag is defined as the trigger (although the detector does not have to be the same). In the case of large vehicles (trucks, buses) a triggering by means of a camera system is conceivable; also proximity sensors can be used. Even more difficult is the release of eCall on powered two-wheelers"

Experts were also consulted to define measures in order to reduce generated falls calls. Some examples from the interview data are given below:

"As a PSAP, I do not want to have any falls calls. But, as a driver, I want it to work when I have an accident. Threshold values should be determined very carefully"

"Difficult question. In principle, false calls can also occur in the current eCall. Because even if the airbag triggers, someone is not automatically injured and needs help from the PSAP. This will happen more often with aftermarket systems. So, to minimize false calls, you probably need to allow user intervention. The driver can then cancel the eCall within maybe 10 seconds if he sees no reason for an eCall"

"In order to avoid false triggering, the requirements should be designed and clarified both in law and standards. IVS should meet certain false triggering threshold values. There should also be testing requirements for type testing"

In brief, to ensure eCall aftermarket system operates correctly following a collision or an incident, and it does not swamp PSAPs with false calls, parameters and threshold values should be determined to specify what level of collision will trigger an eCall. With those parameters, minor and serious crashes should be differentiated, and only serious collisions should be allowed to trigger an eCall. Falls manual eCalls can also be reduced with better HMI designs that inform users and let them know that it is a safety feature and should only be used in case of emergencies. Moreover, different vehicle types might require different triggering systems for automatic and manual activations. For example, manual activation can be operated from outside of the vehicle for forestry, agricultural and plant type vehicles to support operators that might be injured by machinery or injured away from the vehicle in a remote location.

5.8. Data communication technologies

The expansion of the coverage of eCall from 2G/3G circuit switched technology to enable eCall over packet switched technologies and in an IP communications paradigm, using LTE/4G/5G communications technologies and/or satellite communications technologies are also explored within the project sAFE. Moreover, IMS-eCall can be supported by geostationary satellite telephone communication networks providing access to the internet. Since most current generation satellite telephone systems provide access to the internet, they can also support IMS. This means that as long as there is antenna access to send/receive signals, even the vehicles in remote locations can communicate with PSAPs in case of emergencies

The interview study therefore examined the interest between experts as well expected benefits and challenges regarding eCall using IMS. Some exemplars are given below:

"I do not understand it and I do not think that it is very relevant for PSAPs. We need to focus issues at hand: false calls. As PSAPs, we are conservative when it comes to technology. We prefer work with existing, reliable and tested technologies. Now in-band communication is used. Technology will of course change. But we need to plan and be ready for it"

"The main problem for PSAPs with IMS eCall will be that the current decoders cannot be upgraded easily. So far, the technique assumes that eCall is analogue transmitted data (voice channel). So, there will have to be new, additional decoders that will cost quite as much as the original equipment"

"PSAP equipment should be connected to the network and upgraded. MNOs should identify the requirements. However, if there is no regulation, PSAPs will be reluctant to implement them, as they are costly and require changes"

"You have to be compatible with other technologies. 2G is dying out. Digital communications are much more straightforward, and they will ensure future compatibility. They also provide wide range of solutions. It opens up many doors, for example opportunities for small companies, access to much wider population etc."

It was therefore clear that although such communication methods are seen beneficial and nice to have features such as for agricultural and forestry vehicles that are used in remote areas, they are not considered as vital to solve the challenges industry is facing. It is thought that, firstly, the existing problems such as high number of false calls PSAPs receive should be solved. Moreover, as such

features require upgrades on PSAP equipment, they mean high costs for PSAPs. In that context, it is expected that PSAPs will not implement such solutions as long as the costs for upgrading decoders decrease significantly and/or related regulations come into effect.

6. Conclusions

In this paper, stakeholder requirements for aftermarket eCall systems were explored and identified as a part of Project sAFE. This was achieved by conducting a number of in-depth and semi structured interviews with individuals representing organisations in the potential eCall aftermarket service chain. It was found that:

- Permanent or semi-permanent fixing at an authorised service place by a certified and approved installer is a desired installation solution. Installation location should also be selected in a way that it minimises potential for accidental damage as well as the risk of injury to vehicle occupants in the event of a crash or during the day-to-day use of the vehicle. Moreover, the integration of eCall into the existing and emerging devices such as dash cams and navigation systems might support the deployment of itinerant systems and, therefore, self-installations. Nevertheless, as this is a very sensitive issue, it should be further explored in other Project sAFE activities.
- Whereas permanent and semi-permanent type installations might require connection to the vehicle audio system while itinerant type installations might require connecting to additional speakers and microphones fitted specifically for eCall. Some measures might also be required to ensure that noises emanating from within the vehicle be muted and/or do not cause interference/inhibit transmission of the MSD.
- An aftermarket eCall system should be able to maintain a voice call for up to 60 minutes or receive a call-back from a PSAP at any time up to 60 minutes from the successful send of the MSD.
- For PSAPs, the communication procedures with the passengers of the vehicles will be the same for retrofit and aftermarket devices as there are existing standards for them (i.e. EN 16454 for retrofit systems, EN 16102 for TPS eCall systems, and EN 16062/EN 16072 for aftermarket 112 systems.) Therefore, no additional provisions are required for such systems in respect of the interface/transaction with the PSAP, or the way that the PSAP handles such calls, and such systems can be tested under related standards.
- As the number of calls to PSAPs is expected to be increased owing to the manual false calls or not PSAP relevant eCalls or automatic eCalls generated by different vehicles involved in the same accident, workload on PSAPs is also expected to be increased.
- In terms of MSD, no change for aftermarket eCall systems is required (same as defined in EN 15722) However, the use of optional data fields, i.e. for load type of LGVs, might be significant for PSAPs. Since a field for additional vehicle type also exists, the new vehicle categories can be accommodated in the MSD.
- To ensure eCall aftermarket system operates correctly following a collision or an incident, and it does not swamp PSAPs with false calls, parameters and threshold values should be

determined to specify what level of collision will trigger an eCall. With those parameters, minor and serious crashes should be differentiated, and only serious collisions should be allowed to trigger an eCall. Falls manual eCalls can also be reduced with better HMI designs.

- Although, IMS-eCall and satellite communications are seen beneficial and nice to have features such as for agricultural and forestry vehicles that are used in remote areas, they are not considered as vital to solve challenges the industry is facing. Moreover, as such features require upgrades on PSAP equipment, they are associated with high costs. It is therefore expected that PSAPs will not implement such solutions as long as the costs for upgrading decoders decrease significantly and/or related regulations come into effect.
- Different vehicle categories might require different installation types and procedures, audio connection requirements as well as different triggering systems for automatic and manual activations. This should be further analysed and minimum requirements for different vehicle categories should be determined throughout Project sAFE.

7. References

[1] European Commission, “Road Safety in the European Union: Trends, challenges and main statistics.” 2016.

[2] P. Kremonas and J. Pâris, “eCall: Everything you wanted to ask, but did not know how...,” 2015. [Online]. Available: https://eena.org/wp-content/uploads/2018/11/eCall-factsheet.pdf?item_id=111. [Accessed: 08-Aug-2019].

[3] A. Bonyár *et al.*, “A review on current ecall systems for autonomous car accident detection.,” in *40th International Spring Seminar on Electronics Technology (ISSE)*, 2017, pp. 1–8.

[4] Heero 112, “Harmonised eCall European Pilot (Heero 112):About eCall,” 2013. [Online]. Available: http://www.heero-pilot.eu/view/en/ecall.html. [Accessed: 08-Aug-2019].

[5] sAFE, “Aftermarket eCall for Europe (sAFE),” 2019. [Online]. Available: https://safe112.eu/. [Accessed: 10-Dec-2019].

[6] S. Kvale, *Interviews: an Introduction to Qualitative Research Interviewing* . Thousand Oaks: Sage, 1996.

[7] M. Q. Patton, *How to Use Qualitative Methods in Evaluation.* London: Sage Publications, 2002.

[8] EU, “Regulation (EU) 2015/758 of the European Parliament and of the council of 29 April 2015 concerning type-approval requirements for the deployment of the eCall in-vehicle system based on the 112 service and amending Directive 2007/46/EC,” *Official Journal of the European Union*, 2015. [Online]. Available: https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32015R0758&from=EN. [Accessed: 18-Jul-2019].