Mobile emergency notification apps: current state, barriers and future potential

R Repanovici* and A Nedelcu

1Department of Manufacturing Engineering, Transylvania University of Brașov, Mihai Viteazul 5, Brașov, Romania

*E-mail: mm.raluca@gmail.com

Abstract. The main objective of this research is to show that mobile emergency alert apps have the potential to support the Emergency Management system all over the world. Domain experts conducted the decision-making process by evaluating three methods for communicating in an emergency situation: Voice Call, SMS and Mobile Applications. To establish the relative weights of evaluation criteria, the Multi-Criteria Analysis was used. The findings suggest that the ideal solution for communicating during an emergency is alternative no. 3, the Mobile Application. Following the result, we discussed the current state, barriers and future potential of mobile emergency alert applications used for emergency notifications.

1. Introduction

Decision-making is the process of identifying alternatives and selecting the best solution for the defined objective. The decision-making process is based on different factors such as values, preferences and expectations of the decision makers. Multi-Criteria Analysis (MCA) method has been chosen to facilitate the decision-making process. MCA is useful for establishing the ranking order of identified solutions, and for which measurable criteria have been taken into account. The essential element of MCA is the decision-making process, where domain experts should establish the objectives and criteria, estimate relative importance weights and evaluate the contribution of each option to each performance criterion. For the alternatives’ evaluation, the difficult point in decision-making process is the multiplicity and the diverseness of the criteria set, as more than two objectives should be considered. The criterion delimitates, defines properties and attributes of the analysed alternatives. MCA is able to work with a large number of criteria, but only the major criteria are considered. There are several appropriate solutions on the topic of means of access to emergency services, and the selection of the ideal solution from the optimal set is a complex and challenging process, as it depends on several criteria. In general, Multi-Criteria Analysis can be used to identify the most appropriate alternative, to rank the selected solutions, or simply to confirm solutions’ usefulness. The fundamental steps of the MCA are to identify the alternatives, establish the decision-making criteria, assign criteria weights and rank the alternatives by assessing the performance levels [1, 2].

Currently, according to European Emergency Number Association (EENA), there are three major means of access to emergency services [3]:

- Voice calls: available worldwide;
- Emergency SMS (eSMS): available in some regions only;
- Mobile Emergency Applications: available in some regions only.
With the telecom market developing rapidly, mobile devices have the potential to improve citizens’ safety and can be considered an important instrument for getting in touch with the emergency services and provide several opportunities for a more efficient help in emergencies by delivering more than just voice in these situations: accurate location, relevant information about the user, prediction of hazard and disasters etc.

Furthermore, the use of smartphone applications is increasing all over the world, and users expect to be able to contact emergency services with the latest technologies. Therefore, EENA concluded that mobile emergency applications are needed, and they should work in the same way as 112 call. According to EENA, over the last years, several mobile app development companies have contacted the European emergency services seeking for collaboration. The public-private partnership between the emergency authorities and the mobile application companies contributed to the successful development of mobile emergency applications. Some national public authorities together with EENA have tried to create a harmonised mobile emergency application but with no success. In consequence, several countries have developed country-specific mobile emergency applications which are only available in their region and can be used by their citizens [4].

2. MCA of Emergency Communications

The definition of “emergency” is broad and covers everything from heart attacks, crimes, road accidents, plane crashes, natural disasters, terrorist attacks and other similar situations. Regardless of emergency, the common denominator is the need to get in contact with the Public Safety Answering Point (PSAP) or the emergency dispatcher in order to get help and advice. In order to efficiently handle the case, the PSAP’s call-takers are always searching for clear and verified information. To help the person in need, they can dispatch the right resources to the right place only if relevant information is provided [5, 6].

In order to understand what emergency communications means, we consulted the definitions recognised by the European Commission. The European Electronic Communications Code, Article 2 (37) defines emergency communication as “communication by means of interpersonal communications services between an end-user and the PSAP with the goal to request and receive emergency relief from emergency services”. Furthermore, in the same document, Recital (255), the EU commission brings more clarity on emergency communication types, stating that “emergency communications are means of communication, that include not only voice communications but also SMS, messaging, video or other types of communications, that are enabled in a Member State to access emergency services” [7].

Currently, in many regions and countries of the European Union, the European emergency number 112 can only be accessed by voice communication. In 2017, EENA highlighted that voice calls between people in danger and PSAPs is not possible on all occasions due to permanent or temporary hearing or speech impairments or even to circumstances preventing or not advising voice communication (e.g. situations where generating any sound endanger the caller). In this context, it remains crucial to provide citizens and visitors with proper access to emergency services whenever they need, by offering the possibility to select optimal solution of communication, depending on their situation. Although the Universal Service Directive invited the European Union member states to guarantee equivalent access to emergency services to all users, including disabled citizens, this is still in progress, and even if some see SMS as the solution for making Emergency Services (ES) accessible, it cannot yet be considered an equivalent solution, although it can be suitable for citizens with hearing impairment to improve their ability to communicate with ES. Moreover, with the growing use of mobile applications for emergency communication, the potential usage of SMS for emergency access is potentially diminished [8].

2.1. Identifying the alternative means of access to emergency services

Based on the telecommunications industry development, three alternative solutions for emergency communication are examined, and the features of each solution are outlined in this paper. The
comparison of the three methods to transmit an alert during an emergency or disaster situation is reflected in Table 1.

Table 1. Comparison between the means of access to emergency services [8, 9, 10].

| Features                                      | Voice Call | eSMS       | Mobile App |
|-----------------------------------------------|------------|------------|------------|
| Time to make the call                         | 5 - 10 sec | > 10 sec   | 5 - 10 sec |
| Time to answer the call                       | ~ 10 sec   | 0 sec      | 0 sec      |
| Time to gain address details                  | 10 - 261 sec | - b | 0 sec |
| Automatically                                 |            |            |            |
| Manually                                      | ~ 30 sec a | 0 sec c | - |
| Location accuracy for automatically retrieved position | 500 - 40000 m | - | < 100 m |
| Time to gain Event Description                | 30 - 278 sec | 0 sec | 0 sec |
| Total Call length (location and chief complaint) | 30 - 278 sec | 0 sec | 0 sec |
| User Pre-registration                         | All situations | | |
| Not needed                                    | Yes | Yes d | Yes |
| Accessibility                                 | People with communication disabilities | | |
| No                                            | Yes | Yes | Yes |
| Silent emergency situations                   | No | Yes | Yes |

a Can take 3 minutes of extra questions for stressed/injured victims.

b Not available in most cases

c If provided by user in text message

d Required in some regions only

2.1.1. Voice Calls. Voice communication is at the present time, and must remain, a key method for communicating in emergency situations. But, while technology is changing the way we interact and communicate, in some EU countries, the European emergency number 112 is still not accessible by other means than voice calls. However, other types of communication such as SMS and/or mobile application could be reluctant and might confuse the users. On the other side, the lack of relevant information provided through a SMS and/or mobile app could impede the emergency responders to make fast decisions [8, 9, 10].

In 2019 EU reported that calls to “112” increased by 5% since the year before, reaching 141,141,731. Calls from mobile phones largely outweighed the number of calls from fixed phones. Based on the available data 73% of the calls were placed from a mobile phone. Meanwhile the total number of emergency calls dropped 2.5% to 293,510,378. Call abandons may be caused by network problems, call congestion, or people in difficult situations where noises can put them in a greater danger [10].

The call 112 process consists of the following steps before dispatching the resources: call reception - call’s arrival to the dispatcher and assignment of the call to an operator, and call taking - retrieve caller’s and incident location, incident identification and setting-up the case [11].

2.1.2. eSMS. Even if a lot has changed in mobile messaging, with an obvious transformation in mobile markets in favour of mobile applications, SMS remains a widely used in 2020. Most citizens send text messages as communication tool, and according to the latest marketing statistics, 23 billion text messages are sent each day worldwide [8, 12].

In many emergency circumstances, a voice call is the best alternative to warn emergency services, but Emergency SMS (eSMS) can be an option for people with communication disabilities, or in silent
emergency situations. This way, access to 112 for people that are deaf, deafened, hard of hearing or with speech impairment, or for people that are in difficult situations where noises can put them in a greater danger (e.g. kidnapping), can be provided using eSMS [8].

EENA reported that many countries in Europe and all over the world are already using eSMS for communication with Emergency Services. In countries such as Estonia, Ireland, Latvia, Sweden and UK, registered users have the possibility to alert the emergency dispatcher via eSMS, whilst in some other regions such as Iceland and Lithuania, the eSMS to 112 service is open to everyone [8].

2.1.3. Mobile Applications. According to EENA, in present, mobile devices are the primary communication channel for many citizens, and account for over 70% of all emergency calls [13].

The progress in mobile technology and the strong adoption of smartphones can make the mobile applications a powerful tool to provide essential data to the emergency teams by providing instant identification of users and event information and, most importantly, accurate location of users. Over the last years, mobile emergency applications have been developed for a bi-directional communications flow (Authority-to-Citizen and Citizen-to-Authority) and by now, many European citizens are using them [14].

Initially, the primary objective behind mobile emergency solutions was to make use of the high-accuracy location techniques in smartphones and make this data available to emergency management systems, but it’s obvious that important additional information can also be provided, such as caller identity, event description or relevant details about the emergency situation [15].

Similar to SMS, mobile apps can be an option for people with communication disabilities, or in silent emergency situations. Using an emergency mobile app has multiple benefits: allows all citizens to access emergency services, automatically sends relevant information authorities when the emergency occurs, provides caller’s request and short description of the event, provides accurate location, can eliminate the language barrier [14].

2.2. Establishing the decision-making criteria

The evaluation criteria of the three alternatives to transmit an alert can be conducted according to several aspects [1, 2]. In this study, we considered three aspect, as follows: social, economic and technological. Furthermore, the following eight (8) criteria were established in order to evaluate the alternative solutions and achieve a multi-criteria analysis:

A. Manufacturing and Maintenance Cost: refers to the cost of production, implementation and maintenance;
B. Utility: refers to the applicability of the considered solutions;
C. Quantities of Information: represents the amount of information provided during an emergency call;
D. Accuracy of Information: represents the accuracy of information provided during an emergency call;
E. Data Monitoring: represents the utility of information recorded during an emergency call;
F. User Perception: refers to the consumers’ perception towards the three alternatives;
G. Usability: refers to the alternative solutions’ capacity to provide a good user experience;
H. Time of Response: represents the time required by the Emergency Response teams.

2.3. Assessment of criteria weights

For the evaluation of criteria weights, decision-making specialists established the corresponding importance of each criterion. As the criteria established do not carry the same importance, the experts determined the relationship between every pair of criteria by comparing each criterion against the others. Hence, the created matrix represents how these criteria relate to each other.

The weight factor of the MCA is assessed by calculating the weighting coefficients $y_i$ of each criterion. Within this scope, a quadratic table with the same number of rows and columns (equal to the
number of considered criteria \( N_{cr} \), in this case \( N_{cr} = 8 \) is composed. In this table, each criterion on a row is compared to each criterion on a column.

As a criterion cannot be greater or smaller in importance than itself, the main diagonal of the table can only be filled with values of ‘0.5’. When a criterion on a row is compared to a criterion on a column, the weighting of the criteria is established, and a coefficient is assigned in relation to their qualitative importance. Thereby, while assessing the criteria weights, the experts faced three (3) possible situations, as follows:

- Greater in importance, the value ‘1’ is assigned;
- Same importance, the value ‘0.5’ is assigned;
- Smaller in importance, the value ‘0’ is assigned.

On each row the score of each criterion is calculated and the criteria are ranked by their obtained scores. On the first position, the criterion with the highest score will be placed, and on the last level, the criterion with the highest lowest will be placed. If two criteria obtained the same score, the position will be the same: the level will have as value the arithmetic mean (average) of the positions corresponding to these criteria (e.g. in this study, criteria B and D obtained the same score and hold position 2 and 3 in the ranking order, so the assigned level of importance is 2.5).

After the relationship matrix is complete and the rank criteria is established, the weighting coefficients \( \gamma_i \) are set according to the FRISCO formula [1]:

\[
\gamma_i = \frac{p + \Delta p + m + 0.5}{-\Delta p' + N_{cr} \frac{2}{2}}
\]  

(1)

where: \( \gamma_i \) represents the weighting coefficients;

- \( p \) is the sum of the points gained by the respective criterion;
- \( \Delta p \) is the difference between the scores of the regarded criterion and the last ranked criterion;
- \( m \) represents the number of criteria outranked by the analysed element;
- \( N_{cr} \) represents the number of considered criteria;
- \( \Delta p' \) is the difference between the scores of the regarded criterion and the first ranked criterion.

The result of the analysis is determined by the objective and correct comparison of the relative importance of criteria. The weights \( \gamma_i \) of each criterion, calculated with FRISCO formula (1), are presented in table 2. The results show that Time of Response (H) is the most significant factor in evaluating the alternative solutions, succeeded by Utility (B) and Accuracy of Information (D).

| A  | B | C | D | E | F | G | H | Scope (p) | Rank | \( \gamma_i \) |
|----|---|---|---|---|---|---|---|---|-------|-----|----------|
| 0.5| 0 | 0 | 0 | 0 | 0 | 0.5| 0 | 1 | 8     | 0.17 |
| 1  | 0.5| 1 | 0.5| 0.5| 1 | 0.5| 0.5| 5.5| 2.5  | 3.44 |
| 1  | 0 | 0.5| 0 | 0.5| 1 | 0 | 0 | 3 | 6    | 1.07 |
| 1  | 0.5| 1 | 0.5| 0.5| 1 | 0.5| 0.5| 5.5| 2.5  | 3.44 |
| 1  | 0.5| 0.5| 0.5| 0.5| 1 | 0 | 0 | 4 | 5    | 1.75 |
| 1  | 0 | 0 | 0 | 0 | 0 | 0.5| 0.5| 2 | 7    | 0.56 |
| 0.5| 0.5| 1 | 0.5| 1 | 0.5| 0.5| 0.5| 5 | 4    | 2.7  |
| 1  | 0.5| 1 | 0.5| 1 | 1 | 0.5| 0.5| 6 | 1    | 4.63 |

2.4. Ranking alternatives

The next step of the MCA is to analyse the three alternatives in relation to each criterion. Therefore, each alternative is awarded with importance grades (\( N_i \)) from 1 to 10. The performance value, or the importance grades (\( N_i \)), is given by the selected specialists to each alternative in relation to each
criterion [1]. Table 3 summarise the multi-criteria ranking results of the emergency communications, namely the grades awarded to the considered emergency communication solutions, the performance index and the final ranking. In order to determine the final ranking of the three alternative solutions, the performance index \( F_i \) is calculated from the equation (2). \( F_i \) is calculated for each alternative in relation to each criterion.

\[
F_i = N_i \times \gamma_i
\]  

Based on the performance index values \( F_i \), the outcome is calculated for each of the studied alternatives and finally, the classification is established as presented in table 3. The top-ranked alternative according to the Multi-Criteria Analysis is considered to be the ideal solution. This study allows the following conclusions: First, the analysis of the considered alternatives revealed that the ideal solution for communicating during an emergency is alternative no. 3, the Mobile Application, with a final score of 172.75. According to the results, the SMS Text Service alternative is ranked very low, reflecting the need to innovate the Emergency Management (EM) system all over the world.

| Criterion | \( \gamma_i \) | Voice Calls | SMS | Mobile App |
|-----------|----------------|-------------|-----|------------|
| A - Manufacturing & Maintenance Cost | 0.17 | 10 | 1.7 | 10 | 1.7 | 8 | 1.36 |
| B - Utility | 3.44 | 8 | 27.52 | 6 | 20.64 | 9 | 30.96 |
| C - Quantities of Information | 1.07 | 10 | 10.7 | 6 | 6.42 | 9 | 9.63 |
| D - Accuracy of Information | 3.44 | 10 | 34.4 | 7 | 24.08 | 10 | 34.4 |
| E - Data Monitoring | 1.75 | 10 | 17.5 | 9 | 15.75 | 10 | 17.5 |
| F - User Perception | 0.56 | 10 | 5.6 | 7 | 3.92 | 10 | 5.6 |
| G - Usability | 2.7 | 10 | 27 | 8 | 21.6 | 10 | 27 |
| H - Time of Response | 4.63 | 9 | 41.67 | 7 | 32.41 | 10 | 46.3 |
| Final Score | - | 166.09 | - | 126.52 | - | 172.75 |
| Final Ranking | II | III | I |

The multi-criteria analysis of the alternative solutions was conducted with data given by the specialists from different decision-making groups. The evaluation method is based on collecting relevant evidence and classify the selected alternatives. The full results of our assessment indicate what to do next, in order to improve the Emergency Management system potential. In order to understands when and how it is better to implement mobile solutions in the Emergency Management field, the research continues by analysing the current stage, barriers and future potential of mobile emergency applications.

3. Mobile Emergency Applications Analysis

3.1. Current State

The telecom market is developing rapidly, and the use of smartphones and mobile applications is increasing all over the world. Smartphone users install more and more mobile applications on their smartphones for daily usage. Recent studies conducted by EENA show that mobile devices can be a powerful tool to help in case of emergency, not only for those in need but also for the emergency helpers. In addition, citizens expect to be able to contact emergency services with mobile technologies and have clear expectations about the availability of 112 emergency mobile applications. As mobile telephony gives several opportunities to improve the help in emergencies, the researchers and involved actors need to investigate these possibilities [14].
Mobile applications can also support people in emergencies situations: road accidents, natural disasters, health problems or personal safety danger. The initial objective behind mobile emergency solutions was to allow emergency teams to make use of the high-accuracy location information provided by mobile devices. But before long, emergency authorities realized that additional information such as user’s personal data, event details, or any other important information can be provided to the emergency dispatchers [15].

Over recent years there have been good results with mobile emergency applications and to date, there is a very diversified offer, which goes from providing escape guidelines during building fire, during natural disasters and nuclear accidents, or to help patients in medical emergencies. These applications provide more accurate information to emergency services [5].

The alerts sent through mobile emergency applications can reduce the total call length by shortening the time to make the call, the time to answer the call, the time to gain address details and the time to gain event description. In short, if the mobile alert is capable to provide emergency teams with relevant information for the two basic questions - what? and when? - , mobile emergency applications can enable a quicker dispatch of resources in case of emergencies [6].

However, in present, these applications only work in the region in which they were created, and this can confuse and discourage both citizens and emergency authorities. According to EENA, a mobile emergency application should be available all over the European Union (EU). This is the main reason EENA strongly believes that all the mobile emergency applications should work in a standardised way all over the EU and should be compliant with a pan-European standard [14].

3.1.1. PEMEA Project [16]. Currently, the European Emergency Number Association is in the process of implementing a Pan-European Mobile Emergency Apps (PEMEA) policy. The PEMEA project’s scope is to provide the European citizens the possibility to select and install a mobile emergency application that is user-friendly and meets customers’ perception in terms of usability, functionality, utility and costs, with strong security and high privacy attributes, capable to provide in times of need instant identification of users, accurate location and event details to the nearest PSAP anywhere in Europe. A simplified call flow in PEMEA would be as follows:

1. The mobile emergency app sends the emergency data (telephone number, name, language, accurate location, location updates, communications, chat, etc.) to the PEMEA server.
2. The server sends the emergency data to the PSAP Service Provider (PSP) to which is connected. The PSP decides the next routing step in the PEMEA network, depending on the location of the user. The data might be sent to an Aggregating Service Provider (ASP) or it might go to other PSP or even directly to the PSAP in the region where the user is.
3. The emergency data sent by the App is received by the end PSAP (where the user’s call is handled and where the application data is ultimately sent)
4. If the PSAP wants to invoke the establishment of a multimedia channel (i.e. data, voice, chat or video), then it can trigger the creation of the channel to the originating Application Provider (AP) and, subsequently, the AP would open it with the App. Several multimedia channels might be invoked in parallel by the PSAP and established during the emergency.
5. The PEMEA network nodes will manage the maintenance of the established channels till the end of the emergency.
6. All the PEMEA network nodes shall confirm that the rest of the entities to which they are connected are previously registered in the PEMEA Registry Authority (PRA). All the messages from non-registered entities shall be rejected.

The phase I of the project was conducted from June 2018 until the end of March 2019 and the findings revealed the capability of PEMEA project to provide:

- For citizens: access in roaming to emergency services all over the European Union through users’ local mobile emergency application;
For PSAPs: relevant information through a standardized application (e.g. accurate location, caller language, contacts, user’s details, call tracking) so that emergency teams can provide the help as fast as possible.

In this phase of the project, eight participants were involved, as shown in table 4 [16]:

| Participant (Software Provider) | Emergency Service Organization | Software Component |
|---------------------------------|---------------------------------|--------------------|
| Digia                           | 112 PSAP, Finland               | 112 Suomi App      |
| Beta 80                         | 112 PSAP, Italy                 | WhereAreU App      |
| University of Ljubiana          | 112 PSAP, Slovenia              | Snapring App       |
| IPKom                           |                                 | 112 Slovenia PSAP  |
| Basque Country PSAP             | 112 PSAP, Basque Country, Spain | SOS Deiak App      |
| Alterna                         | 112 PSAP, Murcia Region, Spain  | 112 Murcia App     |
| Omnitor                         | 112 PSAP, Sweden                | 112 Omnitor App    |
| Smart12 Mobile                  | 112 PSAP, Monaco                | Smart12 App        |

The scope of PEMEA project phase II, which was conducted from November 2019 until the end of May 2020, was to integrate and connect analysed applications with Public Safety Answering Points in roaming. The findings of this study revealed that the PEMEA network can provide the necessary infrastructure to allow emergency authorities (PSAPs) to connect with the citizens seeking for help, everywhere in Europe. The experiment showed that people in need were able to contact the closest PSAP connected to the PEMEA network using the local emergency application installed on the users’ device. In this phase of the project, seven participants were involved, as shown in table 5 [16]:

| Participant (Software Provider) | Emergency Service Organization | Software Component |
|---------------------------------|---------------------------------|--------------------|
| University of Ljubiana          | 112 PSAP, Slovenia              | Snapring App       |
| IPKom                           | PEMA Consortium                 | DW Demo App        |
| Deveryware                      | PEMA Consortium                 | PSAP Interface Module |
| Telefonica                      | 112 PSAP, Catalonia Region, Spain | My112 App         |
| Cestel                          | 112 PSAP, Extremadura Region, Spain | 112 S-Visual App |
| I-Urgence                       | 112 PSAP, SDIS-6 Region, France | I-Urgence App      |
| Real Rider                      | PEMA Consortium                 | MyNextbaseConnect App |

Thanks to PEMEA project and the available infrastructure, eight PSAPs in Europe and twelve mobile applications have been validated with the PEMEA standard. The PEMEA network is a live environment and ready to integrate other new mobile applications and/or emergency dispatchers in Europe, allowing the roaming of apps in different regions and countries of the European Union.

3.2. Barriers
Regardless of the fast development of mobile applications, when it comes to mobile solutions in the emergency management field, significant barriers are holding back the improvement, including among
others, Low Awareness of Mobile Emergency Apps, Lack of Regulation, Limited Evidence-Based Literature, Privacy and Security Concerns.

3.2.1. Low Awareness of Mobile Emergency Apps. Most users are unaware that mobile emergency applications are now available. Studies show that when citizens need to call 112 in an emergency situation, they tend to dial the emergency number on the keypad, instead of using a mobile application. This can be caused by any of the following:
- The user has forgotten that he installed an emergency app;
- The emergency app is not intuitive enough;
- It is too complicated to find the emergency app in a stressful situation;
- An emergency app is not installed.
That’s why EENA recommends that emergency applications should preferably be added as basic applications in the smartphone itself, instead of a commercial application. [5]

3.2.2. Lack of Regulation. Another challenge that limits the potential of mobile emergency solutions is the lack of international regulation to ensure safety, accuracy, quality, and performance. All mobile manufacturers should use common standards, both for the caller, and the PSAP who needs to be able to receive and interpret the data.
Mobile technologies with emergency features are intended to improve emergency access and increase people’s health and safety, but there are some cases where these emergency calls created chaos. In some PSAPs, the emergency alerts received via mobile applications have created difficult situations because no protocol has been previously defined, and the emergency responders were not prepared to handle these types of communications. Consequently, although citizens were in danger, emergency teams did not know how to manage these alerts and help those in need.

3.2.3. Limited Evidence-Based Literature. The formal literature for mobile emergency applications is limited. The most important evidence of research is conducted in mobile health applications, in areas as fitness and chronic diseases such as diabetes, cardiovascular health, mental health, and others. Until now, systematic reviews of mobile emergency applications are limited or poor. In addition, different studies show mixed results, and although some of them are demonstrating the efficacy of mobile emergency apps, the evidence base remains poor. In order to improve the emergency service sector, the main challenge of involved actors remains to develop at the speed of light a relevant process, evidence-based and with randomized controlled trial.

3.2.4. Privacy and Security Concerns. Mobile emergency applications utilization will increase the quantity of information collected and stored, in particular, users’ personal data such as name, phone number, health information, location, etc. However, the need of privacy collides with the PSAP and first responders need to receive as much information as possible, as quick as possible and preferably as automated as possible. With the rapid development of mobile technology, laws and regulations are often outdated and not adapted to new circumstances. It is therefore important that regulatory authorities keep up the pace with technology so that regulations are updated constantly. For a secure evolution in mobile emergency applications, it is mandatory to guarantee data security and privacy for storage, transfer, encryption and authentication process [5].

3.3. Future Potential
Despite of current barriers and limitations of mobile emergency solutions, the market is rapidly evolving, with the potential to make a dramatic impact into the emergency management system. As such, there is still more research needed to investigate the impact of mobile solutions in real life emergency situations, but the future evolution of these technologies include, among others, designing international standards and regulations for mobile emergency solutions, the integration of mobile solutions into the emergency system, promoting mobile emergency apps.
The PEMEA project conducted by EENA demonstrated that mobile emergency applications could provide citizens with fast and intuitive access to emergency services by providing improved communication channels (e.g. chat and audio-video), accurate location, users’ information and call tracking at the time of emergency. In addition, a mobile emergency application will allow all citizens, including those with disabilities, to alert the emergency dispatcher when an emergency occurs and to automatically send crucial information to the nearest emergency dispatcher [14].

3.3.1. Design international standards and regulations. One of the major limitations for the mobile emergency market is the lack of international standards and regulations and this can be the one of the biggest reasons for the slow development of mobile emergency solutions. Providing access to emergency services without a strong cooperation between involved actors raise substantial doubts about the efficiency of such solutions.

Regulations differ between countries: while some countries have strict and complex regulation, others lack appropriate standards and regulations. That’s why the EU and national regulators should do their part in making sure that the laws and regulations are up to date and in pace with the rapid development in the telecommunications market.

But changes in regulating mobile emergency market are about to happen, as in December 2019, EENA highlighted the need to increase the public-private partnership between the emergency authorities and the mobile application companies when developing such tools. EENA, together with signatories from all over the world, launched a call for tech companies to get involved in this consultation: “We all share the objective of keeping citizens safe and the conviction that technology can and should contribute to this goal. But this will only be achieved by combining the potential that technology can offer with the experience and expertise of emergency services” [17].

3.3.2. Integrate mobile solutions into the emergency system. Mobile solutions can improve the emergency management services due to their capability to provide accurate location and user’s personal information in a short time. Mobile emergency applications are beneficial for both emergency professionals and citizens in danger by enabling professionals to save time and handle the case more efficiently.

For people with communication disabilities (e.g. speech or hearing disabilities) or people in silent emergency situations (e.g. kidnapping) the use of a mobile application can significantly improve their health and life. These citizens are often unable to contact the ES by dialling the emergency number on the keypad and therefore many communities are aiming to integrate mobile solutions.

At the time of writing, connectivity and communication of consumer mobile emergency applications is starting to increase.

3.3.3. Promote mobile emergency Apps. Due to a large number of mobile emergency applications available at present in major mobile apps stores, consumer, without guidance from public authorities, tend to choose from the most popular apps.

More studies substantiating improved outcomes are needed to encourage institutional stakeholders to adopt and integrate mobile solutions into the emergency system. Some countries have begun to develop mobile application and encourage their citizens to use the officially recognized applications in case of an emergency. Such a continued effort is expected in years to come, but further work is required to reach a maturity level.

4. Conclusion
To the present, the consumer mobile emergency market is unregulated. To develop the potential of mobile solutions for emergency management, multiple researches are conducted in this domain to accumulate data, establish evidence and expand data integration into the emergency system. To achieve great success in mobile emergency market, all the stakeholders including tech companies,
professionals from emergency services and researchers must collaborate to overcome the barriers and the needs of this field.

EENA recognises the strong need of an emergency mobile application available in the market. Within the near future, EENA’s goal is to promote the usage of mobile emergency apps that can provide accurate information in a secure way all over the European Union. EENA has taken firm steps in developing the specifications necessary to make to create a harmonized European mobile emergency application. Currently, EENA has officially recognized 28 mobile emergency applications in 13 countries [14]: Andorra, Australia, Denmark, Ecuador, Iceland, Ireland, Italy, Malaysia, Mexico, Norway, Spain, Switzerland, The Netherlands. According to the plan that several PSAPs have communicated to the PEMEA consortium, the following countries may have their connection to the PEMEA network ready before the end of 2020 [16]:

- Finland;
- Italy (several additional regions);
- Spain (several additional regions);
- France;
- Romania.

In the future, it is expected that all Europeans, including citizens with disabilities, will be able to use a harmonized mobile emergency application, regardless of where they are in European Union, and automatically send relevant information to the nearest PSAPs when the mobile alert is initiated.

References
[1] Department for Communities and Local Government 2009 Multi-Criteria Analysis: A Manual (London: Communities and Local Government Publications)
[2] Bobancu Ş 2015 Creativitate şi Inventică (Braşov: Editura Universităţii Transilvania)
[3] Vivier B 2019 Emergency Communications and the Eu Legislative Framework EENA Operations Document
[4] EENA 2014 112 Smartphones Apps EENA Operations Document
[5] Skoglund B 2017 Mobile Handset Requirements: Communication to Emergency Services EENA Operations Document
[6] Lanzian B and Biole M 2018 Recent advances in caller localisation for public safety answering point Recent Trends in Control and Sensor Systems in Emergency Management. Advances in Intelligent Systems and Computing, Springer 675 40-57
[7] European Commission 2016 Proposal for a Directive of the European Parliament and of the Council Establishing the European Electronic Communications Code 2016/0288(COD)
[8] EENA 2015 SMS communication with PSAPs and EROs EENA Operations Document
[9] Lumbreras C and Machado G 2014 112 Caller location & GNSS EENA Operations Document
[10] European Commission 2020 Report on the Implementation of the European Emergency Number 112 COCOM pp 19-04
[11] EENA 2014 112 PSAPs Technology EENA Operations Document
[12] Dobrilova T 2020 35 Must-know SMS marketing statistics in 2020 TechJury
[13] Halliwell D and Lumbreras C 2018 Mobile Identity Platform for the Emergency Services EENA Operations Document
[14] Casse B, Gomez I and Winterbottom J 2015 112 Apps Strategy - Pan European Mobile Emergency EENA Operations Document
[15] Winterbottom J 2015 Pan-European Mobile Emergency Application (PEMEA) Requirements and Functional Architecture EENA Operations Document
[16] EENA 2020 Emergency Apps PEMEA - Final PEMEA Report EENA Operations Document
[17] EENA 2019 Emergency Services Call for Stronger Cooperation with Tech Companies EENA Operations Document