Smartphones as an Alerting, Command and Control System for the Preparedness Groups and Civilians: Results of Preliminary Tests with the Finnish Police

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ABSTRACT

Traditional mobile phones have been used for alerting purposes by utilizing their SMS and cell broadcasting features. They do however not suit for demanding alerting and command purposes, for the observation of special forces, rescue officers and civilians, or for the post-evaluation of the operation. Current 3G and 4G/LTE smartphones can do all this, but the empirical evidence is missing.

This article reports of the preliminary tests which the University of Jyväskylä has made with the Finnish Police for alerting civilians and for commanding two special groups of the police with smartphones. Smartphones were also used for observing police officers' position and status and for post-evaluating action during and after the operation.

The study supports using smartphones for alerting, command and control purposes. Because of external distractions alerts are noticed better at night than in the daytime. In active hours personal alerts should be given not only by a voice alarm but by stimulating 2-3 senses at the same time. Noticing of smartphone alerts might be improved also by using some additional reception device with the handset.

Keywords

Smartphones, mobile alerting systems, command and control systems.

INTRODUCTION

Personal mobile phones are being used for giving public warnings in emergencies but not as much as one might expect. After the Asian tsunami in 2004 a great interest was paid to them, but the usage did not expand rapidly (Chorist 2009, Ceasa 2010, Nederlandalert). One reason for that was the debate between different messaging systems, especially between cell broadcast and SMS (Sillem et al. 2006). Mobile alerting systems were also considered expensive, because governments were expected to pay all of their development and maintenance costs. From the government's side returns on the investment are difficult to receive (Klafft and Meissen, 2011). Also private people have expressed criticism against emergency alerting systems, for example because of creating a surveillance society (Al-Akkad and Zimmermann 2011) or because of not getting enough benefits of using them (Aloudat and Abbas 2009, Haataja et al. 2011). In areas where extreme nature catastrophes like hurricanes, tsunamis, floods and earth quakes are likely, investments on alerting systems can be justified more easily. Mobile alerting systems may also be implemented in politically unstable areas where hostile terroristic activities are common. Examples from more stable are found, for example from Australia (Aloudat et al., 2011) and Luxemburg (Fema 2012).

For finding alternative ways to cover the costs of building and operating public warning systems, and for developing a smarter mobile alerting system compared to the older SMS and cell broadcasting systems, the

University of Jyväskylä started a series of research projects on mobile alerting systems in Finland. In the first phase a new alerting system was built on smartphones in 2009-2011. After that alternative maintenance and financing models were developed for supporting the implementation and usage of these systems in 2011-2012. The project produced new ideas of how smartphone based alerting systems could be used for warning people in various environments, and how they could be financed with other than full government funding. The project also started a close cooperation with the Central Finland Police Department, which then led into national cooperation with the Finnish Police.

With the police, a three-phased series of empirical tests was started in order to evaluate smartphones' ability to support emergency communication within the internal and external communication of the police. The first test was carried out with two different preparedness groups of the police. The test showed clearly, that smartphones have many advanced features which support emergency communication both in the police forces' internal and external communication. In addition, the first test showed that smartphones can support security authorities' command and control activities during specific protection and rescue operations. They also include features which enable operation managers to observe the security forces', rescue officers' and civilian people's status during the emergency operations. Smartphones also enable post-operational evaluation of the incidents after the situation is over.

As an overall result, the test indicates that the smartphone technology itself is a quite promising media as a part of security authorities' emergency alert, command and control systems. This has however not been studied much, which makes the empirical results of this study interesting. Current smartphones give users a much better chance to notice the emergency alerts than older 2G phones and they give also a chance to give valuable information back to the security authorities about the situation and location of the user. Within the security professionals' use smartphones turn into a multifunctional operation management system which enables warning people and managing the operation which will be needed for saving them.

THE RESEARCH DESIGN

In this study a performance of a smartphone based alarm system was tested in police forces' use in Finland in November 2012. Performance was measured with four indicators, which were 1) the police officers' ability to perceive commands and alerts, 2) readiness to take action after receiving commands and alerts, 3) operation manager's ability to observe the position and status of police officers during and after the operation, and 4) the police officers' ability to post-evaluate emergency operations. At the side of the policemen there was also a control group of civilian users, who received same alerts as the police. The tested smartphone system has been created at the University of Jyväskylä and it was originally designed as the security authorities' warning method for alerting citizens of serious safety threats. In this study the system was tested within the national organization of the Finnish police. The test indicated that the smartphone system could be used also as a command and control system for the police or for other security authorities and groups. The test with the police and civilians is described in the following chapters.

The Smartphone Based Alerting and Command System Which Was Used in the Test

The test was performed with a university based alerting system which operates on a server and on smartphones. The system can send alerts and commands in two ways: Firstly, alerts may be sent for selected groups of people independently of their geographical location. Secondly, messages can be sent through a GIS-based user interface for all or profiled people within a selected geographical area whose diameter may vary from zero to unlimited. This feature reminds the work that has been done in Korea (Lee et. al, 2011). Alerting methods may be varied in the system by changing the alerting sound, visual image, vibration and textual parts of each message.

Messages are sent in the system as the smartphone's push messages through wireless data transfer lines. If the receiving device cannot take in push messages the system will automatically deliver the data content as an SMS message to that particular device. The system is programmed on the Android platform and it can deliver alerts into all kinds of mobile devices. It also operates in a multichannel environment by delivering messages to mobile phones, pc's, laptops and tablets, electronic information boards, social media, news media, etc. Also the two-way communication is supported in the system and the recipients can sign each command or alert, and inform the situation center of whether they are all right or need help. Each mobile device may also be localized in real time and the location and status of users may be viewed on a situation map immediately after each command or alert.

The system is independent from telecommunication operators and the delivery of messages within the system is free from costs. The system owner will pay separate data transfer costs only for those messages which cannot be delivered as a smartphone's push message and which therefore need to be delivered as a SMS message. The smartphone users need not to pay anything extra in addition to their ordinary data transfer subscription for being able to receive messages through the system. Messages may also be received and signed for free without a commercial telecom subscription if the mobile device is connected into an open WLAN network.

Smartphone Devices Which Were Used in the Test

In the earlier stages of the study the Android platform was selected in 2009 as an operating system for the first version of the mobile alerting system that was used in this test. Android operating system was selected because it was a very widely used smartphone platform in the World and because it was able to perform those alerting operations which were defined for the new alerting system. For example, the new system should be able to play the wanted alerting sounds and strike up vibration when the alert arrives on the phone. The phones should also be able to play the alerting sound even if the device was muted. Currently Android has been the World leading in platform since 2010 (Canalys 2011), and in Fall 2012 three out of four shipped smartphones Worldwide were Android phones (IDC 2012).

The selection of the Android platform simultaneously determined which smartphone brands could be used in the test. For this reason the test was carried out with Sony Xperia Go, HTC Explorer, HTC Desire, Samsung Xcover GT-S5690, Samsung Galaxy S II and Google Nexus S type of smartphones.

The Test Group and the Course of the Study

The purpose of the study was to evaluate the performance and usability of a smartphone based mobile alerting system for the alerting, command and communication purposes of the national police. The test was also expected to give information of the smartphones' usability for alerting large groups of civilian people.

All activities were designed and operated with the Central Finland Police Department, which collected and commanded all police forces who were participating in the test around the country with the authorization of The National Police Board. Test group of ten policemen was formed from two different preparedness groups of the police. At the side of the police group also a small reference group of civilians was formed in order to monitor results in these two groups.

During the test the leading police officer in the situation room sent test events of simulated real-like incidents to the test users' mobile phones around the country. Users were obligated to sign all messages immediately no matter where they were and what time of the day or night it was. Immediately after sending the alerts all users' location and status appeared on a real-time map on the screen in the situation room. Each user's position and status was indicated with a green, red or yellow flag. Green flag indicated that the user had received and signed the message, and that (s)he was in full operating condition. Red flag indicated that the user had received and signed the message, but was not well and needed help. Yellow flag demonstrated that the user had not been reached and that there might be some problems which needed further investigation or action. After the simulated incidents and operations were over, users could track their operation history by viewing the messaging log on their phones. In each alert the signaling voice, vibration, icon and textual content of the message were altered. By changing these features the researchers could follow how the police officers and civilians would notice and react on alerts which were given in a different form and in different situations and times.

Test users' identity was protected during the test and each user was given a code name which was linked with the smartphone device which they were using. Depending on the professional background and type of the device which they were using, test users were given an individual code name and divided in smaller subgroups. These groups were named according to Finnish wild animals as the Bears, Wolves, Wolverines and Bobcats. All Bears were policemen who had Sony Xperia Go devices, and Wolves policemen with HTC Explorers. Wolverines were policemen with Samsungs and Bobcats civilians with Sony, HTC and Google Nexus devices. Test devices except the private Samsung phones were provided by the University of Jyväskylä for the police officers' use.

The test was operated for two weeks in November 2012. Alerts were given mainly within the police forces' active working hours. All policemen carried out their everyday operations normally while participating in the test. Alerts and commands were given randomly in different times of the day, including night time. There was no advance planning of where the users should stay and what they should be doing during the test. Alerts would therefore reach policemen either in a favorable or in a bad situation, and despite of that they were expected to react immediately.

After the test users were interviewed with an internet questionnaire which included numeric evaluations and written open answers about the experiment. Some key persons in the different levels of the police organization were also interviewed face to face.

The Variables for Measuring the Performance of the Smartphone Based Alerting System

The overall performance and usability of the alerting system was evaluated in the study by the police officers' and civilians' ability to notice, understand and react on the incoming alerts. Users' ability to notice and understand alerts was evaluated from the auditory, sensory, visual and cognitive senses' point of view. Overall performance was also evaluated by the operation manager's ability to observe the police officers' and civilians' location and status during and after the operation, and by the police officers' ability to post-evaluate emergency operations.

The following chapters describe in a more detail the variables which have been used for measuring the performance.

Police Officers' and Civilians' Ability to Perceive Commands and Alerts

It was assumed in the test that if the incoming alerts would stimulate more senses than one the users would notice and understand them better. Therefore many of the smartphones' technical features were utilized in the test for ensuring that the police officers and civilians would notice and understand alerts and take action as fast as possible in all situations.

The possibility of noticing of the alerts was enhanced in the study by stimulating the users' auditory, sensory, visual and cognitive senses with the alerting messages. This was made by utilizing the plentiful selection of alerting sounds and the vibration feature of the smartphone devices. The visual sense of the user was stimulated with colorful icons, which were added as a teaser in the alerting messages. As the fourth sense the cognitive perception was affected by the textual part of the alerting message.

According to these principles the users' ability to perceive alerts with the four senses was converted as research variables. These were

- noticing of the signaling voice of the alert,
- noticing of the vibration of the smartphone device,
- noticing of the alerting icon on the screen of the phone, and
- noticing of the textual message on the alerting message.

Auditory, visual, sensory and cognitive stimulation was altered during the test by changing the alerting tune, vibration, visual icons and form of the textual message. While testing the auditory perception three alternative signaling sounds (siren, alert and warning) were used and silent as the fourth. The siren was a high siren kind of voice and it was the highest tone that could be created on the smartphone devices. The other sounds called alert and warning had a slightly lower and softer tone and they also were used at the highest possible volume on the phones. The silent sound had no signaling sound at all.

While testing the sensory perception of the alerts the vibration function of the smartphones was set on or off.

In order to test the visual perception, alerting icons were altered between a red warning triangle with an exclamation mark in the middle, sole red exclamation mark, and blue police logo with a symbol of sword.

For testing the cognitive perception and reaction time of the users, a description of the nature of the incident and a request to sign the alert were enclosed in the textual part of the alerts. Textual messages might also have written instructions to take some kind of action, or some other information concerning the situation.

Police Officers' Readiness to Take Action After Receiving the Command or Alert

The policemen's readiness for taking action was measured by their reaction time and signing of commands and alerts. Reaction time was counted from the time of sending the alert until the time when it was signed. Policemen's further activities after signing the alerts were not observed and they were not asked to follow any physical or operational procedures after receiving the message.

Operation Manager's Ability to Observe the Status of Police Officers and Civilians

The operation manager's ability to observe the position and status of the police officers and civilians was evaluated by measuring how well they can follow the status information with the system during the operation. The tested smartphone system includes features which make it possible to observe in real time from the GIS-based user interface whether the police officers and civilians are in or outside the endangered area and whether they need help. Status information may be analyzed also afterwards from the log.

Police Officers' Ability to Post-Evaluate Operations

The policemen's ability to post-evaluate their action during the emergency operation was measured by their ability to read and evaluate the log information on their smartphone. Additional information about the course of the action was also found on the user interface of the server-end of the system. The system recorded all alerts and commands which were given during the mission, as well as exact times when they were sent, received and signed. The system also recorded the status of those officers who were called into the mission, but who did not receive or sign the calls.

Background Variables

In addition to the research variables there were some background variables in the test, which may have affected the users' perception and reaction on the alerts. These factors were

- the brand and type of the smartphone
- the operating system and its commercial version, and
- the operator whose data communication subscription was implemented on the phone.

The test was carried out by using Sony Xperia Go, HTC Explorer, HTC Desire, Samsung Xcover GT-S5690, Samsung Galaxy S II and Google Nexus S type of smartphones. All phones were running on the Android operating system. All Sony devices had the version 2.3.7, HTC version 2.3.5, Samsung version 4.0.x and Google Nexus version 4.1.2.

The availability and capacity of mobile telecommunication networks are crucial for the operation of mobile alerting systems. Often mobile phone lines get crowded during mass events and accidents. This will disturb also the operation of SMS based alerting systems. The smartphone system which was tested in this study operates on data communication lines, which do not get crowded in the same way as SMS messaging on mobile telephone lines.

The operation of this kind of system is, however, dependent on the capacity and coverage of the telecommunication networks all over the country. It is unlikely that networks are similar in all parts of the countries or on different sides of the cities. The operation of the alerting system may also be dependent on the telecommunication operator of the mobile device, because all operators do not offer full or any services in all areas. In this test all phones were provided either with the telecommunication subscription of TeliaSonera, Elisa/Saunalahti or DNA, which are the main commercial mobile operators on the Finnish market.

RESULTS

The results of testing a smartphone based alerting system with the police are described on the following. The police officers' experiences of noticing commands and alerts in various situations are explained first and after that their readiness to take action. The operation manager's ability to observe the police officers' location and status, as well as the police officers' ability to post-evaluate the operation are reported later in the text.

The Perception of Commands and Alerts

This chapter explains how the police officers managed to notice and understand alerts in various situations. The auditory, sensory, visual and cognitive perception of alerts is reported in their own sections below.

The Auditory Perception of Alerts

The auditory perception of the commands and alerts was based on the volume and tune of the signaling sound which turned on when the most critical alerts arrived on the phone. Three different alerting sounds were used in the test and all of them were played at the 90-100 % volume of the phone. Some alerts were given with no sound at all.

In a numeric evaluation in scale 1-5 (1=poor, 5=excellent) more than 70 % of the respondents evaluated the sound and volume of the alerts as good or excellent. In the written evaluation one user considered the volume too strong and got sometimes scared about it. Some other users reported that their co-workers at work and family at home in the evening were amused about some of the sounds.

The perception of the sounds was strongly dependent on the situation in which the users were at the time of the alert. In quiet indoor situations like in the user's own office sound alerts were noticed immediately. In other indoor situations where there were plenty of people around, alerts were noticed more weakly and sometimes not at all. For example, in a big lobby or in a lunch room full of people the sound could not be heard because of the background noise. In the noisy situations perception was also dependent on where exactly the mobile device was at the moment of the alert. If it was in the user's hand, on the lunch tray or on the table in front of the user, the alert may have been noticed despite of the noise. Instead, if the phone was in the user's hand bag or pocket, the alert was not necessarily noticed (unless the vibration was on). Sometimes the alerting sound was mixed with other voices and the users may have thought that the sound came from the television or outside from an emergency vehicle which was passing by. Also in outdoor situations alerts were noticed weakly because of the background noise. Outside people also kept their phones in the pocket or bag, which prohibited them from hearing the sound.

Some alerts were sent without any signaling sound, so the users could not hear them. If the phone was close to them on the table or in contact with their body, they could notice it by seeing the alert on the screen or by feeling the vibration against their body. Many users were at their own office during the alerts, which helped noticing them. Silent alerts were tested because in the police work they are needed in certain kinds of assignments.

The Sensory Perception of Alerts

The sensory perception of the alerts was based on the vibration of the mobile device at the moment of receiving alerts. In the written comments users mentioned that in a real situation the vibration and silent alerts would be useful. In indoor situations the vibration helped to notice alerts which were sent without the sound. In outdoor situations vibration helped to notice also alerts which were sent with the voice, if the sound could not be heard because of the background noise.

The Visual Perception of Alerts

The visual perception of the alerts was based on three different icons, which popped on the screen when the alert arrived. In the numeric evaluation 85 % of users evaluated the usability of alerting icons as good or excellent. The figure itself may have not affected much on noticing the alert, but the conception of the message may vary depending on the figure. For example, an image with a striking red color might be taken more seriously than a message with an unnoticeable figure and color.

Different icons may also have contextual or cultural meanings, which may effect on how they are perceived. In this test, among two red colored alerting signs there was also a blue colored police logo. Among the ordinary people police is respected and considered as an authority in Finland, for which reason it would have been expected that the police logo would get people's attention well. In this test most of the users were, however, policemen who see these logos every day. For these users the police logo had no added value and might not mean any serious alert at all.

The Cognitive Perception of Alerts

The cognitive perception of the alerts was based partially on the alerting sound and icon of the message, and mainly on the written text that was delivered within the alert. The alerting sound and icon were the first information to the users about the event which was going on, and the textual message gave literal information of what the incident was about. The literal information may also have given additional information about the operating procedures and actions which the person should take because of the alert.

In the test, users recognized easily the first part of the textual message, which indicated the nature of the emergency and requested to sign the message. Further parts of the textual messages were left on less notice. If the alerts would have been given in a real situation, users may have read all of the information more carefully. In a test situation as an extra work to police officers' normal duties, users may have focused on signing the alerts and switching off the alert sound quickly, rather than reading carefully everything what was written in the message.

In real emergency situations users should read the textual part of the message, because it is the only way to identify the nature of the emergency. Sounds and icons may illustrate the situation in some extent, but if the sounds and symbols do not hold an established status in the society, people may misunderstand them. Also, if symbols are culture related, all people from different cultures cannot understand them. In those cases the role of textual parts of the emergency notifications is even more important.

The Readiness to Take Action

The police officers' readiness to take action was measured by their reaction time on the received messages. The reaction time was dependent on how well the messages were recognized and in which situation the users were at the moment of receiving alerts. If alerts were noticed at once, they were also signed immediately. Possible obstacles may have been for example driving a car at a high speed amongst a hectic traffic. Referring to the situations where the users where at the time of receiving alerts, 28,6 % of the respondents indicated that it was very easy to sign the alerts. For another 28,6 % it was quite easy and for 28,6 % fairly easy. The rest 14,2 % of the respondents indicated that in most of the times it was quite difficult to sign the alerts.

Reaction times between daytime and night alerts varied quite a lot. In average 22 % of the users signed the daytime voice alerts within the first minute, 60 % in two minutes, 82% in five minutes and 88 % in ten minutes. For the rest 12 % signing of daytime alerts took more than ten minutes, but in average not more than one hour. At night when the users were sleeping, alerts were noticed even better. In a silent room the alerting sound was loud, and the users woke up and signed the alerts fast. One police officer reported of waking up even if the phone was in a bag in another room outside the bedroom. At the night time the average reaction time was fastest of all alerts which were sent during the test. 80 % of the users signed the alert within the first minute and the rest 20 % within two minutes.

The reaction times to silent alerts were slightly longer than to voice alerts. In average 17% of the users signed silent alerts within the first minute and 44 % within two minutes.

Compared with the recommended delivery times of emergency notices with SMS in Finland, the delivery and reaction times of smartphone alerts were excellent in this test. According to government's instructions of giving emergency notices to civilian people as SMS messages, one hour's delivery time is considered fully acceptable and two hours fair (Liikenne- ja viestintäministeriö 2009). In this test, 82 % of messages were delivered, received and signed within 1-5 minutes, even if the people we at sleep at the time of receiving the messages.

The Ability to Observe the Status of Police Officers and Civilians During the Operation

During the test the operation manager had an instant view on the map for observing each police officer´s position, status and reaction time on alerts and commands. If all officers did not sign the call immediately, their status was updated on the map after signing the task. The status of signing alerts was indicated on the map with different colored flags. Officers who had signed the task and were in a good operating condition were indicated with a green flag. Those who had signed the task and who were not well or needed help were indicated with a red flag. Persons who were not reached were indicated with a yellow flag.

The visual view on the map gave to the operation manager a good comprehension of the resources which were assigned for the mission. The map view showed instantly where geographically the called officers were, and how long it would take to get them on duty. Map view would also help designing transportations, if personnel should be shifted from one part of the country into another.

The Ability to Post-Evaluate the Course of the Operation

The post evaluation of the operation was based on the automatically recorded log information of the action. Log information was stored on the server and on each one´s own mobile phone, where it could be analyzed easily afterwards. Some of the test users did not see much importance with the log, whereas some others saw it as a valuable support for evaluating the course of the operation. They also reported that sometimes people understand the required tasks differently, and with the written log it is easy to confirm afterwards what the exact assignment was. In the numeric evaluation 67% of the respondents evaluated the possibility to page through the received commands and alerts as quite necessary or very necessary. Other 33% could not say clearly whether the log information was necessary or not.

The Influence of the Background Variables

The background variables in the study determine the primary conditions for the usage of mobile alerting systems. Some observations of the influence are presented on the following:

The Brand and Type of the Smartphone

All equipment in the test were able perform the required functionalities and no particular observations were reported about the differences between various brands. The devices may, however, have differences in the volume and tune of the alerting sounds, which may effect on the recognition of alerts and on the reaction times of the users. For example, in this test some of the users may have not noticed the alerts in certain situations, because some smartphone brands may have a weaker alerting sound than others. Identifying these kinds of technical differences would require additional tests.

The Version of the Operation System

All phones in the test had an Android operating system. For this reason they were expected to operate identically during the test. This is however not always the case. There is a chance that the Android operating system may not run fully identically in all manufacturers' devices. For that reason also those applications which run on the Android platform may not operate exactly in the same way in different devices. As this test was quite small and only few manufacturers' devices were used in it, the study cannot give any clear indication of the differences between different brands.

There is, however, evidence of minor differences in the operation of different versions of the operating system. For example, in November 2012 there were around 10 different versions (versions 1.5-4.1) of the Android operating system on the market (Android 2012) and the tested alerting system would not run perfectly in all of them. The Android versions of 2.1 and older do not support or deliver push messages. The studied smartphone system would however deliver alerts to these phones as SMS messages. In November 2012 versions 2.1 or older represented only 3,5 % of all Android users in the World, so the tested alerting system should run in 96,5 % of Android phones Worldwide (Android 2012).

For getting better understanding of the operation on different versions of the operating system, one should run systematic laboratory tests with different devices and versions of the same operating systems. In ordinary consumer applications possible differences may not cause any noticeable problems for users, but in systems which are built for protecting people's lives they might have a greater importance. If updating causes great changes in different versions, each new version of the operating system might include a risk for critical systems. The risk would be bigger, if the updating of operating systems or client applications would be left on the users' own responsibility.

The Telecommunication Operator

All phones in the test operated in TeliaSonera's, Elisa/Saunalahti's and DNA's networks. The users did not report of any problems which could be connected to a certain operator. Problems in telecommunications may however occur both in normal times and during a crisis (Kuula, 2012b). If also emergency alerts should cross international borders that might cause problems in the delivery of alerts as well (Kuula, 2012a). In this case most users stayed in the city during the whole test, so they may not be aware of possible problems outside the cities. They may also be unable to observe possible delays in the delivery times of the alerts or in their own responses. The performance of mobile networks was measured separately during the test.

SUMMARY AND CONCLUSIONS

Along with the vast expansion in the usage of mobile a growing interest has been paid towards using common mobile phones as a media for public alerts in various emergencies. In older types of 2G mobile devices public alerting systems have been built on SMS and cell broadcasting systems. These have technical limitations which prevent their usage for more advanced purposes. For example, they focus on one way communication, and they are not very flexible for defining the geographical range of sending messages. Also the price for sending masses of SMS messages is quite high, and in many countries the national infrastructure for delivering cell broadcasting messages is missing.

3G and 4G/LTE smartphones represent common technologies and offer many advanced features which 2G devices do not have. Because of these features they should perform better than 2G devices in alerting people of emergencies, but experiences of this kind of usage have not been reported much.

This article reported of an experiment where a smartphone based command and alerting system was tested in police officers' use. The test included members from two different preparedness groups of the Finnish police and a small reference group of civilian people.

In the test the reception of command and alerting messages was evaluated from the auditory, visual, sensory and conceptual perspective. In addition, police officers' reaction time and readiness to take action after receiving alerts was evaluated. Also operation manager's ability to observe the position and status of police officers and civilians in the insecure area, and the police officers' ability to post-evaluate operations was estimated.

The users' overall evaluation of the usability of smartphones for command and alerting purposes was good. Most of the users carried the devices actively with them and gave plenty of written and numeral evaluations of the device and system on the internet survey which was addressed to them after ending the test. All except one answered the survey in time. The overall evaluation of the usability of the system was good or excellent for 71,4 % of the respondents, fairly good for 14,3 % and poor for 14,3 %.

While evaluating the overall usefulness of the system, 57% evaluated smartphones very important for the police work and 43 % quite important. For the question of whether they would recommend the tested kind of smartphone system for the policemen's use, 43% would recommend it very strongly and 28,5 % quite strongly for the policemen's use. Another 28,5 % was not able say whether they would recommend it for the police.

As a conclusion, the study shows that smartphone based alerting and command systems are usable and useful for the policemen's use. Received evaluations were considerably high on most of the questions and strong negative comments were not received. Improvement could, however, be made in the certainty of receiving alerts in active and noisy situations at the daytime and in the evening (or in noisy night time working hours). The average daytime reaction times of 60 % of messages signed within the first two minutes, and 88 % in 10 minutes are considerably high compared with other alerting methods the television and radio broadcast. Specific user groups like the police might still require even greater certainty of receiving and signing alerts, and that could be done for example by using 2-3 different (auditory, sensory, visual) alerting methods at the same time, or by using some additional sensor devices together with the handset of the phone. For example ear tabs or some kinds of sensor devices might be useful in touch with the skin. With the usage of ear tabs the volume of voice alerts should however be used carefully for not causing any harm for the users' ears. As the number of users was quite small in this study, various alerting methods of smartphones require further research for confirming their effect in different situations.

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