NTNU – Trondheim
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Don't Panic Renewed

A mobile game for training of emergency workers using GPS and real time gameflow

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Master of Science in Computer Science
Submission date: June 2014
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Abstract

Many actuators in the field of crisis management such as firefighters are often idle between missions, and use real physical objects to simulate crisis for training. The cost of these training session can therefore be quite high, and thus decrease the number of training sessions due to limited budgets. Although it often requires highly expensive and complex computer systems to simulate the training of practical skills, it's possible to train other aspects of crisis management such as decision making and teamwork with inexpensive systems. As a part of the master degree we continued development of a prototype of a mobile serious game, which was to offer an alternative and inexpensive way to practice soft crisis management skills.

In this master thesis we have improved upon the prototype created in the autumn project, creating an engaging cooperative serious game, using real-time gameflow and the real world as the playing board. This is done by using the GPS in Android smartphones, combining geolocation and virtual elements to create game maps. In addition a reflection process has been created to support Schon's principle of reflection-in-action and reflection-on-action. The game offers two types of participation. Players can play as a field worker or as an observer/manager. The field workers play in a stressful game environment where they can practice and experience important soft crisis management skills. The observer/manager is located in a control room in a calm environment during operations, giving the possibility to analyze and reflect over the active players actions without any pressure. With a discussion at the end of the game session, both sides can present and discuss various game events, and potentially increase each others learning. A short video demonstration of the system can be watched at www.vimeo.com/97919021.

The evaluation was done with two teams, one utilizing the reflection process and the other without. Both teams played two maps with either a break, or the reflection process between the maps. Data was collected using questionnaires and video records which allowed us to better analyze the data. The result showed a bette increase in game score by the team using reflection compared to the team who didnt reflect, as well as an observable improvement of crisis management skills. Both team were strongly engaged by the game, and found it fun even though the game concept places a physical and mental pressure on them.

Sammendrag

This is a Norwegian translation of the abstract

Mange arbeidere innen krisehåndtering som brannmenn har ofte dødtid mellom oppdrag, og bruker fysiske objekter for å simulere kriser for trening. Kostnaden ved slike simulerte trenningsopplegg kan derfor være svært høye, og dermed kan antall øvelser bli begrenset på grunn av budsjett. Selv om det ofte kreves dyre og avanserte datasystemer for å simulere trening av praktiske øvelser, er det fremdeles mulig å trene andre deler av krisehåndtering som f.eks beslutningprosess og samarbeid med rimelige systemer. Som en del av master utdannelsen forsatte vi utviklingen av en prototype for en "serious game", som skulle være en alternativ og rimelig måte å trene krisehåndtering.

I løpet av masteroppgaven har vi forbedret prototypen laget i høstprosjektet, noe som har resultert i et morsom og fengende samarbeideskrevende "serious game", som bruker den ekte verden som et spillebrett. Dette er oppnådd ved å bruke GPS-en i Android telefoner, slik at geolokasjoner og virtuelle elementer kan kombineres for a danne spill baner. I tillegg har vi laget en refleksjon-prosess som følger prinsippene til Schon om refleksjon-i-utførelse og refleksjon-om-utførelse, slik at spillerene kan enten spille spillet som en aktiv deltager og praktisere krisehåndtering, eller spille som en leder som observerer de aktive spillerne fra et rolig spillmiljø som gir bedre muligheter for å analysere og reflektere over valgene til de aktive spillerene. Med en diskusjon på slutten av spillet, kan lederen og de aktive spillerene presentere og diskutere valgene tatt i spillet, og potensielt lære av hverandre. En kort videodemonstrasjon av systemet finnes på www.vimeo.com/97919021.

Systemet ble testet ved hjelp av to lag, hvor det ene spilte spillet med refleksjonsprosessen og det andre uten. Begge lagene spillte to baner, med enten en pause eller refleksjonsprosessen mellom de to banene. På grunn av lavt antall deltagere, ble testdata hentet ved hjelp av spørreundersøkelser og videoopptak, slik at dataene kunne bli analysert bedre. Resultatet viste at laget som brukte refleksjonsopplegget fikk en bedre vekst i sluttpoeng i spillet enn det andre lage, og hadde et synlig bedre læringsutbytte. Begge lagene ble motivert av å spille spillet, og syns spillet var morsomt selv om konseptet med spillet legger et fysisk og mentalt press på spillerene.

Preface

This project was carried out as a Master's thesis at NTNU as part of the MSc programme in Computer Science during the spring semester of 2014. The work done during this project is a continuation of the work done in our specialization project from the fall semester of 2013, so this thesis is a product of work that has been going on for almost 11 months in total.

Over the course of this project we have been introduced to applications of mobile information technology which we at first were unfamiliar with, or even didn't know about at all. This has made us more aware of the things that today's technology can be applied to which we have learned much from. We would like to thank our supervisor Monica Divitni and co-supervisor Ines Di Loreto for helping us with ideas, inspiration, and guiding us through work and topics which was unfamiliar to us before we started working on the project as well as providing us with feedback throughout the whole work process.

Trondheim, 2014-06-11

Andre Sjøvoll Lap To

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Chapter 1

Introduction

This chapter will give a short introduction to the project by firstly presenting information about the background of the thesis, before presenting the research goals and methods.

1.1 Task description

Don't Panic Renewed: a mobile game for training of emergency workers using GPS and real time gameflow.

During the autumn project an early prototype of Don't Panic Renewed was developed and evaluated. The evaluation showed that the game had potential, but also that there are options for improvement of the prototype and the evaluation setup. Thus in this project, we will continue the work from the specialization project and focus on improvement of the prototype and evaluation set up.

1.2 Context

This work is done as a Master's thesis at the Norwegian University of Science and Technology (NTNU) and is a direct continuum of the project carried out in the course TDT4501 - Computer Science, Specialization Project. Further information is provided in chapter 2

1.3 Motivation

Crisis management and preparedness is an important part of todays society. As technology has evolved, so has the field of crisis management, providing better tools for handling for these emergency situations. However, since disaster doesn't occur in a frequent and steady interval, but at random locations and time, there can be a large time gap between each episode which can cause skill decay. To minimize this effect, simulated training, coaching, debriefing etc is used to maintain these important CM skills.

In 2008 a project aimed to explore the possibility of using a growing alternative learning platform known as serious gaming to facilitate the training. Serious gaming combines the element of fun and knowledge to enhance the ease of learning. The result was a board game called Don't Panic which was evaluated with expert users and showed good results. The game concept was to teach and improve soft skills needed for crisis management. To harness the potential of the game concept, the idea of creating a mobile game using cheap and commonly available technology was put in motion. If a successful product is developed and launched, not only do those who work in the field of crisis management get a cheap alternative learning method, but it could also be used by everyday civilians to prepare them for crisis situations.

1.4 Research Questions

Since this master thesis is a continuum of the autumn project, our research question are based on results, feedback and suggestion given during the autumn project.

1. **Can a mobile location based game with real time gameflow be engaging and teach relevant skills for crisis management?** We want to find out if a game with these characteristics can be used in addition to, or even instead of, established training procedures to help cheapen the cost of training and find out how well suited it is to teach the skills needed for this type of work.

2. **Can a reflection process be added to this sort of game to further stimulate learning?** We want to find out if, and how, a reflection process can be used to help the workers to further increase the benefits of playing this type of game for training purposes.

1.5 Research Method

The work done in this project will be continuation of the work done during the specialization project, which in turn was based on the work done during the MoDo project, which again was based on the Don't Panic tabletop game. This project will use a qualitative research method as there is not enough empirical data which will be produced to justify using an empirical research method. The research will be conducted using an iteration loop with 4 stages:

1. Analysis. This stage will focus on trying to analyze the evaluation and feedback from the previous iteration and uncover which parts of the game can be altered in order to achieve better usability, playability and other desired goals.

2. Propose changes. After analyzing which parts of the game needs modification, this phase will focus on generating ideas for solving the problems, or improving areas where there is room for improvement.

3. Implementation. This phase will implement the changes which were proposed in the previous phase.

4. Evaluation. During this phase the new modifications which where implemented in the previous phase will be evaluated by conducting test runs of the game and collecting feedback. The focus will be to uncover how the changes and/or additions to the game impacted the game and if the goals where met.

1.6 Structure of the Report

The rest of the report is structured as follows. Chapter 2 gives an introduction to the problem domain as well as a overview of the work done in the autumn project. Chapter 3 gives an overview of the functionality of the prototype designed in the autumn project. Chapter 4 present background information and research papers regarding reflection which we have used to create the reflection process. Chapter 5 present the reflection goals, the triggers to accomplish the goals as well discussion on how to structure the reflection process to best suit the game concept. Chapter 6 present design choices to improve the usability and stability of the autumn prototype as

well as to support the reflection process. Chapter 7 present the implementation phase. Chapter 8 present the evaluation set-up where we will present how we plan to carry out the evaluations. Chapter 9 presents the evaluation results. Chapter 10 present discussion regarding if the research goal has been meet. Chapter 11 will present technical and nontechnical issues which may limit the usage of the product. Chapter 12 will present our conclusion as well as recommendation for future work.

Chapter 2

Problem elaboration

In this chapter we will discuss opportunities which we can explore to improve the prototype to provide more valuable data and usefulness to the users. The first part will be a general introduction of the main area of the prototype, followed by a discussion about the prototype created during the autumn project.

2.1 Problem definition

One of the most important and dangerous jobs in our society are those that involve emergencies and crisis situations, which can be everything from a fire or large traffic accidents to natural disasters such as earthquakes and floods. These workers are trained to coordinate, communicate, think critically, and tolerate stress, allowing them to work in sudden and unexpected situations [24]. Teamwork, being able to work well under pressure, communication, and being able to remain calm and decisive during emergencies, are some of the skills needed to perform this work efficiently [22], [34]. Since in most cases, emergencies does not occur at the same location at a steady interval, drills and exercises are used to train and maintain the skills requried for a real emergency situation. Different forms of training exists, such as classic classroom lessons, instructional books, and simulated emergencies [12]. The problem with these are that classroom lessons and books tend to be uninspiring and tiresome [17], while simulations can be time consuming, require a great amount of planning and a large commitment of resources [28]. With the growth of technology, alternative learning platforms has been experimented with. One of these

alternative learning platforms are serious games, which are games intended to educated players by mixing the elements of fun and learning. Serious games have gained much popularity as it is a cheap alternative which engages [15] and has shown initial evidence of accelerating learning and increased motivation [8] for students. An example of this is the video game America's Army which was experimented with by the US Army. At Fort Benning, the new recruits which struggled at the shooting range and failed the required test was told to complete all the missions in the video game involving the shooting range. After completing these tasks, they usually passed the real shooting range test [35].

Don't Panic is a serious game designed as a board game in co-operation with expert users, which aim to be an alternative learning method for civil protection workers and others who work with emergency situations. Unlike America's Army which has a virtual reality approach and contain practical education information, Don't Panic use abstraction and other game elements to mimic crisis environments in order to teach communication and teamwork skills while being in a stressful environment. The evaluation of Don't Panic gave positive results, showing the usefulness of a serious game for crisis management. To explore the possibilities of available technology, a follow up project called MoDo was done as a specialization project and Master's thesis. MoDo, short for Mobile Don't Panic, uses an Android smartphone as the client platform. This allowed the possibility of mobility in the game and also to use the real environment as the game board. The result was a mixed reality game which adapted the game elements from Don't Panic. The round based game flow was kept intact, and the real physical environment was used as a board by utilizing PIN codes placed in the environment which were used to represent a location/sector in the virtual sector based game map. Players moved virtually around in the game by physically moving to a location and register the location's PIN code in the game application. Data was gathered during the game session and was used as part of a reflection process, allowing the players to review their game session. Since MoDo was done over a period of a year and used an iterative work process, there were multiple versions and evaluations. Although issues was solved for each iteration, there was one problem which could not be fully solved. The turn based game flow caused pauses which would increase by the numbers of players who participated. This caused the players to be bored while waiting for their turn, which is quite destructive

for a serious game as fun is an important element. Additional game elements was added such as player progression and game achievements in an effort to counteract this.

After the final evaluation of MoDo, we did a follow-up to MoDo as a specialization project. The follow-up project was based on the evaluation feedback from the MoDo project, which some of the feedback showed that the players found the solution with the virtual sector based map and the PIN codes little intuitive. And although features had been added to counteract the players boredom while waiting for their turn, the final evaluation did not reveal if this was satisfying enough. The author recommended an additional feature to solve this issue, which was to allow the waiting players to see the acting player's action in real time. However for the follow up project, we decided to rather explore the use of a real time game flow, instead of the turn based flow used in the MoDo project, as this would remove the waiting time completely instead of trying to minimize its consequence. In addition GPS tracking and geolocation was implemented instead of the virtual sector based map and PIN codes. The result was an early working prototype which uses an Android device for the game client and GPS tracking. The autumn project and the result of the evaluation provided is what we will base this Master's thesis on. The autumn project will be further discussed in section 2.2

2.2 Autumn project overview

During the autumn project an early version of the prototype was developed which was tested and evaluated by two teams. The aim of the prototype was to measure usability, player immersion and collect player input about the potential of learning from playing the game. The main mission of the game was to keep as many civilians as possible alive for a certain amount of time, where the civilians were grouped into several geolocations called zones. Each player was tracked using the device's GPS. In order to keep the civilians alive, the players had to interact with the civilians, which again required that the players had to be within a certain radius of the zones.

The players started in a special zone, called the secure camp which acted as a supply base. While being in the secure camp, the players could pick up or throw away equipment. Players could only carry a maxmium of three equipment at a time, and these equipments where nec-

essary in order to clear blockades, which prevented the players from entering the zones, or to provide a bonus when interacting with the civilians. These equipmenst could only be used once before they were removed from the players inventoru, and thus the players had to return to the secure camp to gather more equipment as the game went on.

To enforce teamwork the game had 3 different roles, each with their own benefit but also some limitations which prevent roles from performing certain critical actions. Because no one role could efficiently perform all the actions needed the players had to communicate throughout the game. Since the players could be quite far away from each other, a physical walkie-talkie was provided to each player which could be utilized to communicate across distances. To mimic the stressful environment of crisis management, time was used as the main "enemy". Civilians health and state degenerated as time passed by, forcing the players to regularly interact with the civilians to keep them alive. However, to interact with the civilians, time was also required as the action required to keep them alive is not carried out in an instant.

To promote strategic planning and quick decision making, each zone had a different amount of civilians, and the numbers were not revealed until the players had explored the zone. Some zones also had equipment that could be used to unlock it, but these required substantially longer time to use than the equipments brought by the players. In addition, the game evaluation maps was created so that keeping all civilians alive was impossible, forcing prioritization. The idea was to create a constant flow of new information as the game progressed, causing the need to re-evaluate decisions and plans as the game played out.

2.3 Autumn project evaluation and conclusion

The evaluation was split into two parts, where the first part was to introduce the players to the game and its elements, without putting any pressure on the players. Time and civilian health degeneration was disabled and a set of pre-definded tasks which was to be done was designed to show the limitations and and benefits of each roles, as well as allowing the players to decide between different possible actions to accomplish these tasks. The second part was simply to play the game with a game time of 15 minutes. The players were observed by two observers, where one was at the same physical location as the players and monitor how the team played

the game, while the other sat and monitored the team from the backroom by using the game client and server client as well as listening to the radio communication.

The evaluation suffered from bugs which made the evaluation process harder and different than planned. However the evaluation revealed an interesting discovery, as well as issues that could not be fully explored with the prototype and the evaluation setup. Although not intended, team one and team two had a bit different gameflow due to bugs, and the result indicated a semi real-time gameflow with regular pauses provides a better usability, while a true real time gameflow gave a better player immersion. However in both cases, the player immersion could have been better as the playstyle was very physically dominated, while the mental effort remained low. We concluded it could be possible to improve this by adding a reflection stage to the evaluation process. However as there was not enough time, this option was not explored during the autumn project.

Chapter 3

Old prototype game design

Since our work is somewhat a continuum of the autumn project and that the reflection process are to be added upon the autumn prototype, we will use this chapter to go through it, explaining the core part of the prototype.

3.1 Architecture

The overall architecture of the system is a client-server architecture. This architecture allows us to create the map, set settings on the server side and distribute it to the clients without any changes in the client side. In addition it allows us to have a master game state, where the game state at the server is always the one which is correct.

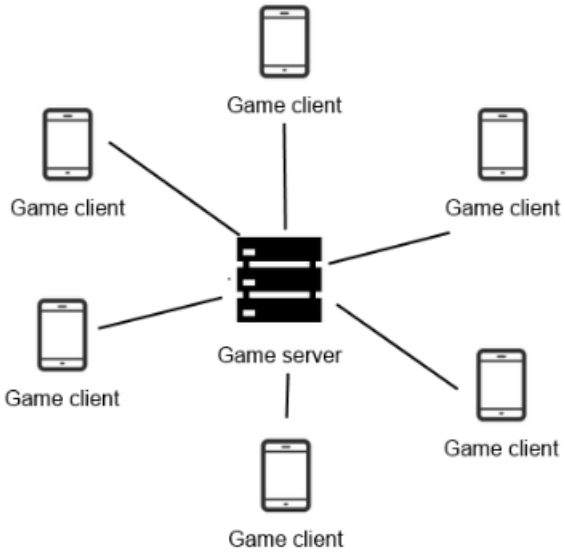

Figure 3.1: Don't Panic Revewed architecture overview

3.2 Game elements

This section explains game elements which effect the gameplay, what they represent and how players interact with them.

Civilian Civilians are interacable non-player charaters which the players must keep alive. The score that the players achieve is solely based on how many civilians they manage to keep alive, compared to the total amount of civilians there are in the game map. Civilians have two stats, health and panic. Health indicate if they are alive or not, and how close they are to dying. Panic will cause the civilian to lose health if its at maximum. Both stats can be effected by player interaction.

Zone Zones represent a physical location where civilians are placed. Zones are blocked by the game element "blockade", which must first be removed to gain access to the zone. Besides containing civilians, a zone can also contain special equipment bound to the zone.

Equipment Equipment is either mobile or zone bound. Zone bound equipments are equipment which exist only within a specific zone, and must be used within that zone. Mobile equip-

ment has greater benefits compared to zone bound equipment, requiring less time to be used, and can be carried. However, mobile equipment can only be used once before it gets discarded. Some equipment is used to remove blockades, while some is used to interact with the civilians. Equipments which can be used on civilians will affect all the civilians in the zone, greatly outperform the player normal abilities which only effect one civilian at a time.

Secure camp The secure camp is the starting location for the players and will be visible on the map at all times during the game session. It's somewhat similar to a zone, however there are no civilians in the zone, instead it serves as an equipment storage for the players. Since players can only carry a certain amount of equipment at a time, this game element helps balance out the game difficulty by allowing the players to return and restock on equipment when they have used up the equipment they started with.

Skill Skills are simply actions which can be performed by the players without the requiring the need of equipment. Skills are directed to the civilians, and only one civilian can receive the benefit of the skill at a time. Currently there is only two actions available, "calming" and "healing". Calming a civilian will reduce the panic level of the targeted civilian, while healing will restore some health to the civilian.

Blockade A blockade is a special game elements which hinders the players access to a zone. The player can't interact with any civilians nor see how many civilians there are before the blockade is removed.

3.3 Game rules

This section will explain game elements tied to a special rule, and game elements which only serve as rules.

Time In the prototpe developed during the specialization project, the players agree to a time limit before starting the game. Once the time limit has been reached the game will be stopped manually.

Panic waves The game server will send panic waves at certain time intervals which will increase the panic level of all the civilians in the game.

Game ticks The game server will send out game ticks at regulare intervall. At each game tick, civilians will lose health if their panic level is at the maximum level.

Equipment limit Each player can only carry a certain maxmimum amount of equipment at all time. If a player tries to pick up more equipment when they are at the maximum amount allowed, they will have to choose an equipment which will be replaced.

Role Each player will play one of three roles. Due to each role's limitations, benefits and penalties, the playstyle will be affected by the role:

- Medic - Best at healing and calming civilians, but cannot remove blockades.
- Firefighter - Best at removing blockades and second best at calming civilians, but cannot heal any civilians.
- Volunteer - Jack of all trades. Can perform all actions, but not very good at any of them.

3.4 Game loop, game state and fragments

The application consist of two Android.fragments were each fragment has its own task. We will explain more about Android.fragments later in 6.2.1, but for now we refer to them as the map fragment and the zone fragment. Although they have their separate tasks, both are connected by the game state/model.

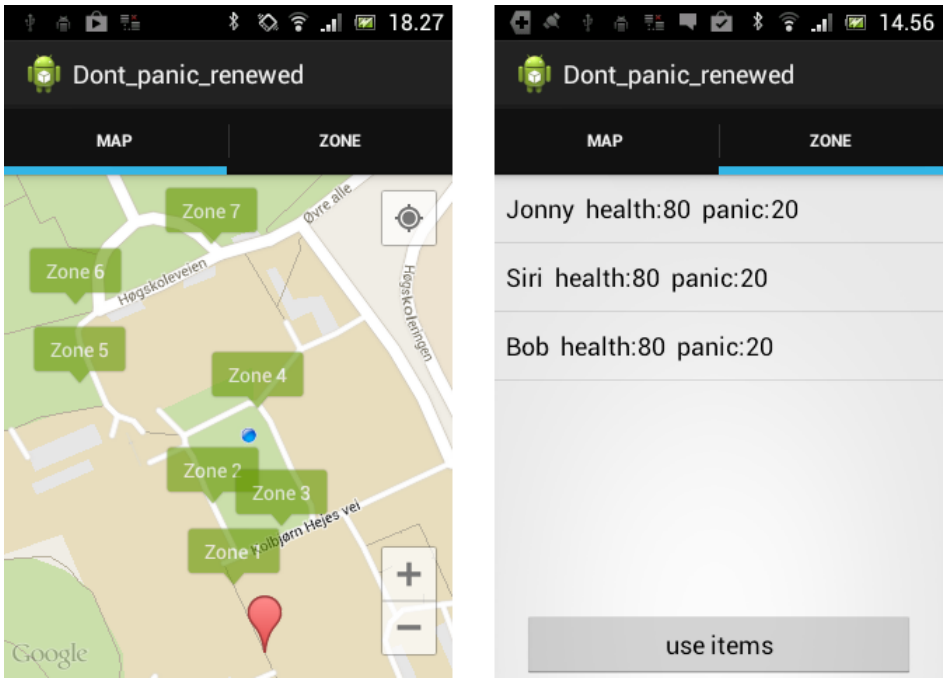

Figure 3.2: Image to left shows the map fragment and image to the right shows the zone fragment

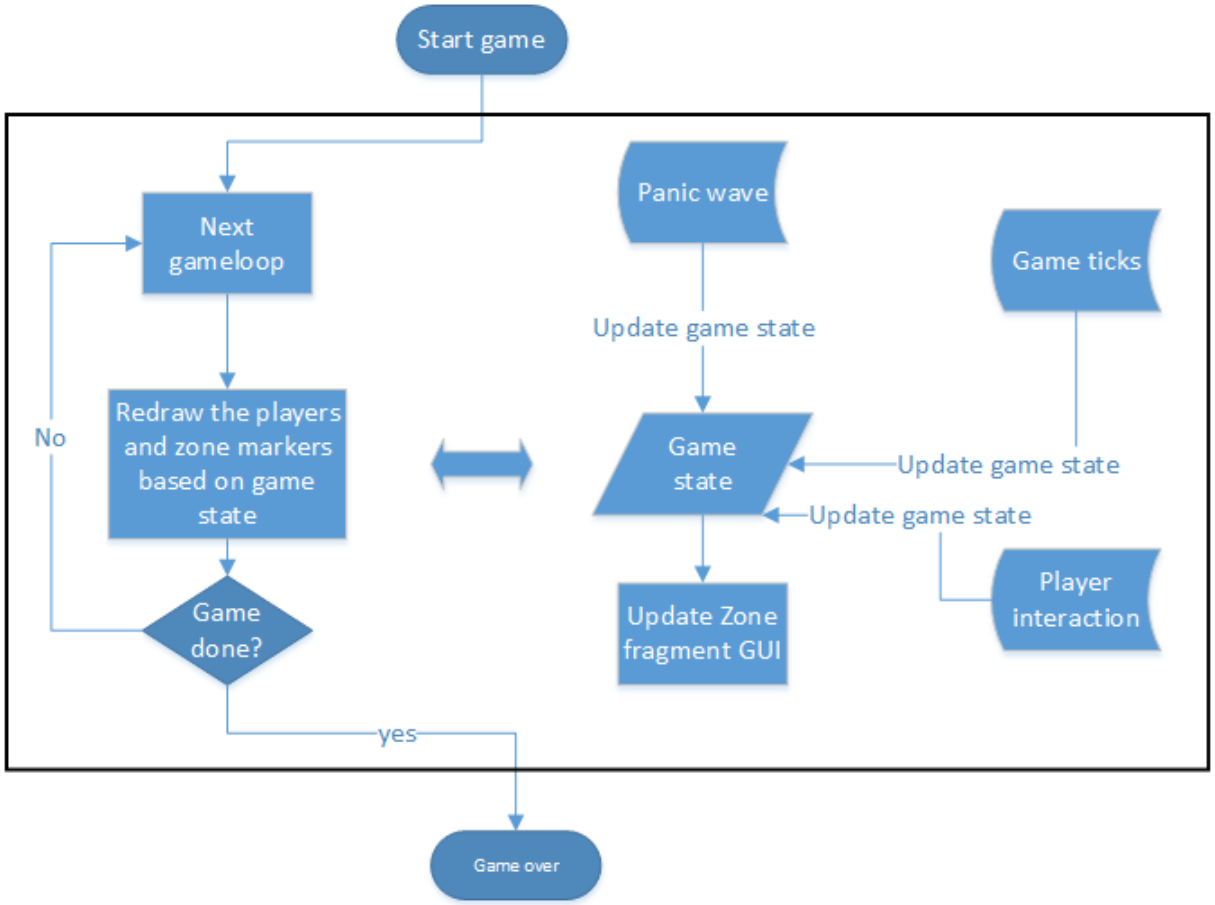

Figure 3.3: The left side shows how the map fragment operate, and the right side shows the zone fragment operate

The left side of figure 3.3 shows the process behind the map fragment. The map fragment uses a loop which will redraw all the markers on the map at a specific interval. For the autumn project this interval was set to 1 second, which allowed the players to track each other in close to real time.

The right side shows the zone fragment. This fragment is fully event driven and will update only when it has been notified that the zone which the player is currently in has been modified. This fragment also allows the player to interact with the zone, altering the game state which again affect the map fragment.

3.5 Game interface and interaction

To get a better understanding of how the players are using the smartphone to interact with the game, we will use this section to go through the basic actions.

3.5.1 Moving around and player tracking

Players are to physically move around during the game sessions, the location of team members are displayed at all times so that some coordination and decision making can be achieved without having to communicate verbally. The nicknames of the players are displayed at all times as well, so it's easier to recognize which marker belong to which player. The role however is not displayed, so that's something that must be remembered.

Figure 3.4: The image shows the player marker as well as the marker used to represent team members.

As shown in figure 3.4 the player is marked on the map with a blue dot. When the player moves, the location of the marker will be updated automatically. Once the location of the player marker changes, the coordinates will be sent to the other player so the marker which indicate the team member's location also gets updated. Due to the pace at which the marker location updates when a player moves, it should be easy to figure out which direction a player is moving.

To enter a zone, a player must be in proximity of the marker. Once the player is close enough, a visual confirmation will be given. This is given for both zones and the secure camp. When a player leaves the proximity of the zone, a visual confirmation shown in figure 3.5 will also be given.

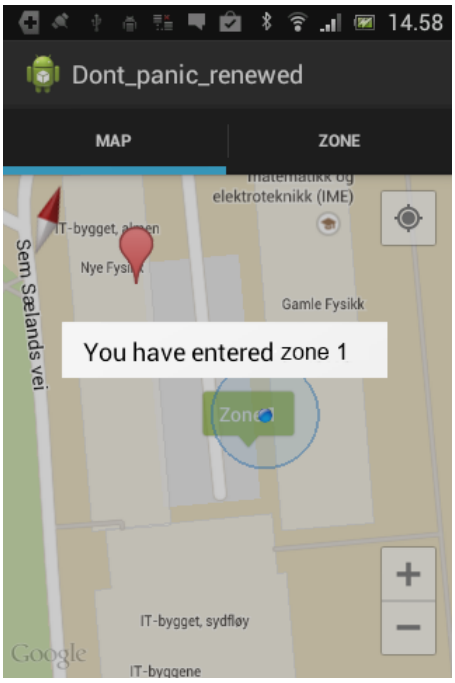

Figure 3.5: The image shows the message displayed when a player enters a zone.

3.5.2 Zone markers and color indications

Normal zones which contains civilians and blockades can either have the color green, orange, red or black, all depending on the panic level in the zone. The colors are supposed to reflect the noise level from zones, where the more critical the color is, the more noise/panic it indicate.

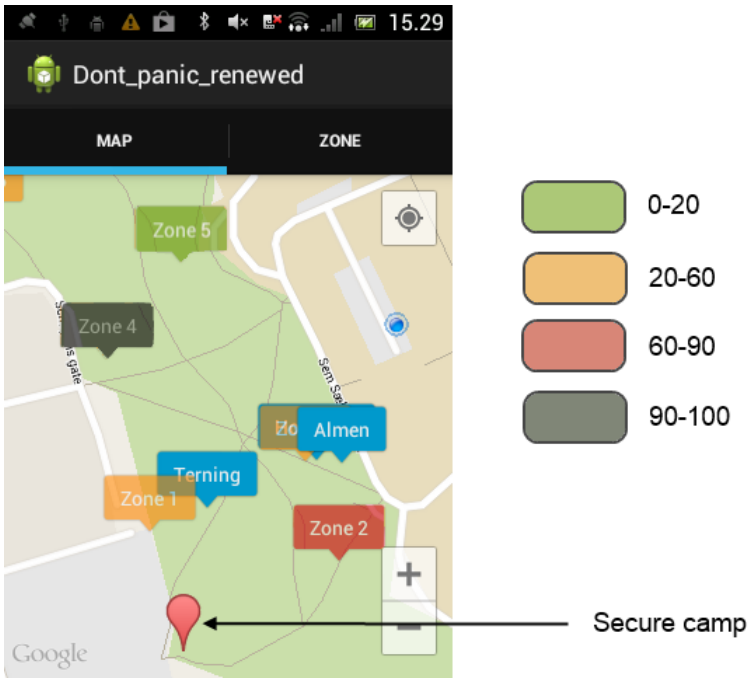

Figure 3.6: The image shows the different type of markers used within the game.

Once the panic level reaches 100, civilians start losing health for each game tick. If all the civilians in the zone are dead, the color goes back to green. Having the same color indication for a zone with low panic and a zone with dead civilians might sound strange and little intuitive, but this was an active design choice we did in the autumn project. By having the same color for both cases, the players have to keep track of which zone are dead by themselves, creating a mental workload and pressure.

3.5.3 Interacting with elements in a zone

A zone will always be blocked, and the blockade must be removed before the players can interact with the civilians in the zone. Once the zone is unblocked, it will remain so for the rest of the game.

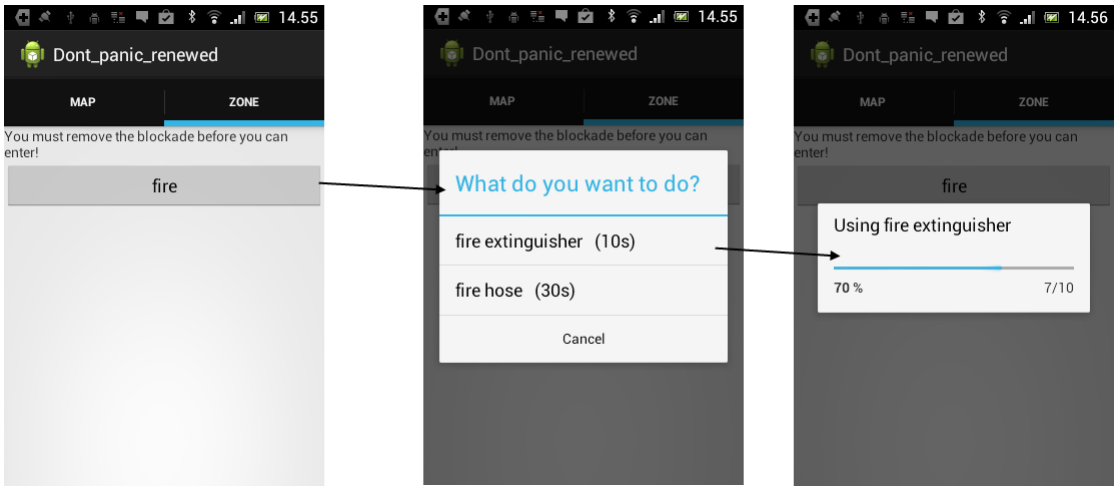

Figure 3.7: The image shows the application screens when removing a blockade.

A blocked zone will not reveal any information regarding the amount of civilians nor their specific state until the blockade has been removed. The blockade can be removed if the player has the required role and equipment to do so.

Once the zone is unblocked, the players can interact with the civilians. The player can either use single a action/skill to interact with individual civilians, or interact with all of the civilians at once using the different equipments. Single actions are faster, but equipment is more efficient for a larger mass. Depending on the civilians state and the number of civilians in the zone, the two has their strengths and weaknesses.

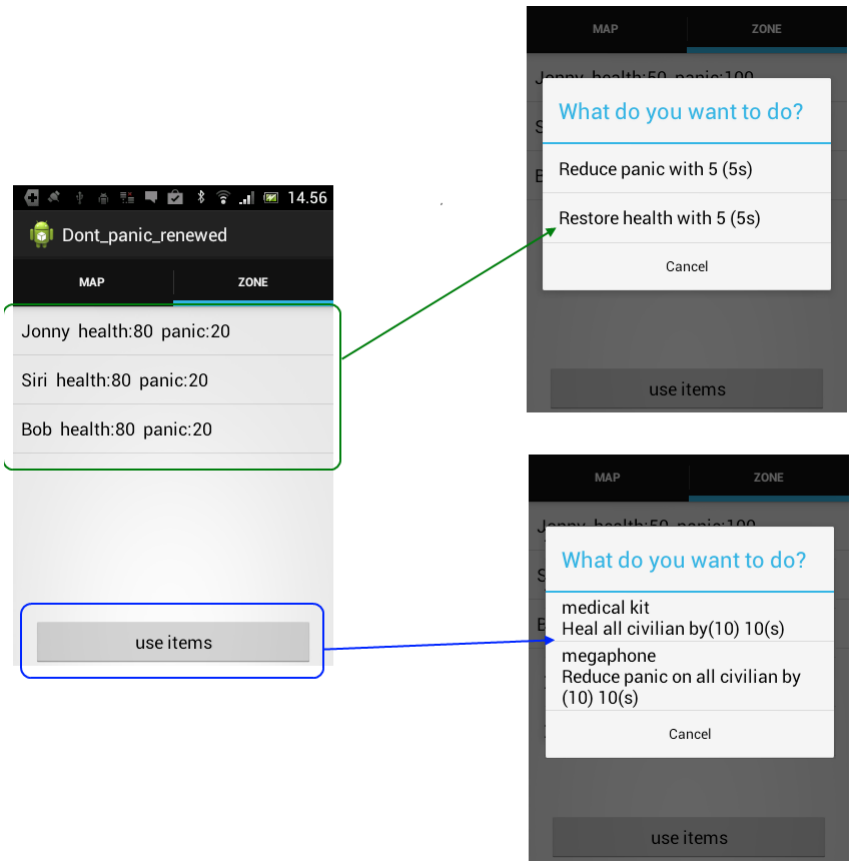

Figure 3.8: The image shows the two different methods for interacting with civilians.

3.5.4 Picking up equipment

In the secure camp, a player can pick up whatever equipment he/she wants to. However, not all roles can use all types of equipment, so if for example a medic decide to pick up a fire extinguisher, he will still not be able to remove a fire blockade. There is an unlimited amount of equipment in the secure camp, but a player can not carry an unlimited amount at the same time. If the backpack is full and the player wants to pick up a new item, the player must choose which item to replace the new one with. This is done by clicking on one of the existing items in the backpack.

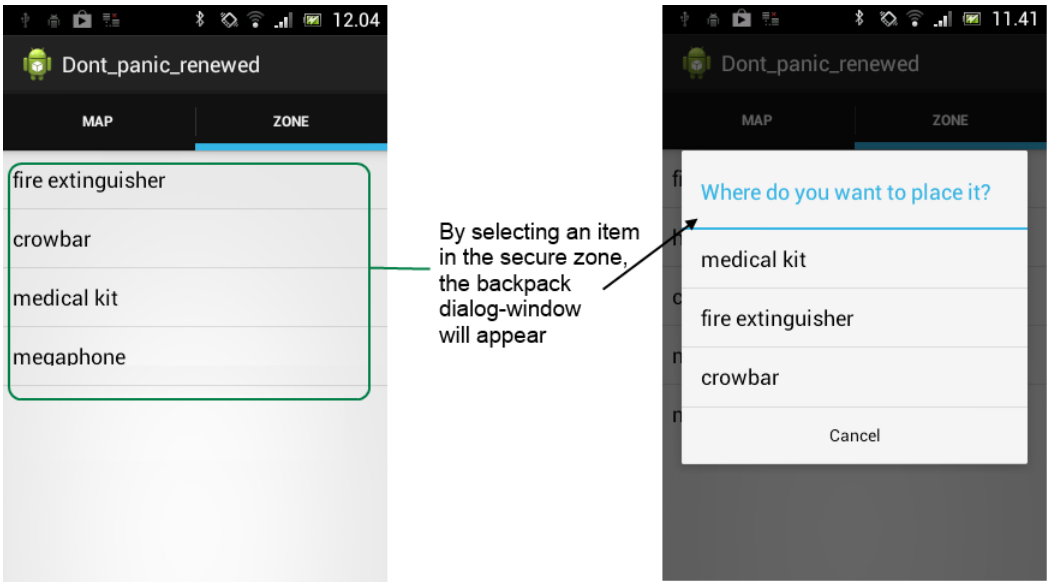

Figure 3.9: The image to the left shows the content of the secure camp, the image to the right shows a full backpack.

Chapter 4

State of the art

As the prototype was build during the autumn project, the research done during that time was focused on creating a mobile game, adapting turn-based game flow to real time gameflow, and the usage of smartphone GPS and its issues. Since we have no plan to add more game functionality, unless it's a part of a reflection decision, we will only look into previous work on reflection

4.1 Reflection and Reflective Learning

This section will give an introduction to some theoretical background of the concept of reflection and its benefits, as well as work done on concepts of reflective learning and work to ease the creation of tools in support of reflective learning.

4.1.1 Theoretical background

In the physical sense, when thinking of reflection one usually imagines mirrors and reflected images. From a human view one can imagine thinking quietly about events in our mind, trying to make sense of our past experiences [5]. Literature contains many interpretations of the meaning of reflection but there are many common-sense meanings of reflections as well. One of the ways it's interpreted in common terms is that reflection lies somewhere around process of learning and the representation of that learning. This interpretation means that we reflect to consider something in more detail ("Let me reflect on what you are saying") or present something in

another form, either written or orally. In general reflection is done for a purpose, although conclusion to issues can just pop up without there being a conscious reflective process. A situation where an answer just pops up like this could imply that reflection has occurred unconsciously and might even overlap with intuition. Another understanding is that reflection involves complicated mental processing of issues with no obvious solution. For example people don't use the word reflection when describing their processing of simple arithmetics, or their mental process when walking to a known place, they use the words "think" and "recall". This suggests that reflection is used to describe a mental process which involves more processing than simply recalling something [20]. When talking about reflection in the context of this project it will refer to serious thought or consideration with the purpose of either solving a problem, learn new things, increasing understanding, raising ones self awareness or improving upon something.

Reflection can be done individually and collaboratively, both comes with different advantages and disadvantages and require different means for support [26]. When reflecting collaboratively, participants need to share their experience and relate their own experience to experiences of the others in their own reflection. According to Boud's model of reflection, a key aspect in making a reflective process happen is triggers [26]. A trigger is an unexpected situation such as disturbance or uncertainty. Positive situations can also be triggers, an example of this would be surprising success. In general reflection seems to be triggered by awareness of when the reality experienced, differs from what is expected. The process can be triggered an external event or agent, it might also develop as one thinks of a whole series of occurrences happening over time.

Using reflection as a means of improving learning is useful because in many instances we do not learn from just doing, but from also thinking about what we do. Some are convinced that in any form of learning, reflection is a vital element [5]. Reflection allows us to consider past experiences, understand why something was done the way it was, if it was the best way to do it, and if a similar situation occurs again what to do then. Reflection facilitates the linking of theory and practice, encourages critical evaluation, and provides a link between an experience and learning from that experience [30]. In other words, reflecting on work or activities will help us evaluate activities and turn them into learning experiences. It makes us learn from mistakes we've made, repeat success, and plan for the future. Reflection encourages and helps us to become more aware of our thoughts and feelings related to an experience or area of practice.

4.1.2 The CSRL Model

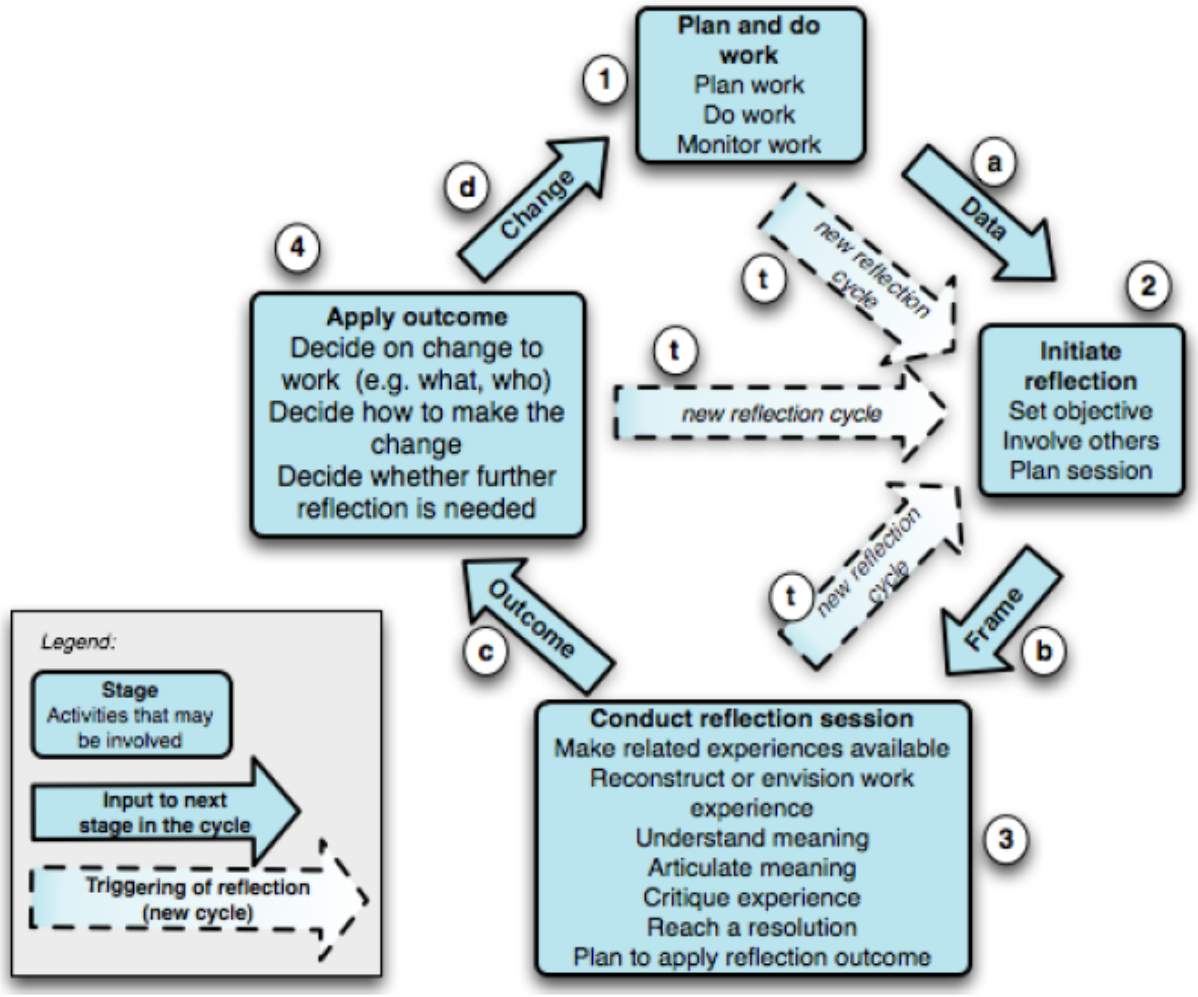

Figure 4.1: The CSRL-model

The CSRL model [18]] is a framework which can be used to describe cases of reflective learning, and link tool use to cycles of reflective learning and the transitions between them. The model is designed to describe cases of reflective learning in workplaces. Figure 4.1 illustrates the CSRL model's reflection cycle. A trigger is what starts the reflection. This trigger could be an experience leading to discomfort which a group or individual want to overcome. Each stage in the model contains a non-exhaustive list of activities associated with each stage. Using this model the reflective learning in a workplace can be represented as a process involving multiple interconnected, cycles.

The model contains four stages of reflection:

1. Plan and do work: The plan and do work stage refers to everyday work done both individually and in groups in the work arena, including planning and monitoring of the work. The stage also includes simulation of work in both real and virtual environments.

2. Initiate reflection: The initiate reflection stage can be more or less elaborate. It's possible to closely integrate it with work or other activities. If the activity of involving others is included, this stage will provide a link between individual and collaborative learning processes. Example of activities during this stage could be to set an objective of the reflection session based on the reason why reflection was triggered, in other words understanding what went wrong.

3. Conduct reflection session: The reflection session can involve just one or many persons. The session has an objective and a reflection topic, it may be facilitated. The reflection session will result in an outcome. Activities during the session could for example be to share work experiences which are related to the objective of the reflection and then perform a critical evaluation of the experience to uncover if a problem could be avoided and how.

4. Apply outcome: The outcome from the reflection session is applied. This could be a change in work, in input to further reflection sessions or both. This may include involving others, switching between individual and collaborative reflection or applying the reflection results to work. Involving others could mean consulting team members to see if they feel the reflection outcome is a good solution to the problem at hand. This solution could for example be new routines and procedures which in turn requires involvement from other groups or persons in the organisation.

4.1.3 Reflecting on 'Reflective Practice'

Although most have accepted that reflection can provide benefits which "traditional/normal" methods can not, there are still quite many views on what reflection is and how it works. The author of the paper "Reflecting on Reflective practice" has therefore decided to explore current ideas and debate reflaction in relation to reflective practice and the practise of the concept itself.

One of the big topics in the paper is the difference between reflection-in-action and reflection-on-action. Reflection-on-action is described as follows: " *professionals are understood consciously to review, describe, analyse and evaluate their past practice with a view to gaining insight to improve future practice*" [14]. While reflection-in-action is described as following: "*professionals are seen as examining their experiences and responses as they occur*" [14]. These concepts where introduced by Donald Alan Schön in 1983 and have had a significant impact on future work on reflection. Schön believed that reflection-in-action was the core of professional artistry, a view which was not shared by all. The idea was criticised by many who favours quantitative studies over qualitative ones and established protocols over intuitive practice. However, Schön held on to his beliefs and argumented that "*As professionals become more expert in their practice, they developed the skill of being able to monitor and adapt their practice simultaneously, perhaps even intuitively. In contrast, novice practitioners, lacking knowing-in-action (tacit knowledge), tended to cling to rules and procedures, which they are inclined to apply mechanically.*"[14] He argued that novices needed to step back and, from a distance, take time to think through situations.

Schön work have inspired many authors and there are existing practices and models which are based on his ideas which are widely accepted. This has not gone uncriticized and many researchers and professors such as Boud and Walker criticise Schön for ignoring the context for reflection [14] [6]. Other has stronger criticism and criticise the concept itself, e.g Moon argues that Schön's concept of reflection-in-action is unachieveable [14] [20].

4.2 Related work

This section will give a overview of works which we have examined to get a better understanding of how reflection can be implemented.

4.2.1 Enriching Archaeological Parks with Contextual Sounds and Mobile Technology

The authors of this work wanted to explore the potential of using mobile technology, and sound to increase the interest of archaeological sites. In addional, explore the potential in increasing the effect of learning by using sound. The system consisted of two applications running on a HTC TyTN II and a Nokia E70, where the first was used to interact with the game and perform actions like submitting answers, looking at reconstructions, and so on. While the E70 was used to run a hint application, which the players could use when they needed help. The test was carried out using two second year classes with a total of 51 pupils. These were divided into two groups, where one group was to test the system with sound, and the other group was to test the system without sound. Although the evaluation showed mixed result regarding the use of sound vs no sound, the benefit of using reflection/debriefing was clear. Without reflection the pupils scored an avg score of 6.9/10, while with reflection the pupils scored 8.3/10. Reflection was done right after the game session ended, and was done with the help of a software application and a person in a game master role. The software application served two purposes. The first was to provide a visual illustration of the game map, the second was to allow the pupils to place the location which they were to find during the game into this game map.

Figure 4.2: Archaeological park: Reflection application

4.2.2 Rescue league- The virtual tutor

Rescue league is a serious game with the aim to train volunteers of emergency services to face anxiety, medical protocols and stressful situations in a safe virtual environment. The game is designed so that the player is placed in a 3D hospital which has been hit by an earthquake and have to deal with wounded persons. The game is structured so that the players will play through different branching stories, where each will require that the players have to decide between multiple actions. At the end of the branching story, mini games which are designed to train skills that are important in the emergency domain can be played.

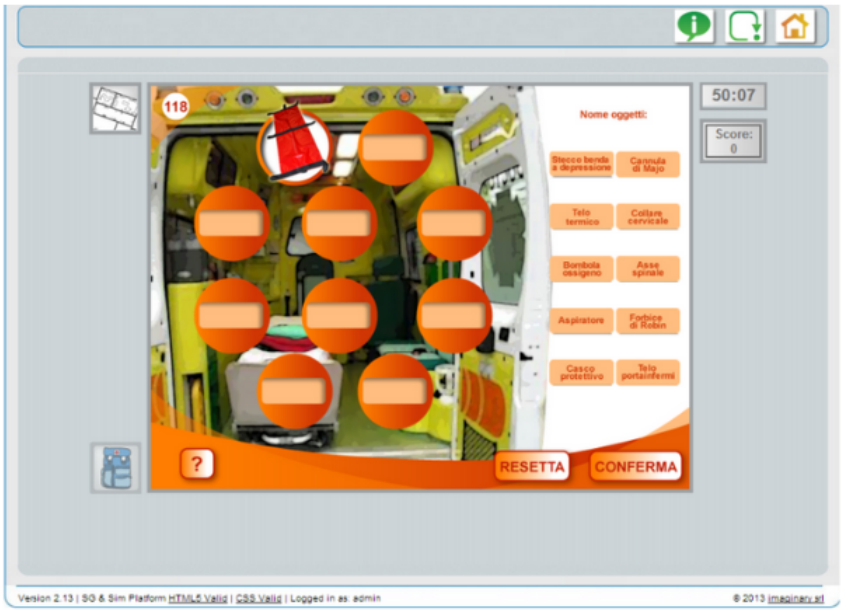

Figure 4.3: Rescue league: One of the mini games

As an aid, there is a virtual NPC called Carlo who can give advice to the player on his own initiative. The player can also ask Carlo for help when needed. Once the game is completed, the player can rate their own performance, which is then compared to the score which the system has given them. At the very end a learning diary is presented to the players, which contains information about game events which the player can reflect over.

Figure 4.4: Rescue league: The diary with game events

4.2.3 TimeLine with gamification

The work on Timeline started in 2011 as a master thesis at NTNU and resulted in an Android application that allowed the user to store notes in various shapes and form, which could be used as aid to stimulate reflection/reflective learning. The default/main view of the application looks much like a calendar, but once selecting a date a more specific timeline is shown.

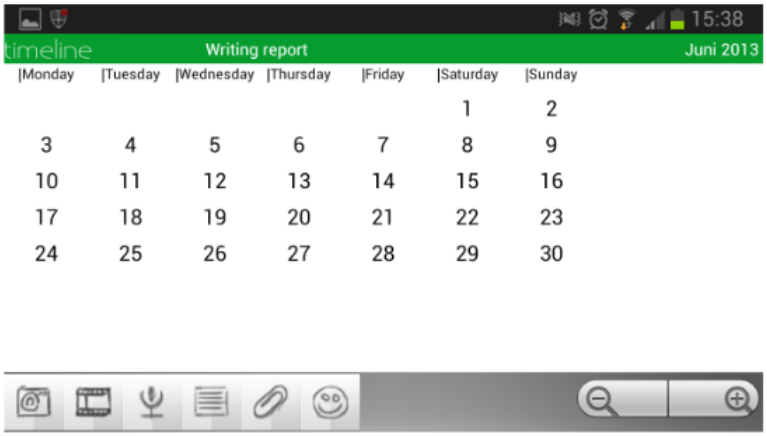

Figure 4.5: TimeLine: The default/main view

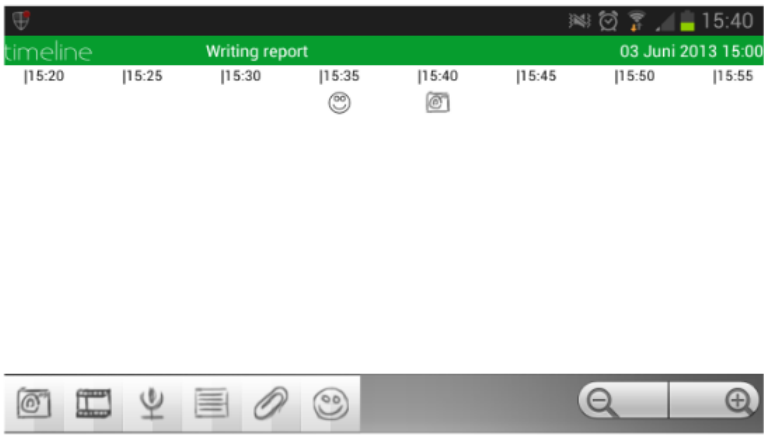

Figure 4.6: TimeLine: The view of a specific timeline

Aside from supporting individual reflection, the application also allows the user to share a specific timeline to a group of people, allowing collaboration on building the timeline and thus support group reflection. A problem with TimeLine, was that the users found it to be boring and a dull task to collect data, and that once the data was collected, there was no motivation for the user to start a reflection process. This issue lead to a follow up project in 2012 and master thesis in 2013 which was to investigate if gamification could be used to encourage data collection and motivate users to reflect. After implementing many gamification elements and evaluating the system, they concluded that gamification elements such as achievements, points and scoreboards, and a leveling system could be used to encourage the capture of data, but that none of the elements which had been implemented had a positive impact on the motivation to reflect. This they reasoned with that the solutions implemented was too individual, and that gamification elements that allowed players to rate each others reflection note would have a better chance to motivate reflection.

4.2.4 v-share - Video-based Analysis and Reflection of Teaching Experiences in Virtual Groups

To support student teachers in their training to become teachers, the author suggesst the use of videos to capture the lectures. These videos are combined with a bulletin board, creating a virtual workspace where the video can be viewed and commented on. This virtual workspace is asynchronous, meaning the workspace supports collaboration at different time and place.

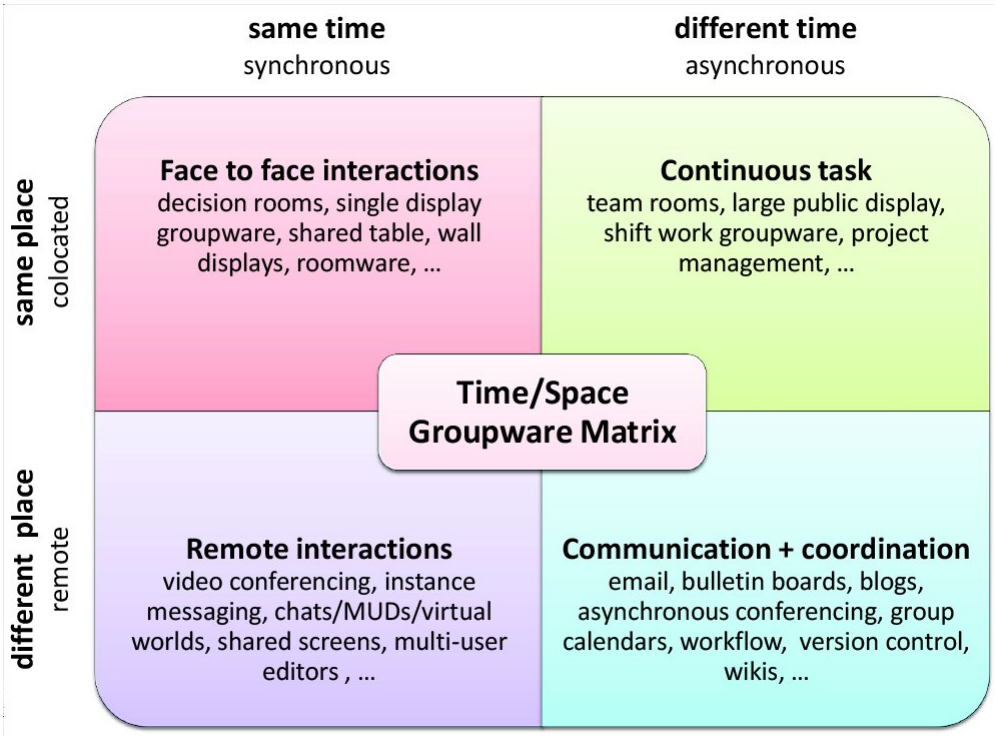

Figure 4.7: v-share: Computer-supported Cooperative Work Matrix

Supporting different place and different time collaboration is one of the main reasons v-share was created. Since student teachers has different lecture schedules, finding the time needed to discuss and reflect upon teaching methods is quite hard. There is also the problem of having enough student teachers at the same place to actually be able to start a discussion. By using v-share, student teachers can view and comment on lectures when they have time available without the need of trying to schedule a meeting with other student teachers.

As figure 4.8 shows, the workspace is a combination of the video recording and a bulletin board. Since a lecture can be quite long, the video is actually divided into many smaller parts.

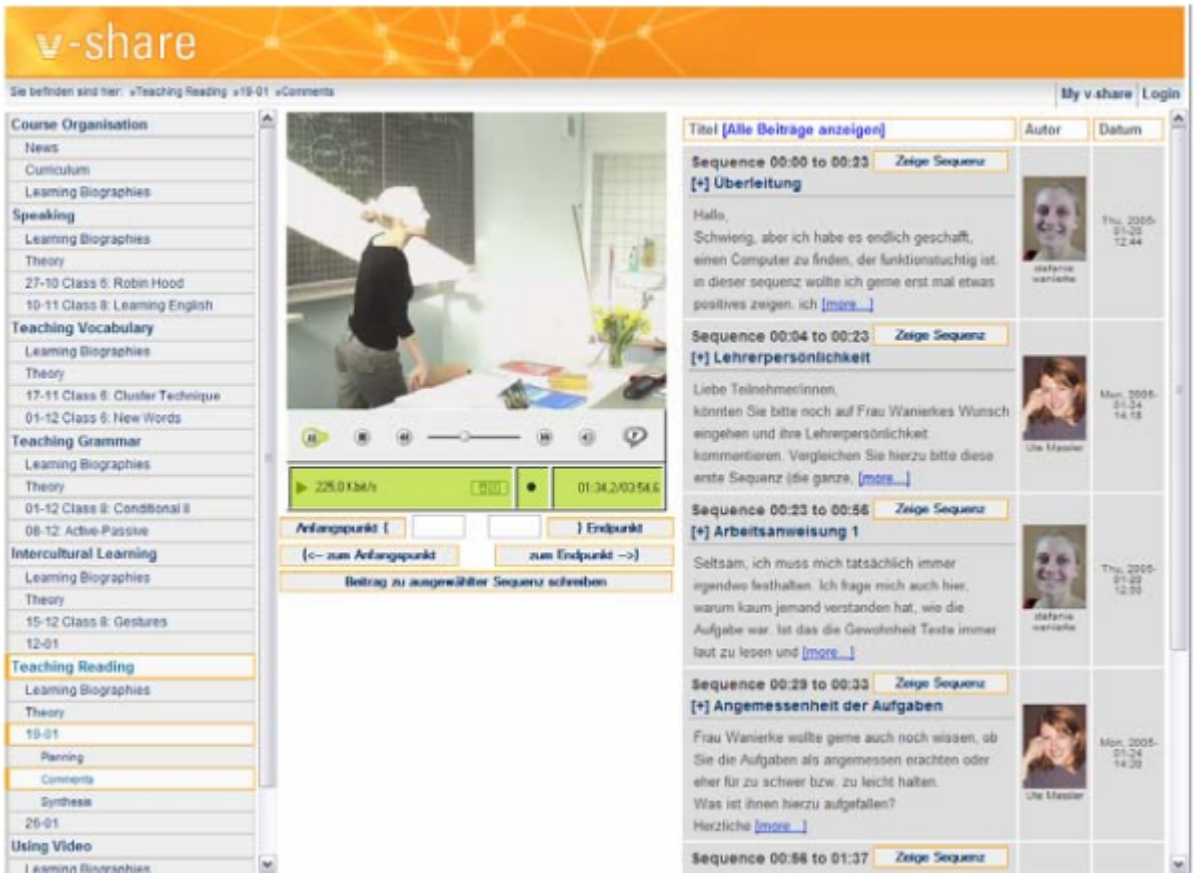

Figure 4.8: v-share: Reflection application

This is done to allow the comment to be linked to a smaller part of the video, making the solution more efficient.

V-share has been used in teacher training seminars at the University of Education Freiburg since 2004. During the seminar, various teaching methods are discussed and student teachers devise criteria for specific teaching methods. Based on these criterias, student teachers are to develop lesson plans and individually select a reflection focus for their lesson. Building on this, the lecturer and the student teachers jointly develop observation sheets, which help to focus the observation of the lesson in the classroom as well as the analysis of the video recorded lesson. Specific parts of the lesson are recorded by means of a digital camera and are archived in a discussion board. This is done by the student teacher who taught the lesson, but with the observation sheet in mind. The different video sequences are timestamped, making it easier to differentiate between them and also reveals when the scene took place in the lesson. The

student teacher who taught the lesson thereafter comment on the different subsections of the video, followed by the other student teachers which again is responded to by the student teacher who taught the lesson. The reflective process conclude with a synopsis written by the student teacher who taught the lesson.

4.3 Discussion

Based on the cases which we have reviewed there seems to be two discoveries. The first is that reflection seems to yield a good result. In the architectural park case, it was clear that the participants that used reflection had a better score than those who did not. However there was no information about the time difference between those who reflected and those who did not. The increased score could have come from those who reflected gaining more time overall with the curriculum which is an advantage. Even with that in mind, we do believe it's likely that the reflection process used had an impact on the score by allowing the players to "step-out" of the competing game environment and calmly process the game session. This follow the points which Schon argumented for. V-share which also showed promising results, uses the same technique and place the reflection process outside the normal working environment, allowing the users to watch themselves from a calm environment. Although a reflection process can provide good results, it seems like it's only possible to achieve these results if the users are motivated to use the system. TimeLine which we found quite interesting and impressive, struggled with this issue. Rescue league doesn't have any open papers with test results, but the solution used is criticised when it's to be used by students, by authors such as Dillenbourg stating that the mere existence of reflection tools does not imply that students will reflect on their learning experience [13].

The second discovery is that, although reflection is an old topic and seen on as an important part of learning, there seems to be a big disagreement about it once the level of details are brought to a lower level. The more specific the information becomes the more criticism it seems to get. This makes it quite challenging for us as we have no knowledge about this area, but have decided to take on the task to make a reflection process that can be used alongside the game. Based on the work which we have reviewed, there seem to be two agreed upon yet somewhat

conflicting statements. The first is that people reflect differently and thus a too specific reflection procedure/routine will not work. The other is that reflection is hard and tiresome and thus is tedious to do. In our mind, a procedure/routine is created to ensure that the task is done as specified, even if some steps may be boring and tiresome. By creating a procedure for the reflection process we could ensure that the participants follow through the reflect process, but by using a procedure we also risk that the players won't be able to reflect due to it being too restrictive. This creates a requirement that the reflection process must allow the players to reflect freely, while being motivated to reflect. However we also want to make sure that the reflection process provide learning benefits regarding crisis management skills and not just the gameplay, which lead to another conflict. Thus we don't think a non-context specific and fully open solution will be able to motivate the users or provide the "right" type of reflection. Therefore we think we should explore solutions which are compatible with the game concept, similar to how the reflection process in the archaeological park was closely related with the game concept. Since we don't see any easy way to create this reflection process, we think we will be better off breaking down the principle of reflection and slowly build different parts of the reflection process one part of the time.

Chapter 5

Supporting Reflection

In this chapter we will discuss the reflection process starting from the ground. As we discussed in 4.3, since we are no experts and have little experience with reflection, we will attempt to build the reflection process by discussing, and creating one aspect at the time.

5.1 Main challenges

Adding reflection isn't without any challenges and introduce some issues which must be carefully solved. One of these issue is how can we use reflection to enhance the learning benefit of crisis management skills, and not just mastery if the game itself. In the case with the archaeological park, the players were introduced to information about the various site using the game application, and the reflection process only had to stimulate the memory so that the information presented during the game, would stick better. Since our game doesn't provide any direct transferable practical skill or knowledge, and instead it indirectly teaches soft crisis management skills, we cannot use a similiare solution as the one used in the archaeological park. The usage of abstraction in our game creates the risk of players reflection over gameplay elements, which means that the learning benefit will be directed to how to master the game and various game maps, instead of improving and teaching crisis management skills which is the actual purpose of the game.

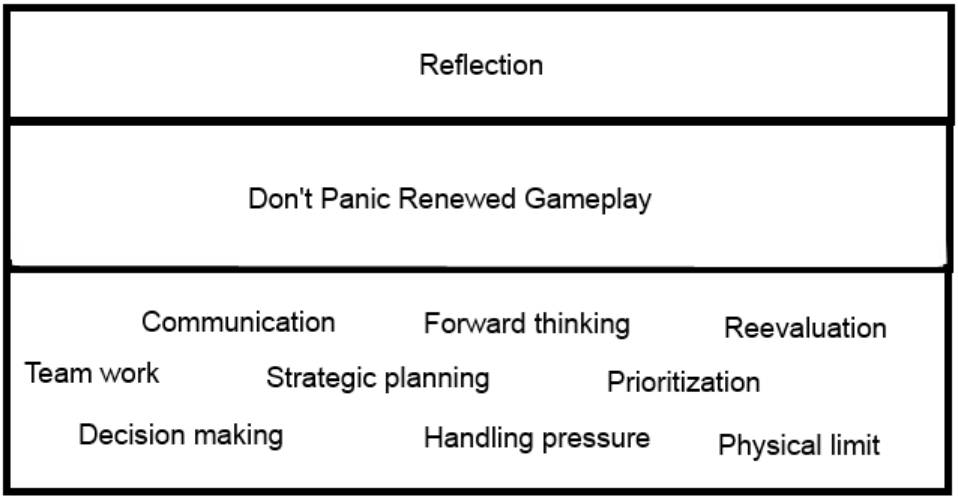

Figure 5.1: The image illustrate how the relation between crisis management skills, the gameplay and reflection can be seen.

As figure 5.1 shows, the game is somewhat a layer between the crisis management skills and the reflection process which we want to add. Since it's the layer the players interact with, it's easier for the players to focus their attention on this, instead of the deeper down layer. Even those who are experienced with reflection might end up with reflecting on the wrong elements. Thus no matter what reflection solution is decided upon, the players should be led to make the reflection focus on the part which has to do with crisis management.

Another challenge regarding the reflection is time. Keeping the players interested during the reflection process is not given. Reflection isn't exactly percepted as fun [25], and a long reflection process often risk to lose the participants motivation. Without motivation, gaining any benefit from the reflection process becomes much harder. In addition a delay between the game session and the reflection process also add the risk of player forgetting experiences from the game. Thus the longer the delay between the game session and the reflection process, the more data aid the player will most likely need.

5.2 Reflection goals

As our game is limited, there are only certain things which the game can stimulate. Reflection can however stimulate things outside of the game scope, whether if this is intended or not. To

properly implement a reflection process, we will therefore discuss reflection goals which we want the reflection process to accomplish. This will be done without considering the limitation of the game, as considering the limitation might prevent viable goals which can be achieved without the help of the game directly.

5.2.1 Improved decision making

In crisis situations, there are often a hierarchy chains of command based on the roles, and the major decisions are often taken by those who specifically have the manager/planner/officer role. However, that doesn't mean that the others involved don't get into situations where they or their squad must make split second decisions. Firefighters are an example of that, they are often divided into small squads, where each squad is supervised by a lieutenant. When the squad is not able to communicate with the rest of the workers, the lieutenant is in charge of decision making. Based on how the structure work, one might think the lieutenant has been schooled in important skills suited for this role. But a lieutenant is often just an experienced firefighter which over time has gained experience with small scale decision making. Human factors training, including situational awareness (SA), task management, communication and decision-making, is relatively new to the fire service—traditionally, most fire service training has focused on long-established hands-on tasks and tactics, and not the decisions that get you there [32]. The big decisions can therefore be somewhat mechanic, where the data is first gathered and then analyzed in order to find a suitable tactic.

By using Don't Panic Renewed, we hope to stimulate the players decisions making. Since the game context and gameplay is different from a real crisis event or a realistic simulation, we hope to prevent the players from just applying a tactic automaticly and apply decision making. Decision making isn't easy though, especially not when being under heavy pressure. The autumn evaluation revealed that the players preferred a mechanical playstyle, using the try and fail method, and had only a few instances of what can be considered decision making. The game itself may be too difficult for those who have not built up experience with decision making and pressure handling, which is why we believe adding a reflection process will benefit the players.

5.2.2 Improved stress handling

In a crisis situation, time is the enemy. From the start of the crisis and until it's under control, each second that pass increases the chance of lifes being lost. Every second used for planning instead of acting, can potentially increasing the total time used to gain control over the situation. This creates a big amount of stress and can cause persons to rush their actions without proper consideration of the consequences. During the action phase, crisis workers can also be affected by this pressure, pushing themselves beyond their limits, or performing dangerous operation without proper equipment or preparation.

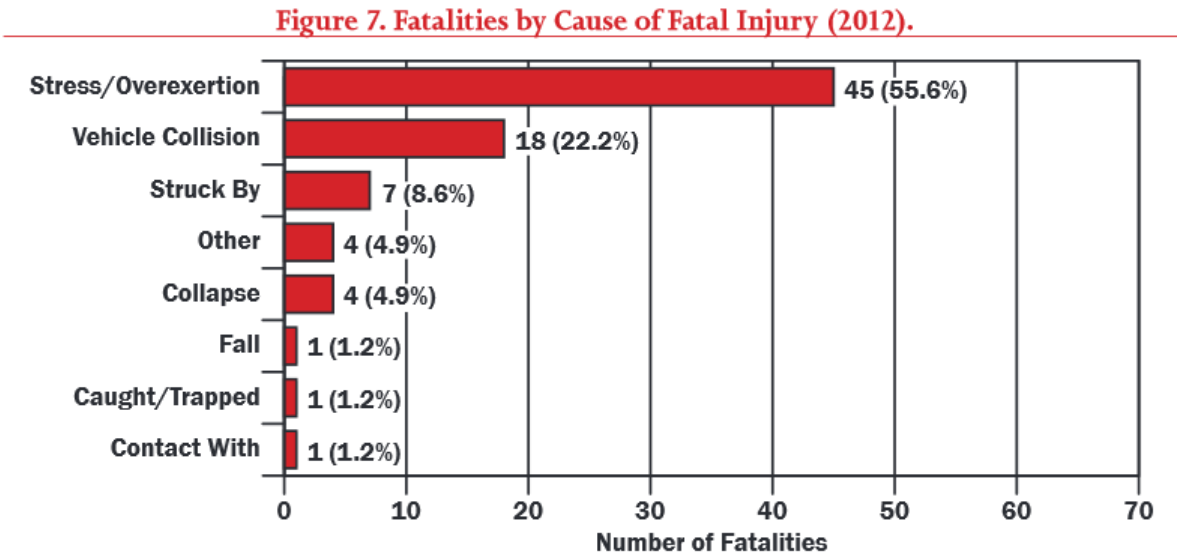

Figure 5.2: Image show the number of firefighter fatalities in US, year 2012.

U.S Fire administration have kept track of fatalities of firefighters since 1978, and a common cause is stress/overexertion. The U.S Fire administration classification of stress/overexertion is as following: "*stress or overexertion is a general category that includes all firefighter deaths that are cardiac or cerebrovascular in nature such as heart attacks, strokes, and other events such as extreme climatic thermal exposure. Classification of a firefighter fatality in this cause of fatal injury category does not necessarily indicate that a firefighter was in poor physical condition*"[18].

As image 5.2 shows, in 2012, 45 firefighters died as a result of stress or overexertion which was the dominating cause [3]. Of those 45 firefighters:

- 39 firefighters died due to heart attacks.
- 3 firefighters died due to a CVA.
- 2 firefighters died from heat exhaustion.
- 1 firefighter died from an aneurysm

Year	Number	Percent of Fatalities
2012	45	55.5
2011	50	60.2
2010	55	63.2
2009	50	54.9
2008	54	45.0
2007	55	51.4
2006	55	53.9
2005	62	53.9
2004	66	55.5
2003	53	46.9*

Figure 5.3: Number of firefighter fatalities in US from 2003-2012

This might come as a surprise for some, as perhaps it's easier to draw the conclusion that fire, building collapse, explosions, etc might be a bigger threat. But as figure 5.3 shows, the stress/overexertion has been the dominating fatality category, for many years.

In England the numbers are sorted/categorised different. However, when counting all firefighter deaths in England since 1978 to 2007, 30% were caused by heart attacks, not counting heart attacks which occurred outside the line of duty [9]. Even with the cultural differences, food habits, routines etc. Stress/overexertion is a common dominating fatality cause, and a recognized issue [1].

This is an issue which we want to address, but Don't Panic Renewed doesn't teach any techniques for handling stress, instead it places the players in a stressful game environment. This mean we have an environment which can be used to practice stress reducing techniques, but it requires that the player has knowledge about stress reducing techniques. Adding reflection without adding information on how to manage stress will not solve this issue, however even

without adding information about stress management, we can still make the players aware how stress affect their performance, and hopefully make them more interested in learning stress management.

5.2.3 Improved prioritizing

Prioritization is a part of decision making, and perhaps the hardest type of decision to take. When there are less resources available than what is needed, one must decide how to best utilize it, which sadly often leaves too little or nothing to some. A resource is not necessarily a piece of equipment, but can be everything from time to available personnel, all depending on the level of operation.

In Don't Panic Renewed, time, equipment, personnel are all resources, and as we mention in section 2.2, we designed the evaluation map used in the autumn project, in such a matter that it would be next to impossible to save all the civilians. This creates a situation where there are not enough resources, and players have to prioritize either passively or actively. As we mention in section 2.3, the players evaluated in the autumn project had a more mechanical playstyle and did not seem to actively prioritize much. In some cases a player would go to the zone which had more civilians and use his equipment there, which can be seen on as an active decision, but in most case players would just stay in the zone which they were in, make sure everyone was ok before heading off. This is something we hope we can address using the reflection process, and make the players start making active prioritization as a team.

5.2.4 Improved reflection/debriefing skills

The members of a crisis team like all other humans have a different sets of skills and abilities. Some may be better at forward thinking, some may be more physically fit, etc. This makes some more fit for certain tasks, but that doesn't mean one should leave tasks one is not good at in the hands of others. Instead one should understand their weaknesses by figuring out just what is it about that specific task which make it so hard. Although it sounds straightforward, this is often considered a heavy and difficult task as it requires the ability to review ones own performance critically. In some cases, the reason to why the task seems hard to do right, is due to lack of

knowledge. This means even if one review the case, the cause of the failure can be missed due to a lack of knowledge. Case studies and debriefing are often used as learning methods. These methods involves a lot of critical thinking, asking question like: "What if we did X instead of Y at step Z, would that have solved the issues?" This is often done in a group, so that multiple opinions can be voiced which hopefully leads to a well mannered discussion, where the group knowledge can be pooled together.

Since Don't Panic Renewed gameplay uses abstraction, not all of the gameplay is relevant to crisis management. However this might work for the case, as the players must filter out the non relevant data, while processing data which is important. This require more effort and reflection ability from the players, which perhaps can develop as the reflection process is used. Since the game can be customized by adjusting several settings such as number of civilians, panic timer, tick timer, ect. Each round can potentially create new and unique game experiences which could potentially cause new topics in the reflection process. Thus, the game in combination of the reflection process could improve their reflection ability over time.

5.2.5 Improved communication skills

In a crisis, information is usually scarce and must be constantly gathered to build a clear image of the situation. The information can come from multiple sources such as civilians, surveillance, police, etc. The value of the information isn't always great, and information from different sources can be contradicting. Information from crisis workers are therefore considered more truthful than those of civilians, as civilians can misinterpret a situation due to factors like emotions. The importance of sharing information is therefore extremely high, both in the grand and small scale. Even if there is a small squad working together at the same location, not everyone will be able to catch the same information. The line of view may be blocked for some, or issues such as a hurt civilians might occupy some of the workers attention. The quicker the information is shared, the quicker others can process and react to the new information. However as crisis workers often communicate using radios with limited channels, too much information is also an issue.

The U.S government did a research project in 1991 on how to improve the firefighters communications. One of the issue which they addresed and recognized hadn't gotten enough atten-

tion, was the human factor. Even if the firefighter had communication training, several types of “bad communication ” cases was discovered. One of these was the inefficient use of radios. With the limit on how much communication can occur over the radios at the same time, it’s important to minimize broadcasting informatio nwhich is not useful. The report especially points out the bad habits of using “um, eh, uh” ect in radio broadcasts, and the lack of active listening skills among the firefighters, causing the need of repeating the same broadcast multiple times. Another issue was that at some departments the culture of “heroism” prevented proper reaction from the firefighters. This type of culture had the consequence of firefighters often delaying requests for help as long as possible to avoid being stigmatized [2].

Information gathering and filtering is a recognized issue, with several works attempting to highlight the issue with information bias and provide a tool to help filter through the information. Although we agree that this is an important issue, Don’t Panic Renewed isn’t designed to address this issue. However with how the game works, where no information is given at first and must be discovered and communicated between the players, it can at least raise awareness of the importance of having a situation overview and the need of communication to achieve it. For the issues with bad communication, this is probably at a deeper level which is harder to recognize without any external help. Within the reflection process, issues with delayed communication, bad listening skills and bad speaking habits should therefore be captured and discussed.

5.3 Reflection data and reflection triggers

Since our game uses abstraction, not all game data is relevant or useful to trigger reflection. Before designing a reflection solution, we will therefore analyze which game data can be useful to support specific reflection goals.

5.3.1 Pathing and player movement

The way the players move during the game session will impact how the game progresses. If players move over great distances in a short amount of time, their stamina will be a limiting factor to where and when they can be at different locations around the game map. A player moving from one end of the map to the other, could quickly result in the player becomming exhausted, which

will impact the rest of the game session. If another player is closer and have a compatible role, an alternative is to delegate that task, so that the team can reduce the physcial usage. Data on players movement can be combined with communication data to provoke players into critically judging how their movement relates to the way they communicate with each other.

5.3.2 Item usage

Throughout a game session, players will pick up, choose between different items and decide when to use them. Picking up new items requires that the player to move to the secure camp, as this is the only place where new items can be picked up. Therefore, deciding when, what, and if to pick up new items is important, as alternativly, the player could have used the time it took to pick up an item for something else. Thus the following events of the game session could play out quite differently depending on what a player decides to do, when he has a chance to decide between picking up a new item or not. However, its not necessary to collect all possible data on items and item usage, such as when player X picked up a specific item, and where he used it. Triggering a reflection could be as easy as just highlighting the fact that player X still hadn't used item Y by the end of the game session.

5.3.3 Decisions

Decisions must be taken continuously throughout the game, and is perhaps the hardest part of the game. Likewise it's also the most time requiring data to analyze properly, as a decision can be good and bad at the same time, depending on the time scope and data available. E.g a player can decide to save his last fire extinguisher and use the firehose at zone X as there is a nearby zone Y which is also blocked. If it turns out that zone Y was blocked by fire, his decision would mean that he and his team saved time. However if it was blocked by something else, his decision would resulting in that the team had to spend more time than necessary. Events like this raise the question on how a decision should be measured, as if it is only to be decided based on the outcome, the same thought process can be punished or rewarded. This is in violation of the game concept and a reason why we want to add a reflection process in the first place. As we discussed in 5.1, the game is the tool which should let the player train crisis management skills

such as decision making.

5.3.4 Emotions

Most people agree that when they are stressed, their performance is not as good as would be under normal conditions [7]. However, there are also some that say that they perform better while stressed. Emotions such as stress can affect several things both positively and negatively, and an abstract term such as performance is therefore too wide to properly understand how one's actions truly is affected by emotions. As the game has a rising pressure development, where there is little pressure at the beginning and much pressure at the end, it could be interesting to gather data about the players emotions at different stages of the game session. The benefit of this data can potentially be further enhanced by using it in combination with other data such as how well is the communication at the different stages, how is the physical effort affected, etc.

5.3.5 Communication

Since communication occurs either over the walkie-talkies or face to face, this data cannot be automatically captured by our application. An option is to integrate the communication to the smartphone, leaving it to be the sole tool which the player are to use. However, this will be quite time consuming as well as making the game application more network consuming. Another option is to leave this as a manual task, which means an observer will have to monitor the communication and process it. As we mentioned in 5.2.5, issues with delayed communication, bad listening skills and bad speaking habits is something which we want to address using the reflection process. This means that the following information should be captured:

- Order of action and communication.
- Unuseful words such as "eh, um", etc, in the radio broadcast.
- Unclear speaking.
- Action done after communication (active listening).

Capturing all the usefull information as a manual task without any support could be quite tedious, and most likely not all the desired information will be captured. Providing a tool to easily capture this data is therefore something we think is important. However even when providing a tool, as long as it's a manual task there will always be the risk of not being able to capture all the usefull data. With how the game is designed, several actions could occur in a small time interval, making it nearly impossible to capture properly. We don't think this is a major issue though, as long as some useful data is captured and can be used for the reflection process, theoretically there should be less and less data to be captured as the players play the game over time.

5.3.6 Game score

The only data which could be considered a score for the game session is the numbers of civilians the team manages to keep alive troughout the game. This data should be very easy to collect and for the players grasp as it's simply comparing two numbers, the remaining living civilians and the total amount at the start of the game. Altough this data is easy to collect and grasp, we think utilizing it for triggering reflection must be done with care. The reason for this is that focusing too much on the number of civilians in this manner poses the risk of the players putting too much emphasis on this number and drift away from the true purpose of the game, training soft skills, to instead focus on adopting measures solely in order to increase this number, and master the game itself and not factors like communication and decision making for the next session. Thus we have to be careful when we use this as a trigger and somehow make sure the players understand that this number isn't the most important aspect and shouldn't be the main focus of playing the game.

5.3.7 Self rating

To achieve better engagement during the reflection process, a method that can be used is to let the players rate their own efforts, and then compare it with other data which can act as a benchmark. One option is to use highscore/civilian alive as a comparison, but this score is affected by many different elements, making it challenging to reflect over. We therefore think it will be a good idea to add additional questions which helps the player break down the gameplay

into smaller pieces. The issue is to find data which can be used for comparison, as a chain of actions can be a smart choice yet at the same time a bad choice, depending on which location the player is in and the status of the different zones. Questions which depends on these kind of data will require time so that the game session can be analyzed. This isn't necessarily a bad thing, but it will potentially remove the possibility for a reflection process straight after the game is finished. To keep the data simple, yet usefull, we could use the players rating of themselves versus their rating on the team overall performance. This gives the opportunity to compare and discuss how the players rated each others. The questions below, are some example which we think may be usefull for this purpose.

- From 1 to 10, with your role in mind, how well do you think you performed?
- From 1 to 10, how well do you think your communication was?
- From 1 to 10, how well do you think your item usage was?
- From 1 to 10, how well do you think your decision making was?
- From 1 to 10, how well do you think your prioritization was?
- From 1 to 10, how well do you think your team communication was?
- From 1 to 10 how well do you think your team item usage was?
- From 1 to 10, how well do you think your team prioritization was?
- From 1 to 10, how well do you think your team decision making was?

5.3.8 Summary

The various data category we have discussed so far have some overlapping reflection goals, but not necessarily the same capturing method.

Data type	Reflection goal	Data to capture	Capture method
Pathing	Prioritization, Decision making, communication, pressure handling	Player location throughout the game	Can be automatically captured by the game server with some modification
Item usage	Prioritization, Decision making, communication, pressure handling	Items in backpack, item pickups and item usage throughout the game. Item remaining in the backpack after the game session is done.	Can be automatically captured by the game server with some modification.
Decisions	Decision making, communication skills, pressure handling	Frequency of decisions taken. Who initialised the decision and participants of the decision.	Observer logs the decision taken. Players logs the decision taken. Record the game session.
Emotions	Reflection/debriefing skills, pressure handling	How stressed the players are. How physically tired the players are. How mentally tired the players are. How the players are feeling	Observer ask the players and log the emotions during various stages of the game session. Get the player to write/log their emotions during various stages of the game session. Create a function ingame which support emotion logging Use an external tool, which allows the player to register emotions
Communication	Communication skills, pressure handling	Frequency of communication by players.	Observers logs the communication Players logs the communications. Record the game session.
Game score	Reflection/debriefing skills, communication, pressure handling, decision making, prioriza-tion	The number of civilians alive	Can be captured automatically
Self rating	Reflection/debriefing skills	Players self-rating and team-rating	Players answer questions.

Table 5.1: How various game events/data can be used to achieve reflection goals, and how it can be captured

Table 5.1 shows how the various data categories are linked to the reflection goals as well as possible ways to capture this data. We believe that an automatic way to capture the data is the best method as long as it does not capture more irrelevant data than relevant data, or capture the data in a way which is hard to manipulate.

5.4 Reflection presentation option

The presentation of the reflection process is extremely important as we must maintain the interest of the player while being able to encourage proper reflection so that the reflection goals can be achieved. In this section we will therefore present and discuss several different presentation methods which we think are most suited to the game concept.

5.4.1 Full playback presentation - visual triggers

The full playback presentation is to present the played game session as a movie, where the game data is presented without any filtering. This means that the players themselves are in charge of picking out events which they want to reflect upon.

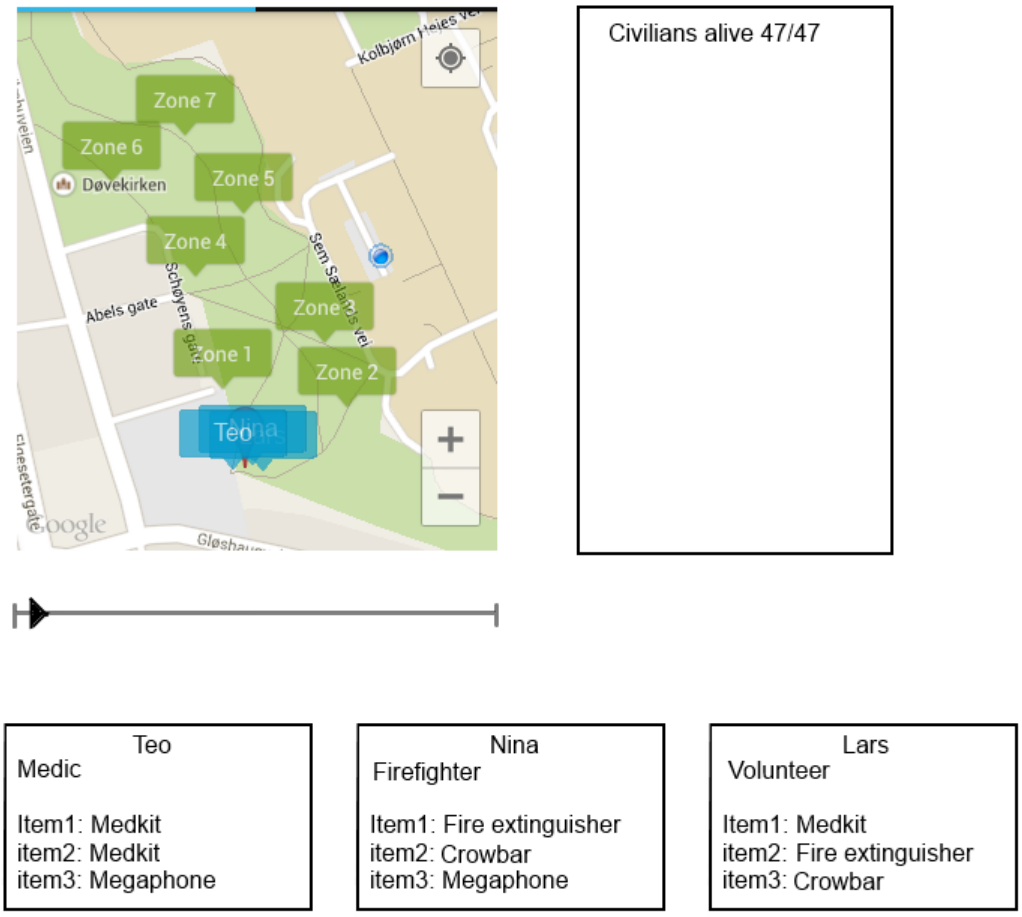

Figure 5.4: Illustration of possible design, showing the planning stage of a new game session

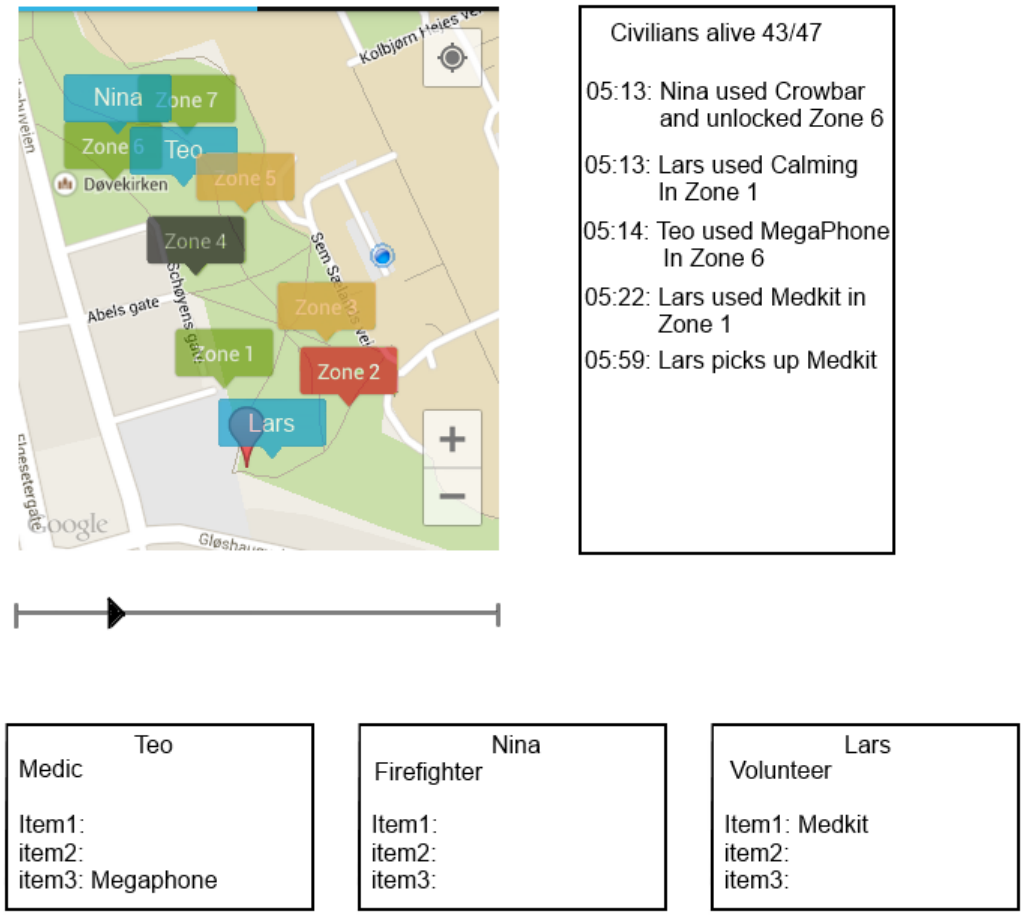

Figure 5.5: Illustration of possible design, showing the game with the timers started

Image 5.4 and 5.5 illustrates a mockup of a possible playback solution which will provide players with all the game data. A solution like this allows the player to review individual players actions as well as the teamwork. A great benefit is that the player will be able to backtrack a bad event through the entire action chain and find the first action that caused it all. This could be quite hard to do without proper information and illustration as a bad decision might not have any visible consequence before several minutes after or that the first bad action might be hard to detect as it could be something with little presence such as the decision that the medic would go exploring with the firefighter instead of using the volunteer.

However a problem with this is that there is some data which can not be automatically captured such as communication, and therefore cannot be displayed straightforward. An option is to record the communication and re-play it alongside with the game data, but this creates a

synchronization issue. Especially if the players are allowed to pause, forward or backward one of these medias.

5.4.2 Filtered playback presentation - visual triggers

Another option which could use the same or similar solution as the one presented in 5.4.1 is to use the observers to log the time of important events and once the reflection process starts, only those events will be showed to the players. An issue with this is that the person observing and logging important events needs to pay close attention and be aware of what could actually be considered an important event. This won't solve the audio synchronization issue which is mentioned in 5.4.1, but it should be less time consuming than the full playback solution.

5.4.3 Observer presentation - verbal triggers

The second option would be to use observers and assign them the additional task of logging thath which could be considered bad and questionable actions and decisions. During the reflection session the observer can present these events verbally to the players and ask questions about them to trigger reflection. This would probably lead to a shorter reflection process as there would be no need to playback the entire chains of events, and theoretically there should be less information to reflect over. However as there is no visual picture, the player must themselves recall these memories and explain to each other what they were doing. This can be quite time consuming, but its also quite useful for the reflection process, as recalling a memory is an important step of reflection.

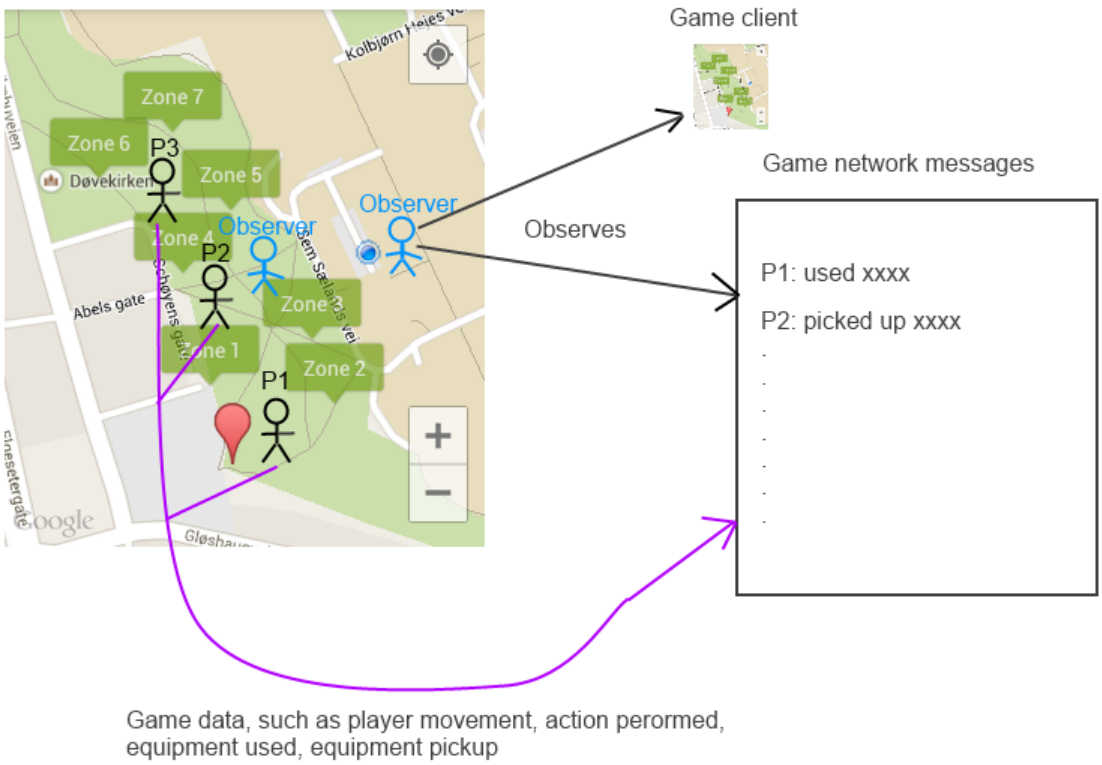

Figure 5.6: Illustration how we monitored the autumn evaluation

As illustrated in figure 5.6, there is two observers who observes the players during the game session. One who is physically at the same location as the players and can visually watch them, while the other observer watches the players by using the game client, server client and by listening to the radio communication channel. Again there is the issue mentioned in 5.4.2 of the observer carefully watching and being aware of what is a potential important event. If the observers over analyze and write down events which may not be of importance, there is the risk that the reflection process may be longer and in worst case, causes a negative learning benefit due to wrong data. If they fail to log important events, the reflection process might not address important issues which could greatly benefit the players, yet give the illusion that all issues have been addressed. Another concern is the additional persons required beside the players. If the game was to be deployed and used by real users, this means that if 3 players are to play the game a total of 5 persons is required for this solution.

5.4.4 Player manager - verbal trigger

Instead of using two observers which aren't members of the playing team, another solution would be to add another role to the team which is in charge of helping the team grow by being in charge of the reflection process. The person in this new role, will not participate in the game in the same way as the other players, instead he will be given a certain task which involves monitoring and logging certain events, which he can use when leading the reflection process. A requirement for taking this role would be that the player must have played the game before. This is important as the player needs some knowledge of the game in order to recognize an important event or else the players will not have anything to reflect on. By playing this role the player can also get a different view of the game, as the physical constraint and time pressure is gone. This should allow the player to think easier, giving him chances to ponder on various events while doing his duty as the manager for at least the calmer part of the game. Hopefully this experience can be in use of the player once he assumes an active role for future game sessions.

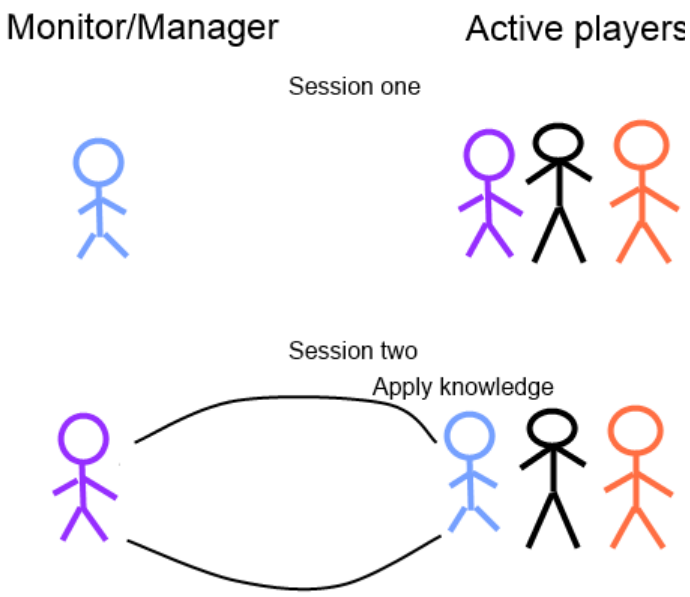

Figure 5.7: Illustration of how the manager role could be rotated between the active players, to provid the possibility for reflection-in-action and reflection-on-action

5.4.5 Player self reflection

The third method would be to try to start a discussion between the players without mentioning any specific events. The discussion would be initialised with open and provoking question such as “How could the team have increase the highscore by using decision making?”, “ How could the team have cooperated better?” etc. This means that the players are in charge of recalling “bad” decisions and events in order to try initiate a discussion without any help. Since the players aren’t able to see all their teammates actions and their thought process during the game, the lack of information could serve as a fuel for the discussion. This is also perhaps the most natural way the reflection process occurs in the everyday life and could perhaps learn the players to use reflection more in the daily life. However, we still think the players are in need of some guidelines or an observer who makes sure the discussion is led in a direction where the reflection goals we discussed in section 5.2 can be achieved. Without guidelines the discussion might be fruitless in regard to learning crisis management skills and it could instead go in a direction where the players end up discussing how to do better in the game itself by mastering the game and the game play.

5.4.6 POV video record - visual triggers

Instead of using time to code a playback solution visualizing data and events throughout the game, we can instead use existing technology. During the autumn evaluation, GoPro cameras were used to record the players from their point of view. The intention was to capture how they interacted with each other and the game, and discover any bugs. This proved to be a bit challenging as it required having the smartphone device in the camera's field of view at all times. The result where that the smartphones was captured close to 50% of the time during the game session. As the players were playing outside in rough terrain, they often scouted the path ahead, had face to face discussion with team mates, or studied the terrain, while waiting for their game actions to complete. The video-record prove useful in its way, but it's clear that the method is more suited to capture the users behavior. This could be an interesting angle of reflection, as the players are able to re-live the game session in much higher degree than any of the other solutions discussed so far. However if the game is played by three players, this means there will be three video-recordings of the game session as well. If the players are to have a group reflection and give feedback on each other performance, they would most likely have to view all the video recordings, which means that the reflection process will require atleast three times the amount of time it took to play the game.

5.4.7 Visual vs Verbal data presentation discussion and conclusion

Solution	How it works	Downside	Upside
Full playback	Record all the game events, and playback the entire session using a specialized GUI . Walkie-talkie communication is recorded and played alongside.	-Require a lot of time as the player must watch it and then start the discussion. - The players might only trigger shallow discussion such as "we should have gone to zone X instead of Y", instead of discussion how and why. - Audio and video synchronization issue as its captured using two different media.	-Allows them to backtrace bad events several steps back to find the origin cause of it. - use a familiar interface to display the data.
Filtered playback	Use same solution as the above, but observer logs important events during game session and only playback those events.	- same as above.	- Require less time than the non filtered option. - Don't rely on the active players to find and trigger reflection- same as above
Observer presentation	We log/note game events which we found "bad" and use them to trigger discussion.	-Rely on us to function -Less reliable way to capture data.	- Require the players to recall the events, which may make it easier to trigger a deeper discussion.
Player monitor	Add a new role (manager) to the team which is in charge of observing the players and to lead the reflection session.	-Rely on the manager to both capture and trigger discussion.	- Require the players to recall the events...- Both the active players and the manager might learn from each other.
Player self reflection	Use questions which are not based on game events, but can get the player to find association between the questions and game events themselves.	-Relying on us asking the questions. -Questions must be carefully created.	- Require the players to recall the events ...-Not reliant on capturing any game events.
POV video records	Use GoPro camera to film the entire game session from the players perspective.	-Produces much data(time consuming). -May distract the players and to find "fun/clumsy" behaviour instead. -May get the player to focus too much on how the player interacted with the application.	-Allows players to see how their team mate dealt with various game situation. - All type of communication is captured.

Table 5.2: Short summary of the different presentation options

Although the presented methods are different, what they have in common is that the presentation is either done visually or verbally. Visual data presentation such as movies are often less used than verbal data presentation. However, this is heavily dependent on the situation and career. Athletes often use video recordings to analyze their performance, speakers often use video recordings to practice etc. But athletes have coaches and a support team which review the video together with the athletes and discuss potential for improvement. The same is often true for professional speakers, as even the slightest body gesture may indicate something which isn't desired. So even when the reflection process involves visual data presentation like a video recording, there is also a need of verbal data presentation, often in the form of discussion of some sort to supplement the video-record. The use of video recordings is also a growing point of interest in the field of teaching. However there is quite a disagreement if video recording is suited for reflection for teaching or not [27]. Sharp argues that due to the intensely personal nature of addressing one's teaching and learning processes, reflection comes from self-awareness and is therefore not generalizable [33]. Dewey and Greene have addressed the concept of teacher reflection, rejecting the idea that it can come with a set of instruction [27]. While Rich and Hannafin argues that recent development in video annotation tools makes video reflection increasingly viable accessible [29]. Some experiments have been done to uncover the potential of using video recording for reflection. Pellegrino and Gerber did a small scale experiment with five participants, using video recording and a set of instruction to ensure the participants would analyze their video properly. This was followed up by a group discussion between all the participants. All the participants agreed that instructions encouraged their engagement in reflection, and while using video-records and detailed reflective evaluation was a tiresome activity to do often, it was a worthwhile to supplement less formal reflection[27]. Rich and Hannafin who reviewed 7 different video-record reflection project, argues that the data collected indicate that video-annotation tools can augment and extend teacher reflection experience by facilitating and structuring the analysis process [29]. While other such as Aleven and Koedinger are skeptical to the use of visual system as they prevent the user from recalling relevant knowledge and instead makes them recognize the event, which prevent an important step of reflection [4]. Amercian socity of anesthesologist ran an experiment on the benefit from using oral vs video-asisted oral feedback in aid of debriefing during simulated crisis management.

Where there was three groups given either no feedback or used one of the two above options, concluded that by giving feedback and trigger reflection, improvement could be documented, but that there was no benefit on using video-assisted oral feedback compared to normal oral feedback [31].

The various discussions and experiments about using video-records are quite interesting, however there seems to be a lack of focus on if the users would actually use the system frequently in their normal working life. The experiments also seems to be directed toward teaching practical skills such as body language and vocal use, but some also try to capture the students reaction. There seems to be an agreement among the pro video recording crowd that the it's is an important supplement, and not necessary a tool which will replace the other reflection processes. A quick Google-search indicates that abstract tools such as dices, cards, pie charts, journals, etc are more popular and recommended choices [25]. Perhaps this is because video-annotation tools require more expensive equipment, or perhaps an abstract tool is more tempting as it is easier to use and less time consuming. Although a video record solution is generally more time consuming, an abstract tool require more of the users in the way that they have to recall the memory themselves which could also take time. Recalling memories has its benefit in strengthening the neural pathway to that memory, making it easier and faster to recall it the next time.

So far we have mainly discussed the usage of video-record for reflection for the teaching domain, this is because there are more publications in the field of teaching than in the field of crisis management when it comes to reflection. Although the domains are far from each other, many of the topics which are discussed are relevant for this project. As we discussed in 5.1, we are concerned about how to actually promote crisis management skills using reflection in combination with the game. Unlike a teacher watching him or herself holding a lecture and analyze it directly, in our case the players would have to watch themselves play the game and analyze it indirectly, trying to look past events which are irrelevant for crisis management. This seems like a tiresome task, which concern us, as our product is supposed to be a serious game, and serious games rely on being fun/engagement to efficiently teach the players. The fact that feedback from video-record shows that the users think it is tiresome, just further increases this

concern. In the end, we don't have nearly as much as that we want to have before making a decision, but it seems like there is scarce information about this subject. But based on what has been discussed so far, we think the option which has the less conflict with the principle of serious gaming, would be to use verbal data presentation.

5.5 Reflection process execution

The reflection process can be done in several ways, but it's mainly at two different times it can be applied. Specifically this means reflection can be done either while playing, or after the game session, or perhaps a combination of both.

5.5.1 Reflection during gameplay

With reflection during the gameplay, there is a higher risk of losing players engagement to the game as there will be a break which would last for a noticeable amount of time. This means that whatever plans and actions which are currently being carried out by the players will be disturbed and thus they must re-enter that mentality once the game continues. Thus a full stop with the playback option discussed earlier will probably not be a viable solution, at least without changing some of the game dynamics. A possibility would be to change the game dynamics to plan->act->pause->discussion-reflect->plan->act etc, where the players decides how much time they wish to spend on reflecting and planning, meaning that they would be in charge of resuming the game session again. However this would most likely lower the stressful game environment which is a key part in mimicking crisis situations, as well as allowing the players to take important decisions in the reflection environment instead of the stressfull game environment.

The upside with reflection during gameplay is that the players are less likely to have forgotten events or information which could be useful for the reflection process. This reduces the amount of information which needs to be collect throughout the game, and by adding multiple pauses throughout the game session, the players can compare how well they functioned at different stages of the game.

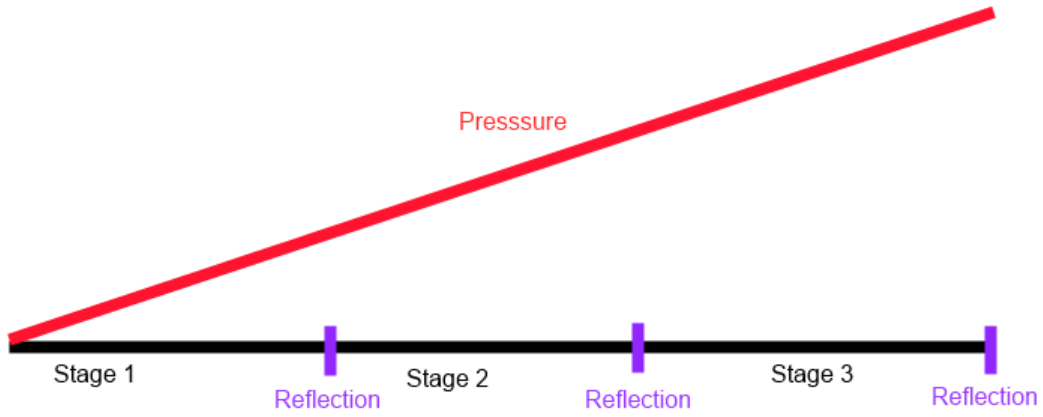

Figure 5.8: Illustration of how the reflection process could be held at various stages of a game session

As a game session length is currently 15 min, a reflection process at the 5th, 10th and 15th minute may allow the players to better understand how their performance are affected by the pressure, and just how well they can cope with the different levels of pressure. With a lengthy reflection process, the game lenght could be adjusted so that the game lenght becomes longer, giving the possibility to cause enough usefull game events which can be discussed in the reflection sessions.

5.5.2 Reflection post gameplay

Reflection post gameplay bears the risk of cognitive failure, which may result in players not being able to recall all relevant memories. This risk is increased by the amount of time between the game session and the reflection process. Thus the longer delay we have between the game session and the reflection process, the more important it is to capture and log data during the game session. A longer delay will also require more details in the data than a short delay, creating a need for a more sophisticated method of capturing this detailed data, as it's unlikely that an observer will manage to capture the amount of detailed data manually. More detailed data also set a requirement for the method of presenting this data, creating the need of a method which can display all this information in a clean way, to prevent players falling off due to information overload.

The upside with post gameplay reflection is that the players can stop worrying about the

current state of the game since it's already over. Instead they can focus only on the reflection process and have a lengthy discussion without any pressure. Any hypothesis, theory or conclusion which they may end up with, can be placed under test by playing another game session.

Figure 5.9: Game sessions and reflection timeline

Image 5.9 illustrate a timeline of how a post game reflection can be used and how the players can test if they have manage to develop better crisis management skills. As knowing the content of the zones have a huge impact of how well the players can predict, prioritize, plan and execute, playing the same map would most likely yield a better result than the first round. This improved result from playing the same map again would not tell if the players have actually gotten any better, thus the need of a different and unplayed/unknown map will be required. Since the maps are different, comparing score directly would not yield any indication if the teams have performed better at the second map or not, as it could be easier or harder than the first map. This could however be in use for the reflection process, as we could ask the players to decide for themselves if they did better at the second map or not, by discussing how they used crisis management skills in the second map compared to the first map.

5.5.3 Reflection session execution discussion and decision

Looking back at the results from the autumn project evaluation pauses might not be a bad idea, but letting the player decide the length of the pause might. A stressful game environment is important for our game concept as skills such as decision making are experienced and executed quite differently while being under pressure compared to when being calm. To somewhat uphold the stressful environment while having pauses, we think the pauses should have fixed time limit instead of letting the player control the length. By limiting the pause time in such a matter that the player wished they had more time to discuss and plan the next act, the player pressure can be upheld. Holding a reflection process while being under time pressure, which may forcibly be ended before the discussion is done due to the time limit, may be too hard for the players. Thus we have a conflict with the idea of having reflection during the game and up-

holding the stressful game environment. With this conflict in mind, we think the option of post game reflection would be better, but with a twist. As we mention in section 2.3, the autumn evaluation result indicated that there may be some potential usability benefit by having small breaks during the gameplay, and as we discussed in section 5.3, not all useful reflection data can be captured automatically. Having these short pauses, could therefore give us opportunity to gather data such as player emotions which we can used as a part of the post game reflection as well as attempt to increase the usability of the application.

5.6 Summary and conclusion

So far we have discussed various aspect of a reflection process, starting by exploring the goals we wish to achieve using the reflection process, before linking game events to reflection triggers which could help reach those goals. After establishing the data needed, we shifted focus to find a suitable presentation option to present this data, discussing many different possible solutions which could be grouped to either visual data presentation or verbal data presentation. As we don't have the necessary knowledge in this domain, we reviewed works which had experimented on using different video-records as the reflection tool, which revealed that although the participants found it useful, the amount of detail made it quite tiresome to use often. There also seems to be a disagreement of the use of video-records as a reflection tool, where in many case the conclusion draws to that video-record may be an important supplement, and not necessary a tool which will replace the other reflection processes. This we think are valid arguments as video-records seems to make the participants focus too much on the physical/practical execution and too little on the thought process the player had while executing the actions. With this in mind, we decided to not use options which can be grouped in the visual data presentation and instead go for solutions for verbal data presentation. To further eliminate possible reflection presentation options, we decided to look into the timing on when the reflection process could be held, which is either during the game session using pauses, or after the game session each with its strengths. The first solution would allow the players to reflect over how their performance is at various stages of the game and compare them with previous stages, which would work quite well with the game concept as the pressure level starts low and increases throughout

the game, thus allowing the players to better understand how the increasing pressure is affecting them. However, the downside of this solution is also large, as having long pauses during a game session could ruin the game engagement as well as reducing the focus on the reflection session as well as a longer game session to balance out the time spent in the game and in the reflection session. In the end, we found the downside of this solution too great and decided to go for a post game reflection. This option will allow the players the properly discuss the game events without worrying about the game state, as its already over, but has the downside that there are a risk of players forgetting important game events the longer the pause is between the game session and the reflection session.

The discussions and eliminations so far leaves us with three alternatives, player self reflection, observer presentation and player monitor. Without doubt, the player self reflection solution would be the easiest to integrate to the current state of the prototype. It requires no coding, instead we would have to create questions and guidelines which would provoke a discussion. However we are unsure if it would give the same benefit as the two other reflection options, as it highly relies on the motivation and players reflection abilities. Instead we think it would be better to use a more structured option to make it easier for the players to narrow down events. By using ourselves as observers and aid in the reflection process, we can use our deep knowledge of the game and the game concept to help the players narrow down events which may be useful for the players to discuss. Although this would be a good solution during the prototype development, this wouldn't work if the game would be used without us. This leaves us with the player monitor solution where we expand the amount of players to 4 players were one have the duty of monitoring the others. This solution is probably the one which will require most work out of the three as we have to develop a user interface which will help the monitor to capture data as well as writing guidelines on what and how the data should be presented. But it also works well with the CSRL-model, as well as the principle of Schon where the players can practice their "reflection-in-action", as well as taking a step back and analyze it from the outside when playing as the monitor/manager. However, this bears the risk of the reflection ending up more like a discussion depending on the managers reflection/debriefing abilities and the ability to spot important events. This we think, can be prevented by providing the manager with guidelines

with mandatory questions which can help him trigger reflection, until his reflection/debriefing skill has grown to a level where he is more confident to lead the reflection process on his own.

Chapter 6

Prototype design

In this chapter we will discuss how two important parts of the system can be further improved, namely the game application and the server application, and also how support for the reflection process can be integrated into the current state of the prototype.

6.1 Overview

Since we created an early but working prototype which include the game application and server application during the autumn project, our main goal when it comes to design will be to re-evaluate it and try to find faults or parts which can improved. We will avoid adding any new game features to the application which does not relate to reflection as there were no indication from the evaluation during the autumn project that it was needed, and it's neither the focus of this master thesis. However as stability and usability is a concern, we will explore various options to improve this, which may require some new features.

6.2 The game application

In this section, we will explain the autumn protype design as well as issues which was revealed during the evaluation of it. Followed by a discussion about features which are needed to support the collection and presentation of data for the reflection triggers, as discussed in section 5.3.

6.2.1 The autumn project prototype design

The game application is built for the Android platform and requires a smartphone or tablet with a GPS and must be connected to a mobile network. The design use something called Android fragments which allows multiple independent operations/interfaces to cooperate without anyone of them having to close down. This allows for a more fluid and dynamic application [11], which is important as the application must change its content depending on where the user is located physically and since the players are playing against the time, it's important that there is as little delay as possible. The downside with how this has been implemented, is that both fragments are in the device's memory at the same time, which means it requires more memory than a solution which uses activity switching.

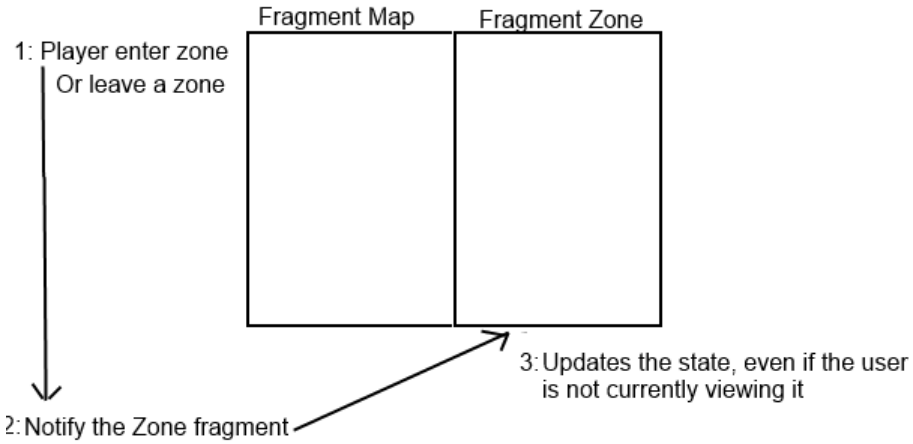

Figure 6.1: Simplified illustration on how the two different interfaces work togheter

This means that if the user is currently using the Zone fragment and interacting with the civilians while moving, the interface can dynamically change depending on if he moves outside the geolocation or not, without the need of switching the view to the Map fragment.

6.2.2 Possible feature improvement

During the evaluation of the autumn prototype, one of the players had an issue with the GPS tracking features. This resulted in the player receiving a notification saying he entered a zone, where he would stop to interact with the game. Once the player stopped moving, the application

notified the player that he had left the zone, which forced the player to start moving toward the center of the geolocation again. This could be caused by the GPS setting on the phone which enables "prediction" of the player movement which makes the GPS position update before the person has actually moved to that location, or it might be a fault with the algorithm which is used to check if the player is within a zone or not.

6.2.3 Improving stability and usability

Since the autumn prototype was made as a rapid early prototype, robustness was not prioritized during the development, and thus there are several improvements which can be implemented. Starting off with the issue where players would accidentally exit the application and thus had to rejoin the game which caused some time loss. The usual cause of this was players which were unfamiliar with the Android system accidently hitted the back button. It also happened when some device models, which was owned by the players, interpreted the application code a bit different than our test models which made how the users interacted with the dialog windows in the application different than planned and required the use of the back key to function properly.

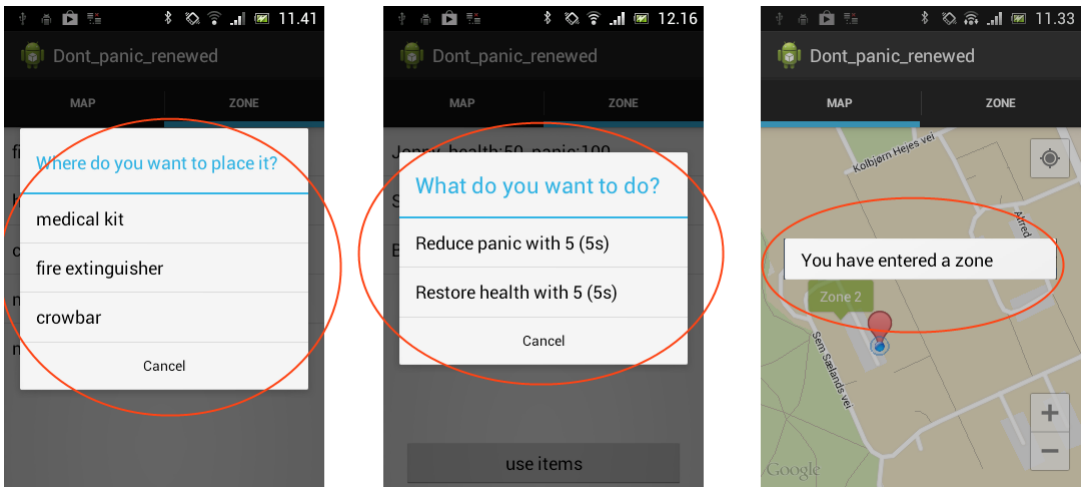

Figure 6.2: The image displays some of the dialog windows used in the application

Dialog windows are an important part of the application as they are used to notify the players about new events as well as serving as the interactive part of the application which the players use to change the state of the game. When a dialog window is active, it will prevent any form of player interaction with any other game element. The way we intended to implement it, and

which worked as intended for our test devices in the autumn project, was to close the dialogue window if the user pressed the area outside the dialog window. This allowed the player to interact with the application using only one hand, which was important since the player was holding the walkie-talkie with the other hand. Those that suffered a dialog window bug, often had to use the second hand to click the back button as the smartphone was too large and thus the back button couldn't be reached with the hand they held the smartphone in. This might sound strange since most of us which use smartphone can easily reach the back button with the same hand which is holding the smartphone, but keep in mind that we are often holding the smartphone with a quite low grip which place the hand much closer to the buttons. This grip isn't suited when we are in physical activity which involves fast pace movement as it does not provide a good grip or balance, making it easy to drop the phone. This was observed with the players as they held the phone with a middle placed grip providing a better hold, but places the hand far away from the buttons.

6.2.4 Supporting player emotion data collection

As the applications is now, it forwards information about the players actions, location, player equipment pickup and player equipment usage to the game server. As we discussed in section 5.3, emotion is also something which we want to capture. At section 5.5.3 we discussed the usage of a pause feature in order to capture the players emotions during the gameplay. As it is now, the pause functionality only stops the timer at the server side. As the pause and resume functionality was only coded to provide a recovery functionality when the player disconnected, there is no visual messages on the client side. The solution can be used as it is, and use the person playing as the game manager to ask and write down the emotions of the different players, but since the players are communicating with walkie-talkies, only one can respond at the time. In addition there could also be interference or other technical issues. This means that the pause must be long enough for the manager to ask the question and allow the players to answer, as well as sort out which sequence the players should respond to. Since the pause and resume functionality is currently a manual task, this shouldn't be an issue as we can wait until everyone has responded before resuming the game. This however, creates an unpredictable amount of time the pause should last, and as the manager is to also watch other kind of data, the manager

might forget to start and resume the pause at the right time.

Another option would be to make the pause and resume functionality an automatic task. With this, we can be sure that it will start and resume at the right time as well as have a strict constant pause length. However this require that we remove the uncertainty element, which in this case would be to set the pause length to a time which we can be sure that the player will be able to report in the data. But since we only want a small break, to ensure that the player don't lose the game engagement, we will have to have a solution which can be executed quickly. Thus instead of the player reporting it by walkie-talkie, we will create a function within the game application which gives a visual notification that there is currently a pause and in addition, the possibility to submit their current emotion using the smartphone. As the smartphone isn't limited in the same way as walkie-talkie, the players can submit the data concurrently, reducing the time needed dramatically. However, by making the pause functionality automatic, we will trade off the ability to ensure that the game session can be paused if a player suffer from technical issues. As the game uses technology which can be unstable and is affected by elements such as weather conditions, this tradeoff is unacceptable. Instead we keep the old pause function but from now refer it to emergency pause, and add the automatic pause as a separate function. This means there will be two different functions to pause the game where one function is used in an emergency case when players lose connection and drop out of the game, while the other is to pause the game on purpose in order to ask players about their emotions.

6.2.5 Supporting player self rating

In subsection 5.3.7, we discussed the potential usefulness of gathering data about how well the individual player thought themselves and the team performed during the game session. This could easily be done with a piece of paper, but the player who plays as the manager should also be able to see this data. This means that either he has to go get the data or that the players fill out papers before delivering them to the manager. Although this is possible with how we have placed the physical area for the test game map and the server location, making the distance not too far and should not cause much extra waiting time between the game session and the start of reflection session (due to the need of analyze the data). It becomes a problem if the players had long range walkie-talkies and was 5-10km away from the server where the manager is sitting.

Combining too many different tools and platforms is also quite ungraceful from a designer point of view. Having to change between different tools to complete an activity will usually give a bad impression of the product and potentially lower the usability of the product.

Another option would be to use the smartphone to gather this data and return it to the manager. This function could either be triggered manually by the manager or the players, or automatically when the game timer has run out. A manual function triggered by the manager has some downsides which we discussed in 6.2.4. A manual function triggered by the players also share some of these concerns. Although a manual trigger has downsides, it also have a big upside for us developers. A manual trigger is much more failsafe than an automatic solution. E.g if a player disconnects while filling out the data, the player could re-start the application and trigger this part again. While with an automatic solution, we would have to code in a failsafe solution in addition to code the function which allows the players to fill in the data. Even so, we think an automatic solution would bother the players the least and provide the best usability and thus is the solution we will go for.

6.2.6 Displaying pathing information

As we discussed in section 5.3, the player pathing information could be useful for the reflection session. This is also a data type which is very tricky to present, as it have a much higher frequency than e.g players emotion, players self rating etc. The Google Maps API for Android used in the app, has an inbuilt function for tracking the players which we are using. We estimate that on average the player location is reported about once per 1 second. This is of course highly variable as while a person is running this could be as often as 10 times a second, and while standing still in a zone it would be next to nothing. The reason why the location is still being updated and reported when the player are standing still, is because of the triangulation method which can be affected by the environment and weather condition. The location reported in these cases are almost the same, with perhaps 20-40cm apart. Thus showing a player where he has been walking/running the last 15 minutes with with this detail level will limit the possible platform. It should be clear that by just telling a player where he has been walking/running during the entire game session will yield little benefit. The player will probably have a hard time grasping the data which is presented to him. Time is also an issue with this solution as it would require maybe too

much. Displaying this data on the Android smartphone would be an issue as the screen size for most mobile phones is quite small for this use. The map could quickly become quite cluttered if the entire game map is fitted on the screen which forces users to zoom in to distinguish things more. Zooming adds another problem because it makes it tedious to clearly see all the pathing information clearly as the area displayed would be small.

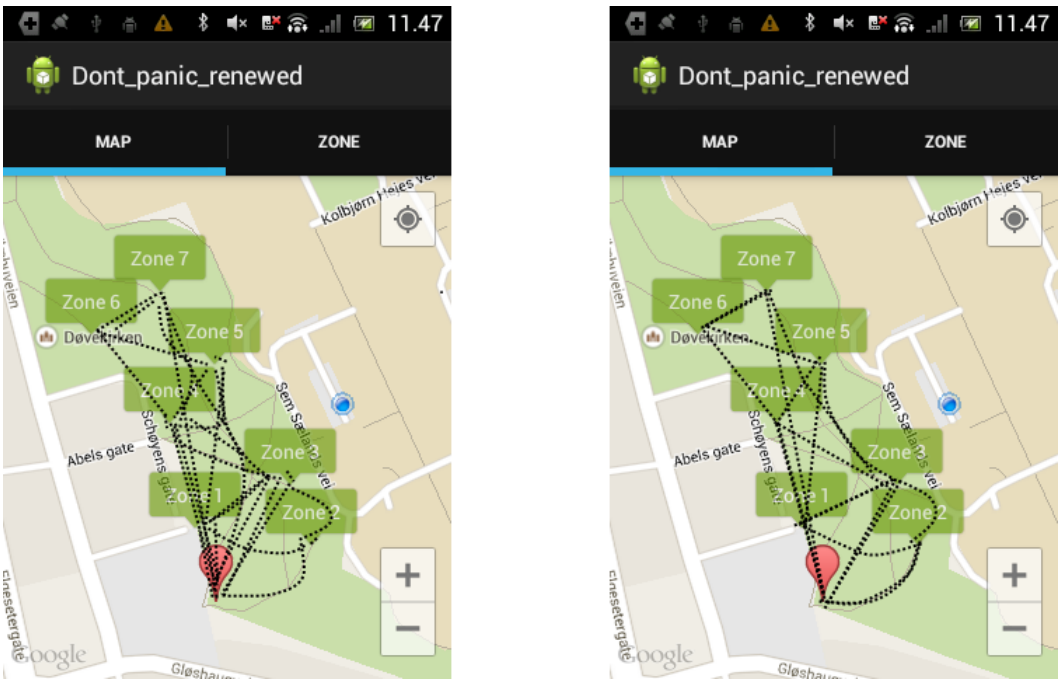

Figure 6.3: Illustration on how a possible sollutions could look like

Image to the left illustrating the estimated amount of location data that would be recorded by a jogging player on a non-snowy, slippery terrain during 15 min. Duplicated path taken are shifted a little so it is easier to see. Image to the right shows the estimated raw data without shifting the data.

As the image illustrate, the pathing data is to hard to read. Although the players can see where he has been during the game, interpreting in which order he went to these location is a whole different matter. An option would be to separate this data into the different stages as presented in 5.5.1, showing only 1/3 at the time, but even then we still think the pathing data would be to hard to interpret. Thus we think the data must be manipulated in some way, reducing the amount that is needed to be displayed. If we were to filter the data in such a way that if the

recorded location X is too close to the already drawn location Y, we should not draw it, we would most likely end up with little useful data. This solution would lead to that only the pathing data which was collected at the start, will be presented while ignoring the rest, as they would be to similare/close. This could lead to the players being confused, or worse thinking that the data is true.

Another option would be to narrow down the focus from showing the player pathing to which zone the player left from and to which zone he arrived at. However, this means that the data wouldn't be useful to show how the player travelled from a zone to another.

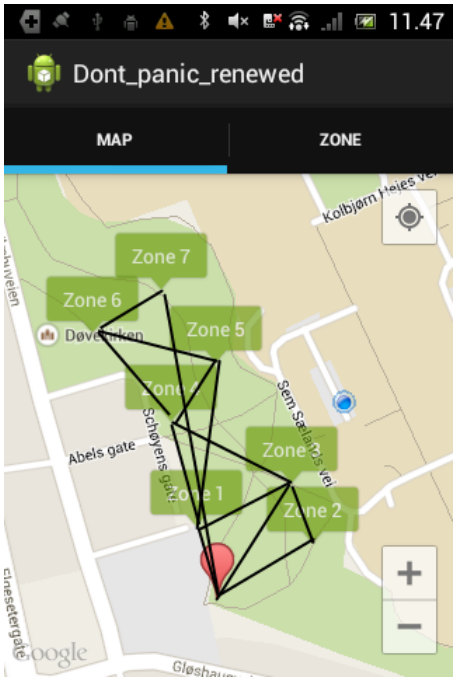

Figure 6.4: An illustration on how a zone to zone history could look like

As figure 6.4 illustrate, the solution doesn't provide detailed data on which path and how the player got from a zone to another. This solution will also have a problem presenting paths taken multiple times, as the lines would just overlap each other. This could be fixed by shifting the lines a bit, making them not overlaps each other. But even then, distincting the order of pathing is quite hard as the image could represent that the player started in the secure zone and headed straight to zone 7 or zone 2 or zone 3 or zone 4, etc. Another possible way to present this data is to use text. Insteading of drawing lines on the map which will struggle with the issues we have discussed so far, we can display the zone the players have visited as a history list/log.

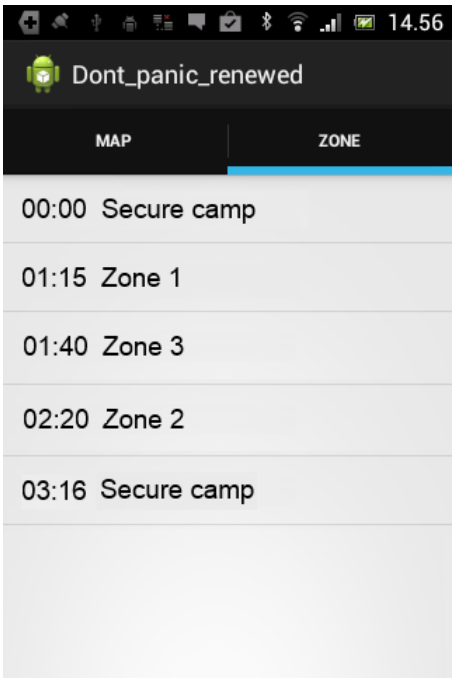

Figure 6.5: An illustration on how a zone history list could look like

As we can see from figure 6.5, reading where, when and in which order the player visited the zones are quite easy. A downside is that this solution won't provide the level of detail of the first solution which we discussed, and that this solution can be seen as boring compared to both the first and second solution discussed.

6.2.7 Summary

The game design which are discussed and planned to be implemented is derived from either feedback from the autumn project evaluation and is aimed to increase the usability and stability, or as a requirement to support the reflection process as discussed in chapter 5. Table 6.1 provides a short re-cap of the design tasks.

Design tasks	Reason for implementing	Other discussed solutions	Chosen solution
Change dialog window behaviour 6.2.3	Potential to improve usability. (feedback from autumn evaluation)	-	Enforce the dialog window behaviour with explicitly code, even if its not needed by most versions.
Change GPS behaviour 6.2.2	Potential to improve usability. (feedback from autumn evaluation)	-	Explore android settings and check if there is any possibility to disable "movement" prediction. Change the alghoritm used to check if a player is within a zone.
Prevent accidental termination of the application 6.2.3	Potential to improve stability and usability	-	Disable auto exit when hitting the back key and instead, prompt a “are you sure you want to quit” dialog window.
Gather emotion data 6.2.4	The data is needed for the reflection process	-Pause the game using the manual emergency break and use the manager to write down the emotion using pen and paper while the players broadcast it using the walkie-talkie. -Implement an automatic pause, which last a specific lenght and gather the data using pen and papaer	Implement an automatic pause, and a function which allows the emotion data to be captured using the smartphone. This should be triggered from the server side.
Gather player self rating 6.2.5	The data is needed for the reflection process.	-Use a paper questionnaire. - Use the smartphone as a questionnaire and allow the active players to trigger the function	Use the smartphone as a questionnaire and trigger the function from server side
Supporting pathing history 6.2.6	The data is needed for the reflection process	-Show the location data as dots on the map fragment using each registered location. - Show the leocation data as lines between zones on the map fragment.	Show the location data as a history list, using time stamps and zone names in the zone fragment.

Table 6.1: Design task and decision summarization

6.3 The server application

In this section, we explain the server protype design developed during the autumn and the required changes which must be made to support the manager role and the reflection process.

6.3.1 Overview

Since some of the design choices taken for the game application also affect the game design for the server/manager application, the remaining design choices will be to support the manager role. And since the server application from the autumn project was extremely simple and unfit for a non-technical person, this will require a full re-design. The design will only cover the need of the manager and the reflection process, and will not involve a user interface for creating maps or to change game settings. Thus, most of the work will be to find a proper balance of the information which is to be displayed for the manager to observe the players in real time, as well as the information which should be provided during the reflection session.

6.3.2 The autumn prototype design

The server application developed during the autumn project does not support any in-game changes. Settings such as the delay between panic waves and game ticks are hardcoded as well as the zone and all its settings. Since the goal of the autumn project was to evaluate the game and the game mechanics, features for altering in-game settings wasn't needed and would just add extra work and potentially add more bugs to the system.

```
public void setUpTaskTwoAlternative(){
    zones = new ArrayList<Zone>();
    Zone z = new Zone();
    z.setNormalZone(false);
    z.setCord(63.41555,     10.40110);
    z.setName("safty");
    zones.add(z);

    Zone z2 = new Zone();
    z2.setCord(63.41603 ,   10.40079);
    z2.setName("Zone 1");
    z2.addBlockade("Fire");
    for(int i = 0; i < 2; i++){
        Civilian civ = new Civilian("Civ" + i);
        z2.addCivilian(civ);
    }
    zones.add(z2);
```

Figure 6.6: The image shows how the zones are added

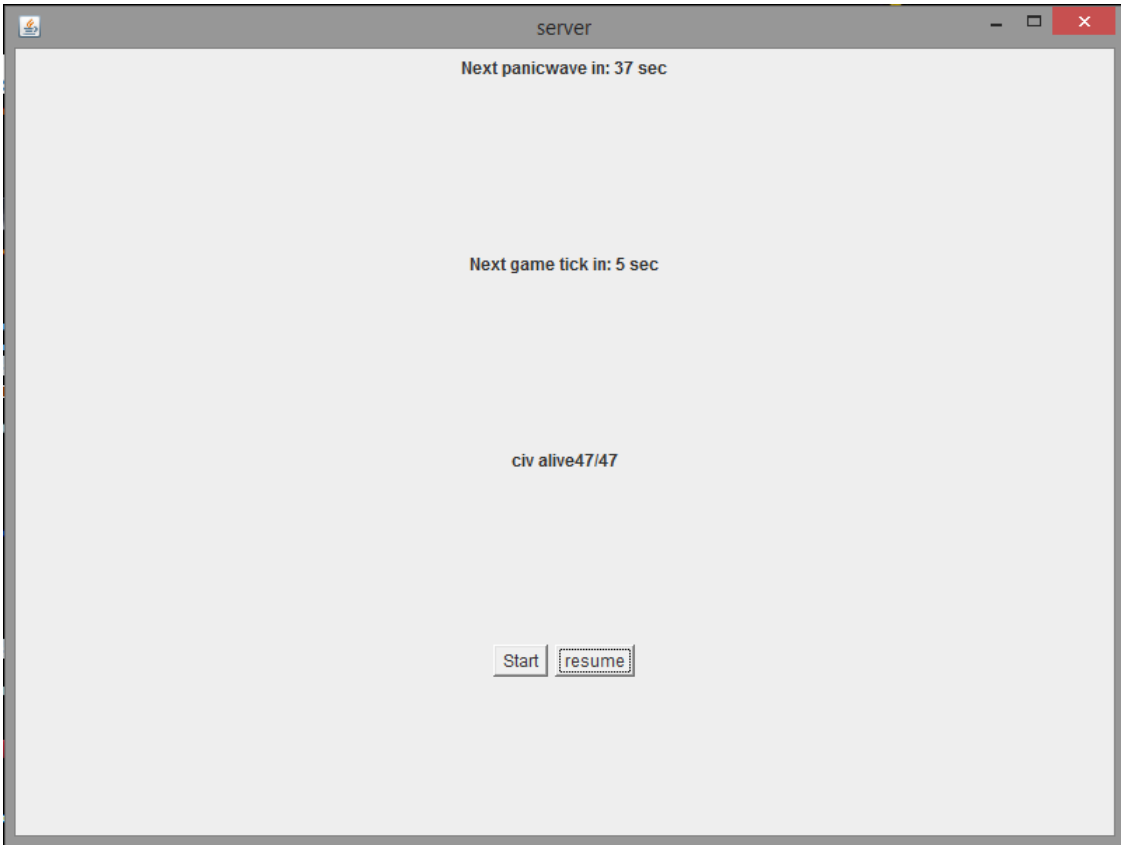

Figure 6.7: The image shows how the autumn server interface looked

The server user interface was also extremely simple, providing only information about when the next panic wave would occur, when the next game tick would occur and how many civilians was still alive. Information about player locations and actions was displayed using the IDE-console since it contains tools which can be used for bug tracking, making it easier to find and uncover details about bugs which may occur during the game session.

6.3.3 Supporting data filtering for the manager

As we discussed under the reflection chapter, with the intention of adding a manager role, there will be a need for filtering the data. As the manager is supposed to provide input about the teams decision making, prioritization, teamwork and communication, this person must be able to spot mistakes or actions which may be worth discussing during the reflection session. As it is now, all the actions performed by the players are displayed in a list using the console in the IDE. This will most likely cause an information overflow, making it quite hard to spot important events. In addition since the communication data is real time, if the manager isn't able to process the data due to being distracted by something else, there is no way to recover the lost data. To reduce the risk of information overflow, we should therefore reduce the amount of data displayed so only data which can be considered essential is presented.

Starting with location data, as we mentioned earlier we plan to allow the manager to use the same game application as the rest of the players to keep track of the other players. This is because the data which says where the player was and where he went can tell a lot about the player's decision making, prioritization, teamwork and communication skills. As the game application runs on an Android smartphone and the server application runs on a normal PC, the manager would therefore have to keep track of both the smartphone and the PC. This could be quite distracting and make the work much harder. An option would be to implement the map and player tracking functionality to the server application, which would require an architecture change as the Google Maps API can only be used on the PC platform via web programming. The server architecture would therefore have to have two layers, where the first layer is the game server, which hold the game state and allows the player client to communicate. The second layer would be a GUI for the manager, written in JavaScript.

The big issue would be to get the same functionality in the JavaScript application as in the Android application. We had to use third-party and custom solutions to get text markers and to update the markers dynamically as it wasn't any built in support for this in the Google Maps API for Android. As software developers, we think this solution would be the best solution architectural wise, but we must also keep in mind that at this stage we are not sure if reflection in combination can aid the players in improving their crisis management skills or not. If we are to go with this solution, we are more or less committed as the amount of work it required means that we will most likely not have enough time to do any changes, that is if we can even get it finished on time. Another option would be to reduce the amount of location data to which zone the player was in last and which zone he currently is in. This means we will lose the data indicating where he is in real time. But this type of data doesn't make sense unless the manager knows the map, thus we will still need some sort of graphical map which shows the placement of the zones. This leaves us with having to continue to use the game application for player tracking, but by implementing the last and current zone location for the players in the server application, we hope to reduce the amount needed to switch focus between the applications.

The second useful data would be the players equipment. Having equipment left over once the game is done could for example indicate that that the player didn't plan ahead on what sort of equipment the team actually needed. Equipment also have a huge impact on decisions taken during the game and can reveal a lot about the player's decision making, prioritization, teamwork and communication skills. It's hard to understand how the player reasoned about using equipment, picking up a type of equipment, etc. But as the manager job is attempting to trigger discussion, he doesn't need to analyze everything. An example could be that 3 minutes in the game, the firefighter is carrying two fire extinguisher and is currently in zone 4, In zone 4 there is a firehose which he decided to use instead of using one of his fire extinguisher. This decision may seem odd to the manager as even though the fire hose is free to use, it require much more time than using one of the fire extinguisher. Events like this could be quite useful to discuss, as the firefighter could have reasoned that with the amount of remaining blocked zones, there is a large chance he would need both his fire extinguisher or else he would have to return to the secure camp to pick up more, which would take more time than using the firehose.

A third useful data would be information about the zone which the player is currently in. Information such as the amount of civilians and their health, and panic state affects the players decision about moving to the next zone or staying to try heal and/or reduce panic. By providing this data, the manager could also reason about if the player should call for help or not, as well as if the player should use equipment or not.

The last type of data which we think could be wise to add, is the current action of the players. Although the manager should be able to deduct what the player are doing by using the other types of data which we have discussed so far, he might not be motivated to do so. Presenting a player's current action also prevent a static GUI as players might be standing in zones and carry out actions toward the civilians which may not be as easy to spot. By providing this type of data, the manager can also easier spots bad events which are useful for the reflection process. E.g the firefighter unblock a new zone which has 10 hurt civilians and broadcast this to the other players. The medic is in a closeby zone which has 3 hurts civilians, after hearing the broadcast, he still decides to use up his equipments to faster heal/reduce panic at the zone he currently is at. This is definitely a bad decision which could be due to several things such as bad decision making, or bad communication skills at either ends, or technical issues, etc.

Based on what we have discussed so far, a solution such as the image 6.8 will provide the needed information in such a matter that all three players should be viewable at the same time.

6.3.4 Supporting data presentation for the reflection process

As we discussed under the reflection process, we planned to capture several types of data. This include the pathing of the player, their emotion during the various stages, the remaining equipment and the self rating questions. This could be quite place demanding, as there are several self rating questions as well as the pathing history could be quite large. Since the data is more useful when it can be compared to other data, we want to display the players stats close to each other.

As the image illustrate, we have decided to create a tabbed solution for the pathing information as well as the player self rating questions. This is due to space issue as it wouldn't be

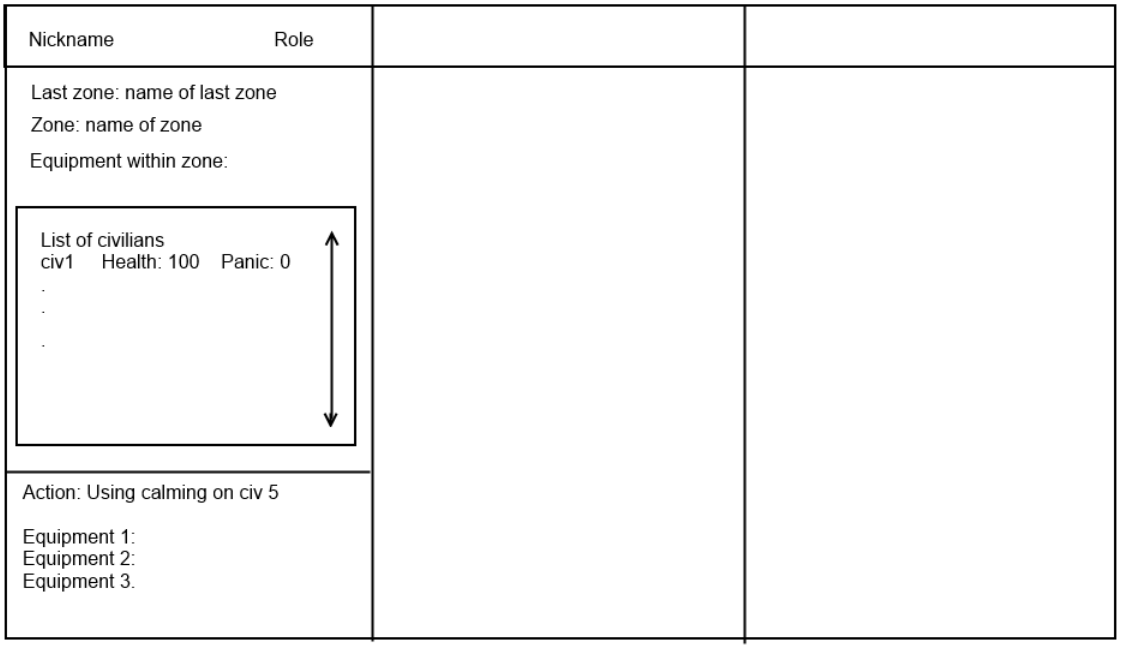

Figure 6.8: The image illustrate a possible solution to display game data in real time

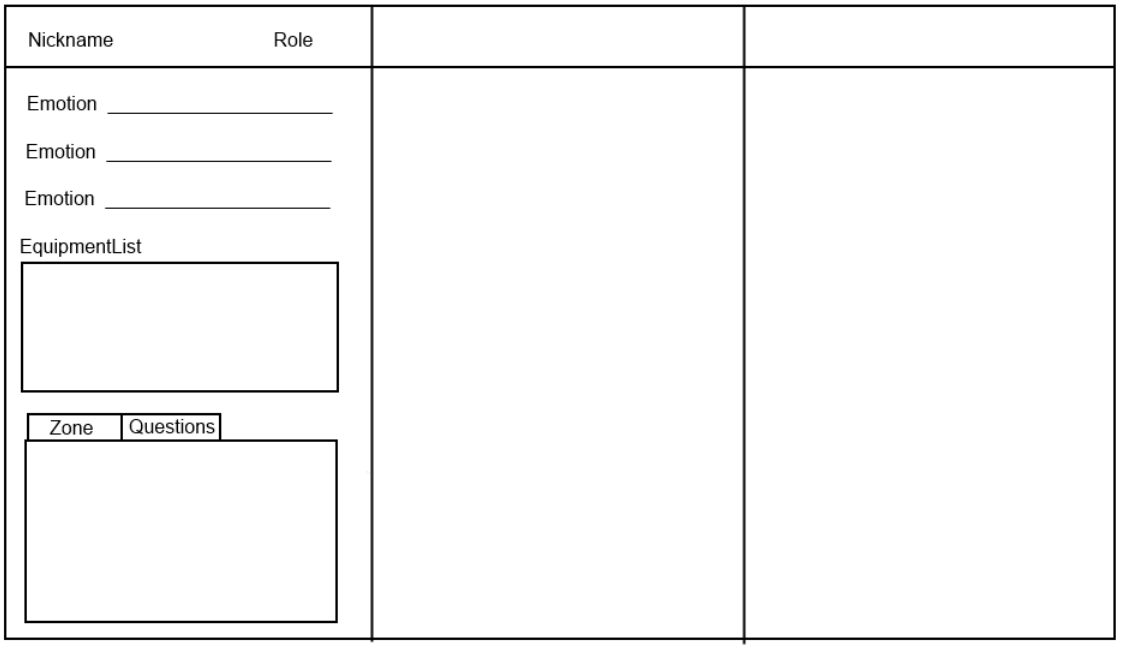

Figure 6.9: The image illustrate a possible solution for showing the data gathered during the game session

possible to display all the information in a normal screen height. We have prioritized the emotion data and the equipment data as we believe it will provide more value to the manager to be able to use these data in synergy with the zone and self rating data, than other ways around.

6.4 The reflection process guidelines

So far, concerning reflection, we have only explained how various features to support reflection are technically integrated into the server and the client application. However there is also a need for non-technical reflection items which we will discuss in this section.

6.4.1 Manager guidelines for observing

Since the manager will be played by a person with previous experience with the game, the person should be able to register game events based on his/her previous gaming experience. However the manager could have problems understanding how to present and use these during the reflection session, which could cause uncertainty on if an event should be captured or not. To prevent this from happening and to increase the likelihood of the manager capturing important game events, not only are example of events which are useful to capture needed, but also explanation of why they are important. However, as the manager must capture these events in real time, using pen and paper, screenshots, etc. An overcomplicated guideline might work against its intention. Thus we will keep it to the three most simplest game event categories, which are decision making, prioritization and communication. Table 6.2 contains example of game events which we think are easy to spot, and could be usefull for the reflection process.

Game events	**Category**
Use of “umm, eeh, uuu”, when speaking in walkie-talkie	Communication
Not reacting to new information from other players	Communication, decision making, prioritization
Long periods of silence	Communication
Relevant information in broadcast	Communication
Item usage	Decision making, prioritization
Item pickup	Decision making, prioritization
When to return to secure camp	Decision making
Ignoring a zone	Decision making, prioritization
focusing on a zone	Decision making, prioritization

Table 6.2: Game events and skill category they can belong to

6.4.2 Manager standard questions

A concern with the reflection process is the possibility of lack of participation from the players. As we have mentioned before, reflection is not commonly thought of as a fun activity which make it quite challenging to engage unmotivated players. Although the manager are responsible to start discussion by presenting game events, we cannot take it for given that this will be the case. To ensure that there will be discussion during the reflection process, we cannot rely on that the manager will for certain start any discussions, and in additional, we want to trigger discussion around our reflection goals, thus the need of a set of mandatory question will be needed.

In section 5.2, we have already presented the reflection goal and in section 5.3 we have presented the possible game elements which can trigger discussion around the reflection goals. In this section we won't repeat this information, and instead present the topics/triggers which we think are useful and and explain what we hope to achieve with them.

Topics/Trigger	**Possible benefit**
Discussion around the players estimate of civilians alive, compared to the real number of civilians alive, and how they came up with the estimated number	Better understanding the importance of information, which in turn could affect communication, decision making, prioritization and debriefing skill.
Discussion around the players strategy	Better understanding the importance of a proper strategy, why they are hard to make in a crisis situation, and the importance of re-evaluating the strategy based on new information. This could stimulate pressure handling, prioritization, decision making, communication, debriefing skill.
Discussion around players effort and the team effort	Better understanding of the team dynamic, the role benefits/limitations, the need of co-operation and the possibility to give each other feedback. This could stimulate pressure handling, communication, debriefing skills, prioritization and decision making.
Discussion around communication	Better understanding of the importance of communication. This could stimulate pressure handling, communication, debriefing skills.
Discussion around how decisions were made	Better understanding of the difficulty of taking decisions in situation where the lack of information and time is a big factor. This could stimulate decision making, prioritization, communication, pressure handling and debriefing skills.
Discussion around emotions and performance	Better understanding of how the pressure is affecting themselves as well as their teammates. This could stimulate pressure handling and debriefing skills.
Discussion about what the player felt they did well	Better moral for the next round.
Discussion about what the players felt they could do better	Better engagement for the next round.
Open discussion	At this point the players can discuss whatever they feel is untouched. The benefit will generally be a better team bond, and depending on subjects, perhaps also some of the reflection goals.

Chapter 7

Implementation

In this chapter we will discuss how we have implemented the various functions which are needed to support reflection, as well as functions whose purpose is to increase usability and stability.

7.1 The android game application

In this section we will explain how various function has been implemented to the game application to fulfill the design choices which was taken in the design chapter to support reflection, as well as to increase the usability and stability of the application.

7.1.1 Adding network debugging

As we discussed in section 2.3, one of the bugs which we discovered, but wasn't able to trace during the evaluation in the autumn project, caused the players of team one to lose connection to the server. The game application for the players crashed at random intervals, while the phone which we had connected to the pc for debugging purposes didn't crash. Thus we were left without any useable log of what happened. This event proved that the way we had planned to trace bugs wasn't sufficient, and that we have to implement a solution which can be deployed to each phone, so that they can log any bugs which occurs.

There are basically two way to do this, either this function can be included within our application, meaning that the user won't notice much of it. Or it can be a separate application, which make it more noticeable for the user, but also make it more fault proof. Google actually has an

inbuilt support in the Android OS which monitors the various application and can log any errors that occurs. Sadly there is no direct way to access this log locally beside using the two options which we discussed earlier. However part of this log can be accessed through Google Play if the application is published and downloaded through it. For privacy reasons the entire log isn't accessible, but the part that is, tells where the bug occurred in the code. This part should be enough, and since the log is sent to the Google Play developer console, we can access it through the web, instead of having to borrow the players phone and copy this data over manually. Because this is a easy and reliable way of acquiring error logs when a bug or error occurs this will be the solution used.

Since this feature requires that the application have to be downloaded from Google Play, it means that we had to either have to upload 3 different version, one for each role. Or allow the players to select their roles within the application. Coding and uploading three different applications for this purpose would be considered a very bad solution for the problem when it is easy to implement a feature which allows users to select their role within the application. The application has therefore been extended with an activity where the players can enter their nickname and select their role in the game. This is now the start up activity, meaning that every time the application is restarted, this is the first thing they see. Image 7.1 shows a screenshot from this activity.

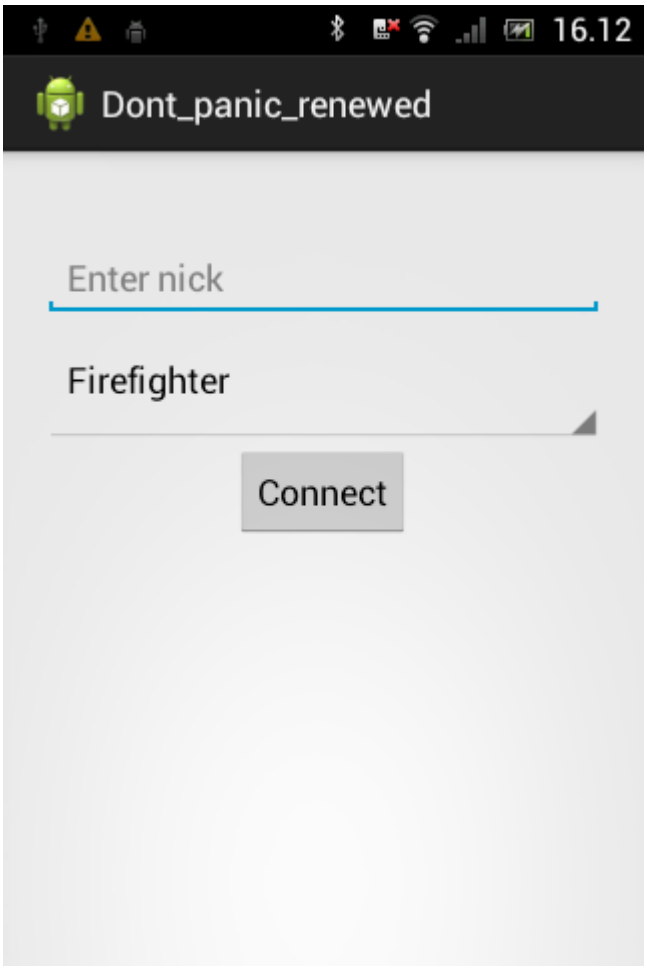

Figure 7.1: Screenshoot of the login activity from the game application

This left some concerns as this meant that a player can change his role during a game session by accident or on purpose by restarting the application. To prevent accidental role shift during a game session, we implemented a local storage function, which will remember which nickname and role the player had last time. Thus if the application crashes or restarts, he can simply just press connect without filling in the information again. Even though the application will remember this information players can still change it on purpose if they so desire, but we have decided to leave this alone for now, as it is highly unlikely that the participants would do this in order to cheat. Even if this occured it can be discovered anyway by watching the server application.

7.1.2 Changing the algorithm to check if a player is within a zone.

As one of the player in the autumn project evaluation had issue with the GPS, we decided to change the algorithm. The one used in the autumn version, was quite simple, but actually checked if the player was within a X given distance north,west,east or south. This mean that the algorithm used, checked a square area where the corners would be at a longer distance from the center of the zone then straight north, west, south or east, and yet still be legal.

```
/**
 * A check to see if the player is nearby the zone
 * @param lat the latitude of the zone
 * @param lng the longitude of the zone
 * @return true if the player is nearby, false if hes not nearby
 */
public boolean isWithinZone(double lat, double lng){
    double radius = 0.0002; //length given in latitude/longitude cord. equal about 10m

    if(Math.pow((lat - this.latitude), 2) + Math.pow((lng - this.longitude), 2) < Math.pow(radius, 2))
        return true;

    return false;

}
```

Figure 7.2: Screenshoot of the code used in this version of the prototype

The code implemented will now properly check a circle area around the zone, making it an equal legal distance no matter what angle the player enter it from. 10 meter is used as the radius which according to the research done during the autumn project would compesate for the inaccuracy and slower position updates.

7.1.3 Enforcing dialog window behavior

The code that handle dialog window has been re-coded to ensure that the dialog window can be closed when the player press the screen area outside the dialog window. This is with some exception, as there are some dialog window we don't want the player to be able to close.

Dialog window type	**Can be closed by the users?**
Enter and existing a zone	Yes, can close by tapping on the screen
Picking up equipment in the secure camp	Yes, can be closed by tapping on the screen or by using the cancel button
Using an equipment	No, must wait until equipment is used. This will be closed automatically when done
Using an action	No, must wait until the action is completed. This will be closed automatically when done
Game paused (Will be explained in 7.2.4)	No, must wait until the countdown timer is done. This will be closed automatically when done.
Reflection question (Will be explained in 7.2.5)	Yes, can be "closed", by pressing the "next" button until all question has been answered.
Failing to connect to the server	No, must press the "close application" button
Connection lost to the server/Lost heartbeat (will be explained in 7.3.4)	No, must pressing the "reconnect button"

Table 7.1: Dialog windows and their enforced behavior

7.1.4 Adding functionality for automatic pauses and emotion data gathering

To support the new automatic pauses and emotion data gathering we could either create a new activity which is perhaps the more traditional way to do it in typical Android application development, and shift between this new pause activity and the game activity when the pauses begins and ends.

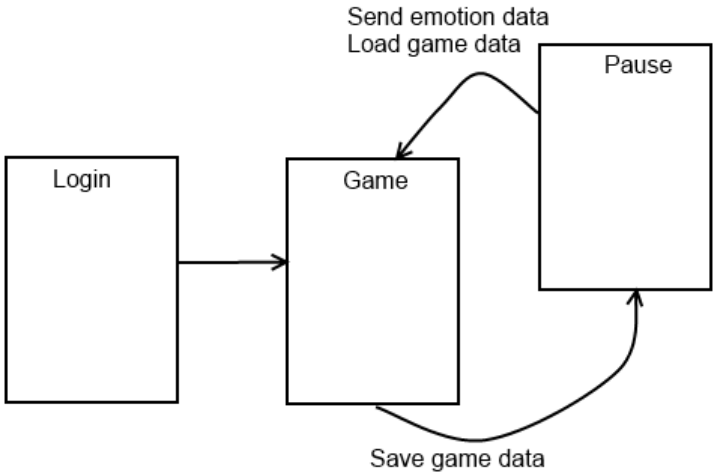

Figure 7.3: Illustrate how the activity transition would look like with a pause activity

Image 7.3 illustrate the changes of activities. Since Android encapsulate data in the activity, this data will be marked for deletion once the activity is closed. The only way to keep this data alive is to manually pass it along to the next activity or save it to a persistent data storage [10]. Since the game state, including the players state are kept in the server applications memory, the Android application would just have to disconnect when the pause would occur, before reconnecting and download the game state once the pause is finished. This is quite simple, but redownloading the game state multiple times during a game session will result in a lot of data traffic between the server and client devices. When performing a test we measured and estimated that during a 15 minute game session, the data usage from the different network message is only about 20% of the entire data usage. This means that 80% of the data traffic is used to download the game state from the server. Luckily this data is quite small in volume as the game data is sent as a large JSON-message, and all objects are created in the Android application instead of sending serialized objects from the game server. This is the reason why the application is a bit sluggish during the first 2-3 second after entering the game activity. Although, it isn't a large amount of data used, its still more than a solution where we wouldn't have to reload the state from the server. An alternative option was to save the game state locally, and resume by loading this data, but this option could cause trouble if the pauses occurred at different times, due to for example network lag, leaving the players to save a different state of the game, causing chaos once the game was resumed. Besides, we wanted to keep the concept of having the player interact to the game activity as much as possible, as it would provide a less conflicting user experience.

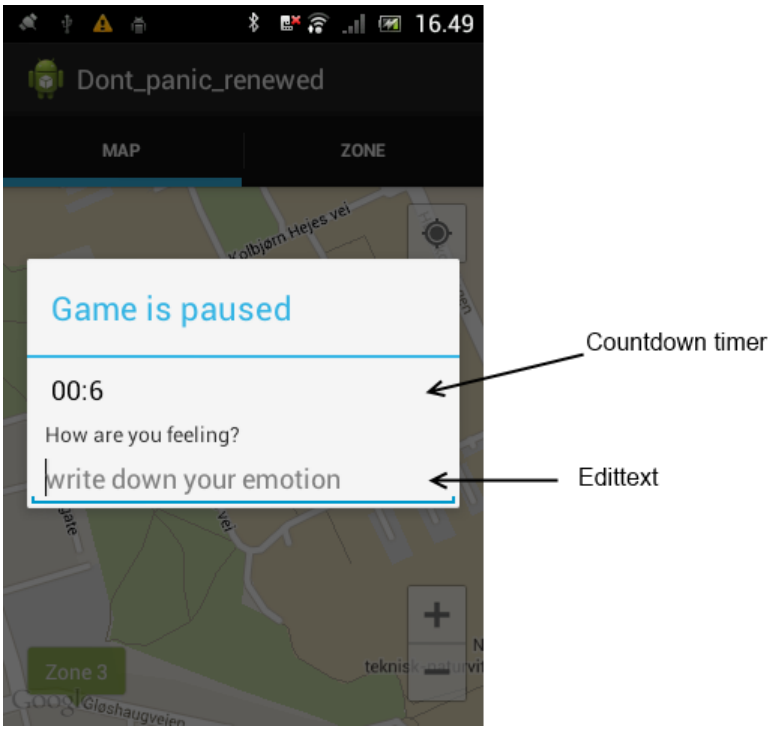

Figure 7.4: Illustrate how the pause functionality can be done as a dialogwindow

Thus, we ended up with the solution which is shown in Image 7.4. The pause is shown as a dialog window which can not be closed by the player unless the device is powered off. The dialog window also display a countdown timer, which will tell the player how many second there are left of the pause. At the end, there is an Edittext, which is a field where the player can type in whatever he wants to. Once the time is out, the dialog window will close itself, and the answer is automatically sent to the server. As our network messages are formatted with symbols, the answer which the player enters are cleaned, removing these reserved symbols to prevent any conflicts. Although this method doesn't bear the risk of having the game state desynchronised, having players being paused and resumed at different times due to network lag could be quite annoying, and even affect the team score if the time difference is large. To prevent this, we thought about implemented the pause in such a way that the server sends the information about when the pause should begin and the duration of it, but this solution requires that the clock on each smartphone is synchronised, which in most case it isn't.

We considered to let the pauses be triggered client side, but this could create some serious unsynchronization issue, as we would have to have a game timer on the client side, which could

be messed up if the application hangs or crashes. Thus we have decided to go with the solution where the client application will immediately pause when receiving the network message to do so, and resume once it has counted down the duration of the pause. In a worse case scenario, the emergency pause can be used to prevent any large difference in resume time.

7.1.5 Adding player self rating functionality

Just like with the emotion data function, we could have separated this into its own activity. Since the game is over, we don't have to worry about synchronized game state and thus much of the worries which we discussed about separating the pause/resume-emotion data function into its own activity is gone. However as this function intention is quite similar to the emotion gathering function, we decided to keep the "look and feel" similar. This decision is more based on design principles to achieve good usability then comparing strength and weaknesses.

Similar as the emotion data dialog window, the users cannot close the dialog window in a normal way. These dialog windows cannot be closed, except by pressing the next button or by turning off the smartphone. Each question is presented as a separate dialog window, and by pressing next, the next dialog window with the next question shows up.

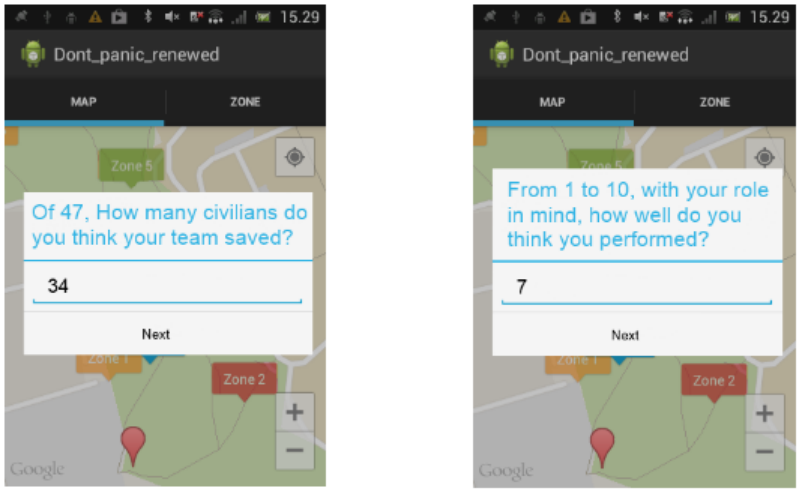

Figure 7.5: Shows some of the questions that will pop-up as dialog-windows

As image 7.5 hopefully illustrate, one question will lead to another question until all the question are answered. The last question has a "finish" button, which will end the sequence. The questions used are the ones presented in 5.3.7

7.1.6 Adding player self rating review functionality

Unlike the other function which we have discussed so far, we didn't have any plans on adding this functionality, but after implementing the zone history functionality, we thought that the players could also have the use of the questions answer which they are to submit, as it could trigger a deeper understanding during the discussion when players has the possibility to give each other feedback. Since there are quite some few questions, it's unlikely that the players would remember all the answers, and by providing a quick way to access the answers, there are also potential for increasing the discussion quantitative and quality during the reflection process.

This function is also different from the other discussed so far as it doesn't fit in anywhere. There is no function which is similar and thus there is no look and feel principle to worry about. There is also no space to display this information in the game activity, except if we were to use a dialog window or an overlay. But this prevent the users from changing fragments between the map fragment and the zone fragment. This is in conflict with the zone history functionality which we discussed in 6.2.6. Thus we will need to create a new space which we can display this information. The first option is to use the traditional activity solution as we discussed in 7.1.4. Since the game is complete we don't have to worry about any synchronous issues, nor any "look and feel" design principle. The only issue is the conflict with the Zone history functionality. Since the zone history function is displayed in the game activity to allow the players to view both the map and the list of visited zones easier, the player would have to change between this new activity and the game activity if a discussion involves both subjects. Although its not technically hard to implement this solution, there will be a noticeable lag when changing to the game activity, as the map must be drawn and the markers must be drawn upon it. In additional the map details must either be downloaded from the server, or stored locally on exiting the activity and loaded from local store on entry of the activity.

If it wasn't for the zone history functionality, using a separate activity would be a great solution and also easy to implement. But with the need of both type of data during the reflection process, there is a high possibility that would want to change the activity several times, making the lag more and more intruding. With this in mind, we decided to use a little less traditional way to display the data. Instead of creating a new activity, we decided to create a new fragment

and expand the current game activity from holding just the map and zone fragment to include a review fragment as well. This is done dynamically and at the end of the game, triggered by users as he submits the last question and get confirmation from the server that the data has been received.

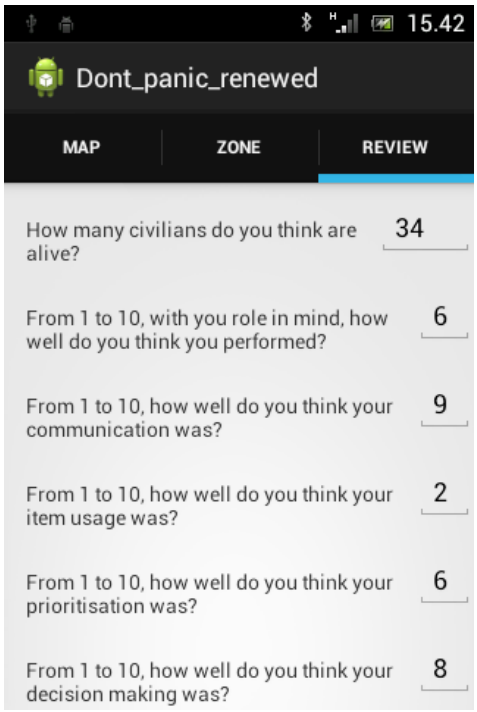

Figure 7.6: Shows how the review fragment looks like

As the image shows, a new tab arrives once the questions has been arrived. The content of the zone tab will now show the zone history while the map fragment will continue to show the game map.

7.1.7 Gameflow summary

With all the implemented changes, keeping track of how the application works might be hard. We will therefore use this section to try to make it easier to understand.

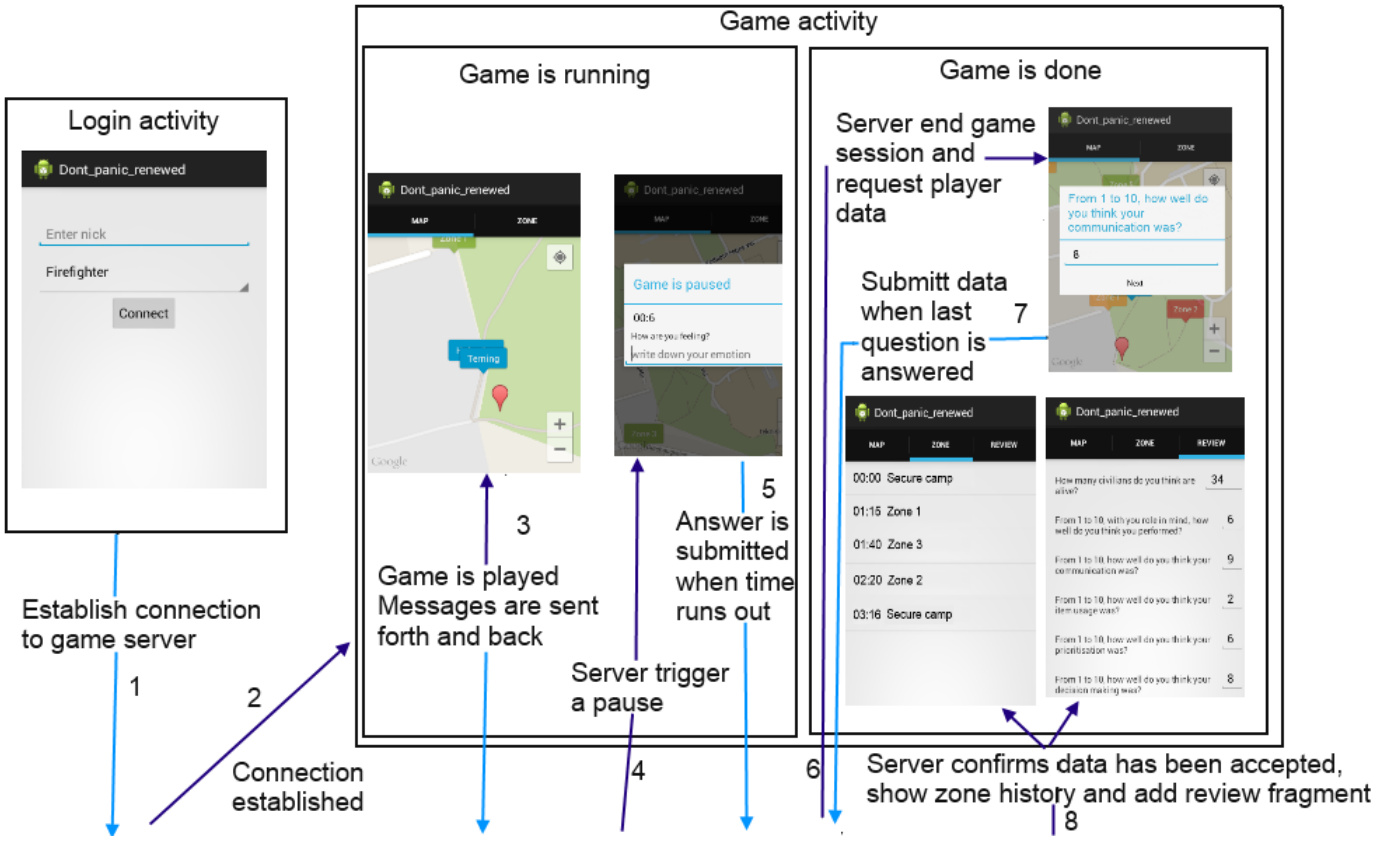

Figure 7.7: Shows a simplified version of how the various important game stages are occuring

When the user starts the application, the player will be meet with a login screen. If the player has played the game before, the application will remember the players nickname and his role from last time. Once the player press connect, the application will attempt to connect to the server and transition to the game activity. If the connection fails, the player will get a warning as a form of a dialog window as explained in 7.1.3. If the connection succeed, the players arrives at the first stage of the game activity, where the game fragment and map fragment behaves as explained in 3.4. While playing the game, pauses will appear at each 1/3 intervals, where the players can enter their emotion at the various stages. The game ends at the last pause, and the reflection questions will be triggered shortly after the last pause. This moves the game activity over to the second stage, and once the reflection question has been submitted and confirmed, the zone fragment will display the zone history to the player, and the review fragment is added and displays the answer which the player has submitted.

7.2 The server/manager application

In this section we will explain how various function has been implemented to the server/manager application to fulfill the design choices which was taken in the design chapter to support reflection.

7.2.1 Adding timer to support automatic pauses and game over function

To support the new automatic pauses and game over function, we implemented a timer called the game timer. This timer is started once the manager press start game and will run until the game session is over. However it can be stopped by the emergency pause, incase some technical issue occurs to the players. As we are to have 3 pauses during the game at 5, 10 and 15 minute mark, the pause function will be triggered and pause the game timer along with all other game function such as game ticks and panic waves. The pause function has its own timer, and once the pause timer is done, it will resume the game timer. This timer is also in charge of signaling the end of the game after the last pause by sending a network message to the game clients as well as changing the manager GUI from “observer” mode to “review” mode. We will explain this further during subsection 7.2.3.

7.2.2 Storing player emotion data and player self rating

As the player are to submit their emotion data at 5, 10 and 15 minute mark and also the self rating score at the 15 minute mark, we need to store it somehow. This brought up the discussion if we should create an persistent data storage, which would allow us to access this data once the server application was closed and also in external application. By having an persistent data storage, future work such as an website for viewing the player stats over many game session would be easier to implement. However as we already discussed earlier, we don't know if the reflection process will be useful for the players or not, and until we can confirm the usefulness of a reflection process, we will keep it simple. Thus we decided to keep this data in memory of the server application which means it is only accessible while the server application is running. This data is sent from the application as a normal string as well as returned as a set of strings to keep the data usage low.

7.2.3 Creating the manager GUI

The manager GUI will have two mode as the manager has two main task. The first mode, which we call observer mode, shows player information in real time.

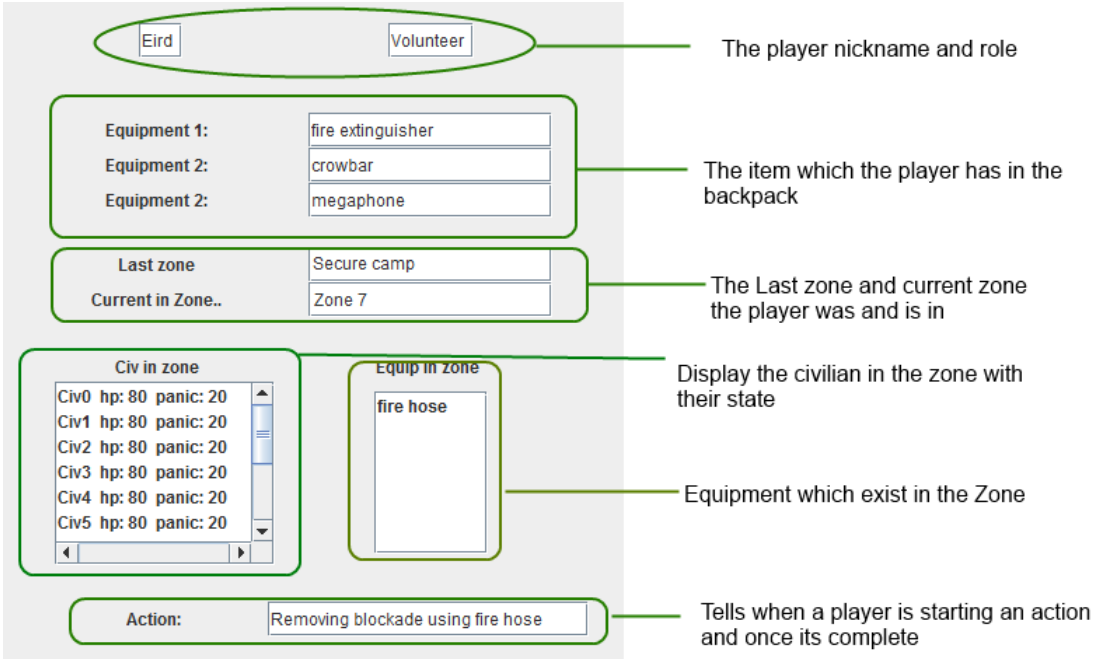

Figure 7.8: Shows how the various data is displayed in play mode

The network code had to be extended to support several features, which we will explain in 7.3. As the image shows, information about the zone including the name, number of civilians and zone bound equipment which exist in the zone is revealed. This information is real time and once a player enter a new zone, this will be replaced by the information in the new zone, as well as being updated when the player interact with the civilians. When a player connect to the server, this GUI is automatically created, except when the player role is manager or when its a reconnect. This means that the amount of players aren't limited to only three players and can be played with more players, even when using reflection.

The second mode, which we call review mode, shows the answers which the players has given to the questions, their remaining item in the backpack and the zone history. This mode is triggered when the game timer has reached its maximum, which we have set to 15 min for the evaluation. Incase something goes wrong, and the reflection questions aren't retrieved from the player, we have some backup solution which will re-request this data. And incase the player disconnect during the reflection process, there is also a backup solution which allows us to send the reflection data to the player.

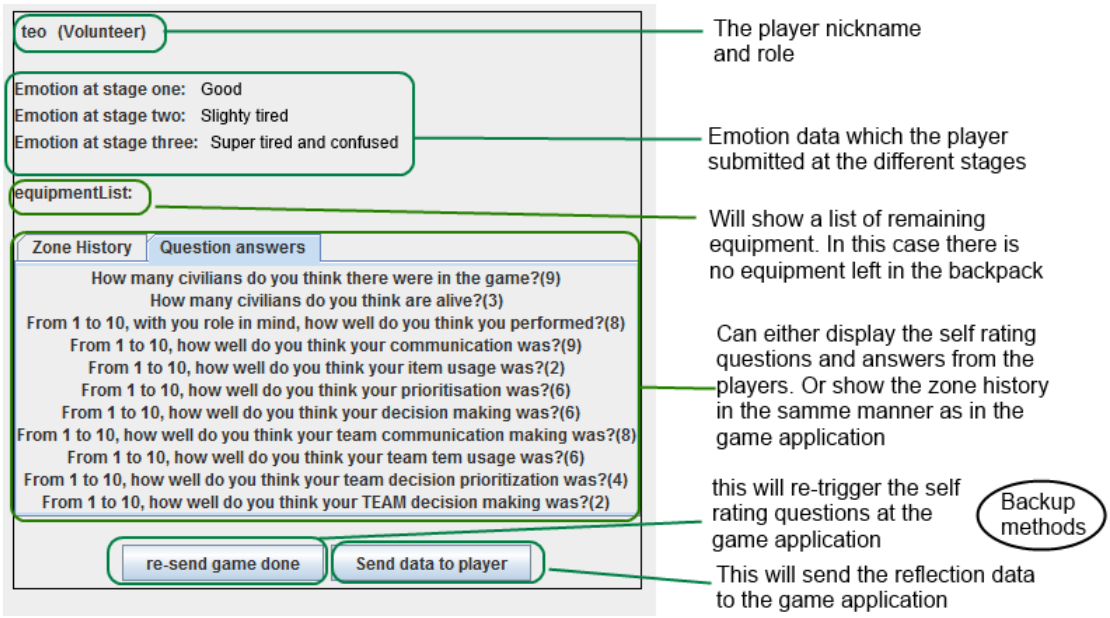

Figure 7.9: Shows how the various data is displayed in review mode

The two buttons, triggers these backup solutions and are triggered for players individually.

7.2.4 Implementing heartbeat

This was also not a function which we had planned to implement, but towards the end of the coding phase we noticed that the application was more and more unstable. At first we thought there might have been a bug in the code which caused this behavior, but as we are sitting at the same room as 16 others, we quickly noticed the complaint about the network. To confirm this, we used a tool called PingPlotter which indeed confirmed that the network was quite unstable and caused both package loss and disconnections. After day 3 with this network behaviour, we decided to implement heartbeat as we got more and more concern about synchronized game states. In short, the server is sending a special network message every two second, and if the game application doesn't get any of these messages within 5 second, it understand that it has lost the connection with the server. If it get one of these messages, the 5 second timer is reseted and will continue onward. This heartbeat will only occur during the game session and will be disabled as soon as the reflection session starts. For those who are more familiar with socket, which may wonder why we didn't use the pre-made method "setSoTimeout(int time)" which will throw an error if the socket fails to read a message within X given time. This is because of the possibility of events where all the players are within a zone, standing still and waiting for an equipment action to be done. In these cases, there will be no message sent from any clients until the players starts moving or have completed the action and thus, the pre-made method may think that the client has lost the connection to the server as it hasn't received any network message for a while.

7.3 Network

In this section we will go through how the network part is implemented as it can reveal a lot about the architecture behind the system.

7.3.1 Client-server communication protocol

There are currently two protocols that are widely in use by the community, each with it benefits and downside.

UDP (User Datagram Protocol) is a lightweight and unreliable communication protocol. Unlike TCP it does not maintain any connection between clients, but require information as IP and port number for each message sent. It's referred to as unreliable, as it doesn't really care if the messages it should send arrives in correct order or even arrive at all. This might sound like a bad thing, but there are many games that use UDP for this reason. By not making sure each packet sent is received, UDP performs better than TCP when it comes to speed. In many games, its more important to have a consistent low latency than avoiding lost packages. In these games lost packages are often ignored, or is handled in the application itself.

TCP (Transmission Control Protocol) is a reliable communication protocol. When two clients are connected, a stream is created which lasts until the clients no longer wish to communicate. TCP is a protocol emphasizing reliability, error checking and makes sure packets are received in the correct order. If a lost package is detected, all other other packages will be held back and the lost packet will be resent until the receiver receives it before continuing.

In the autumn project we decided to go for the Transmission Control Protocol, and although we had network issue in the autumn evaluation, we are still holding on with the TCP. Although we can't be sure, we don't think any of the network issues can be traced to the network protocol. And the main reason to why we choose TCP over UDP in the autumn project are still valid for the current prototype.

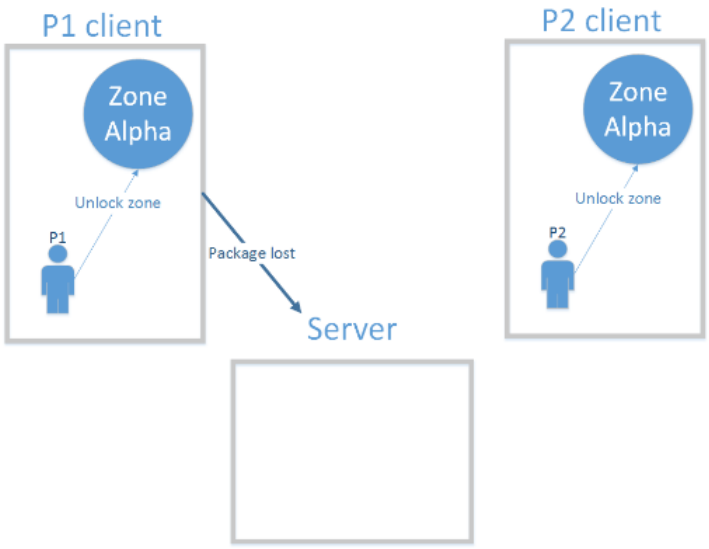

Figure 7.10: The image shows a potential consequence when a data package is lost

Image 7.10 illustrates a scenario where Player1 unlocks Zone Alpha. This data needs to be sent to the server so the game state is updated for all players. If the data package is lost because of network issues it would have to be resent to make sure the game state isn't desynchronized. If UDP is used, a solution would be to continually send data packages and compare the game state of the client with the servers game state. The actions performed would have to be time stamped to tell which client holds the "correct" state, and an algorithm would have to be run on either all the clients or the server. The end result would be something that does things very much like TCP does "out of the box". All the extra amount of work needed to make UDP a viable choice makes TCP a better choice, which is why TCP was chosen as the protocol for the autumn prototype and why we are sticking with it.

7.3.2 Network messages

In this section we will present the various network messages generated by the game application and server application, as well as what they do.

Player joining game session

When a player wants to join a game session, there are two requirements. Firstly if the amount of players, including the player who wants to join, exceeds the player limit he will be unable to join. Secondly, his nickname must be unique as to stop confusion if two or more players were to have the same name. Once he has successfully joined the game, all other players will be notified with a visual notification. This is done so the team can be sure that all members have joined before starting the game session.

Map data

When a player has successfully joined a game session, the map/board will be sent to the player from the server, ensuring that all players have the same map. This message can be quite large depending on the amount of civilians, zones and equipment in the game map.

Game state/Player recovery

If a player disconnects during a game session, he will receive a copy of the game state when rejoining. The data his game client had before the disconnect will be the same as the one he receives from the server.This message can be quite large depending on how many civilians, zone equipments,zones, and how many items the player carries.

Geodata

When a player physically moves, the new geodata will be sent to the other players, allowing them to have near to real time location awareness of all players. This is limited to occur maximum once every 600ms to prevent too much data usage.

Equipment data

When using or picking up equipments, a message will be sent to the server so it can update the player state for recovery and reflection purposes. This message won't be sent to the other players, and is only visible for the manager.

Zone data

When a player performs an action within a zone, the other player will receive a “non visual” message that will update their game state if they are not within the same zone. If they are within the same zone, the user interface will be updated, reflecting the new state of the zone. These messages are off two category, one which is sent when the action is started and is meant only for the manager application, and the second one which is when the action is done and the state are to be updated on all the players application.

Game Pause

At certain points of the game, the server will send out a pause message to the players. This message is currently set to be sent out at 5,10 and at 15 min into the game, and is used to gather the emotion of the player as discussed in 7.1.4

Emergency Pause

Unlike a normal game pause, which is triggered automatic and both pauses and gather emotion data. This type of pause is triggered manually and will only pause the game state. The players will not get any notification in the game application when this type of pause is used, thus they must be told over the walkie-talkie. As the name indicate, this pause should not be used, except in dire situation such as network issue which require more time to solve then a couple seconds.

Heart beat

This is used to ensure that the game state stays consistent and that the player can be notified quicker about a possible disconnection between the client and the server, while being safe from false disconnection as described in 7.2.4

Game Over

At the end of the game, a game over message will be sent to all the players which will trigger the reflection questions. Once the reflection questions has been answered and returned to the

server, an confirmation message will be sent to signal to the player that the application should go into review mode.

Request reflection data from client

This network message is a backup solution incase of a player loses connection with the server before the questions which he is supposed to answer at the end of the game has been submitted to the server. This message will re-trigger the questions boxes and allow the player to redo that part.

Request reflection data from server

This network message is a backup solution incase the application is exited during the reflection process and had to be restarted. This message contains the answer which the player has given to the server and will proper restore the application into “review” mode.

Chapter 8

Evaluation set-up

In this chapter we will look back to the planning stage of the evaluation, where we will discuss how we carried out the evaluation, what we hoped to achieve, what challenges we expected.

8.1 Overview

By conducting the evaluation we hoped to find out if the addition of a reflection process could aid the players in becoming more aware of the importance of things like communicating and pressure handling. This was done by splitting the participants into two groups, one which played using the reflection process, while the other played without using the reflection process. After both groups had played two sessions each, we have planned to to determine the impact the reflection session, by comparing the outcome of the two teams . To keep the two group's experience as similar as possible, the group which played without reflection, was given a pause which could last up to the same time we had set off for the reflection process, and it was their decision when to continue on to the next map. During both test runs one of us observed the players in the field during the sessions.

8.2 Challenges and concerns

In this section we will discuss some concerns and issue we experienced when attempting to plan and run the evaluation.

8.2.1 Network stability

During the finalizing of the server and game client, we struggled a lot with network stability. We decided to monitor the server network stability and used a simple tool, called PingPlotter, which allows us to measure the network stability over a longer period of time by sending small packages at certain intervals. We set the interval to 5 seconds which would allow us to detect disconnections which didn't last very long, but long enough to cause problems during a game session as data is transmitted almost constantly when playing the game.

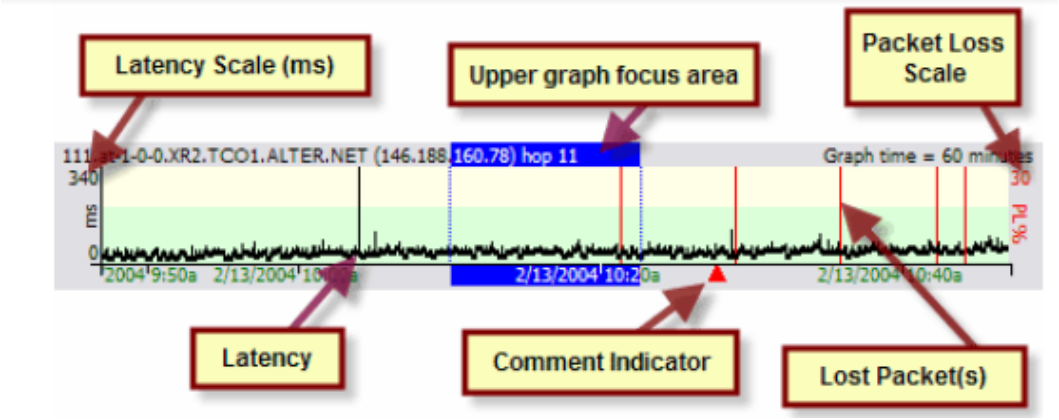

Figure 8.1: How to read PingPlotter measurements

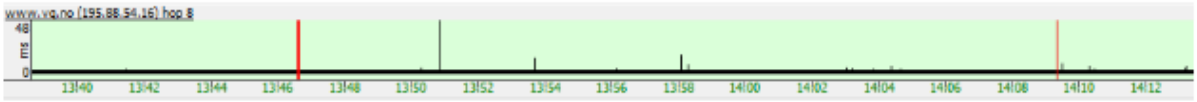

Figure 8.2: Measurements done on the server network the 28.04

Figure 8.2 is an image from PingPlotter where we did a test that ran for one hour. The image shows two cases of total package loss, but the latency remained at low with a max response time of 48ms.

The test illustrated in 8.3 ran for several hours, and we experienced quite many package

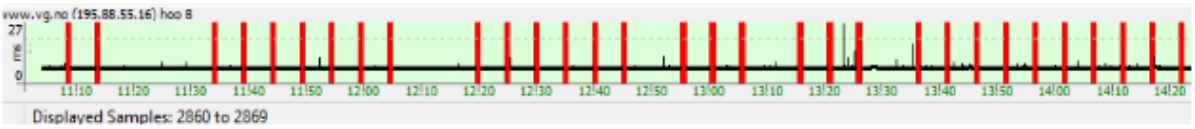

Figure 8.3: Measurements done on the server network the 01.05

losses, as well as quite long recovery time. This ever changing stability of the network made it extremely hard to properly test the system, which we wanted to do before running any form of evaluation. It also made it hard to set a date for the evaluation as it would be quite horrible to run the evaluation with network conditions like this. Because of the instability of the network we had to postpone the pre-evaluation tests until the network was stable enough. During the actual evaluation the network worked flawlessly, meaning the server was fully available to the clients at all times.

8.2.2 Getting participants

Getting participants to voluntarily test the game became quite difficult as it required them to set off at least an hour and a half of time and all participants in the team had to be available at the same time as well. During the autumn project we used classmates as participants as it was easy to plan the timing with them as we shared both workspace and time schedule. Unfortunately we needed new participants for this round of testing as previous experience with the game may influence the evaluation results. This combined with the network issue we experienced, created some extra concerns.

8.3 Potential factors which may affect the result

The data gathered from the evaluation could be affected by several factors. We therefore took some precautions to help us tell if the results were affected by some of these factors or not, so it could be taken into consideration when analyzing the data.

Potentianl factor	**Consequences**	**Measures to limit impact on result**
Previous experience with the game.	Gives a player or team an unfair advantage as they know what to expect.	Only used players who didn't have previous experience for the evaluation.
Physical fitness.	Gives a player or team an advantage in that they can move more easier which can affect the end score	The players where asked ahead of the game to rate their own physical shape.
Individual effort and motivation.	A team who is more motivated to put in more physical and mental effort will most likely do much better than a team who lacks motivation.	The players where asked ahead of the game how much effort they were willing and planning to put in.
Experience with similar work.	Players who have training or background in similar work such as leadership, military work, medical work may have engage in similar exercises will have experienced simulations which can be similar to this game and therefore have an advantage that way.	The players where asked ahead of the game to tell us and possibly elaborate on any related experience they had which could give them an advantage over those not experienced in with this type of work.

Experience with Android devices and apps.	If a player has used Android devices and applications he will be more familiar with the user interfaces and how one interacts with it. Someone not familiar at all will most likely use more time, and struggle more to interact with the application. This could lead to players having different perceptions on the usability.	The players where asked how familiar they where with interacting with Android devices and applications in order for us to see if their perceived usability could relate to their experience with these devices and apps.
Experience with games.	Research has shown that playing video games can give both, cognitive, motivational, emotional and social benefits[16] which can all be beneficial when playing this game.	The players where asked how much prior experience they had with video games.
Weather conditions.	The weather conditions can limit the movement speed of the players, their ability to interact with the Android device, and also affect the player's motivation.	In order for the weather to play as little role as possible on the outcome, all evaluation runs where conducted under the same weather conditions.
Technical issues.	If one team experiences more technical issues than the other team, they could rate the usability lower, lose motivation, lose focus, etc.	In order to limit this factor we have performed tests prior to the evaluation in order to uncover issues which could occur during the evaluation and fixed them.

Experience with walkie-talkies.	Having experience with communicating using technology where only one person can broadcast at a time, will make it easier to communicate efficiently. This advantage gets larger if more than one player on the team has experience with this.	Players where asked ahead of the game to tell us how much experience they had with this type of communication.

Table 8.1: Potential factors which can influence the data collected

8.4 Participants

Ideally we would have carried out the evaluation with poeple who work with crisis management, however as several new functions were implemented, we decided to run the first few rounds using available students. As having game experience could have affected the game result, we decided to only recruit students who did not have any prior information about the game. For the manager, we decided to ask the previous testers from the autumn project, as having experience with the was a requirement to the role.

8.5 Game maps

In this section we will present the various maps which were used for the evaluation, as well as the purpose of their design.

8.5.1 Overview

There were three different game maps for the evaluation. All of these were played by all the participants. The first map was only used as an introduction to the game, giving the players the

chance to experience the various game elements and practise how to interact with the game. The two other maps, referred to as map A and map B, were used to evaluate the players. Thus, both those who utilized post game reflection, and those who did not, played the same maps and were given the same introductions. The idea behind using two maps, was that it would allow us to compare the score growth/change instead of comparing score directly. Although comparing score directly was the most simple approach, and in many cases a good measurement method, in our case there was the risk of too many differences between the teams. E.g if a team consisting of athletes was to play against a team of non athletes, the team with athletes would be more physically fit and therefore most likely manage to get a better score, that is unless the non athletes were better at other aspects. In any case, by looking at the growth or diminish of the score between map A and map B, we could measure the effect of the reflection process without being that much affected by participants different set of skills or condition.

8.5.2 Introduction map

Just as in the autumn project, we planned to use a simple map and to give the players some instructions which they were to carry out. The idea behind this, was to let them experience the difference between game roles, how the GPS tracking works, how the blockades works, and generally how to interact with the different game elements like the civilians, etc. During the autumn project, we had the panic waves and game ticks disabled for the introduction map so that the players could take their time to learn the game. This caused some insecurity when panic waves and game ticks occurred when they played the actual game after the introdiction map. Thus, for this evaluation, we decided to turn the timers on, so that the players could experience all the game elements during the introduction.

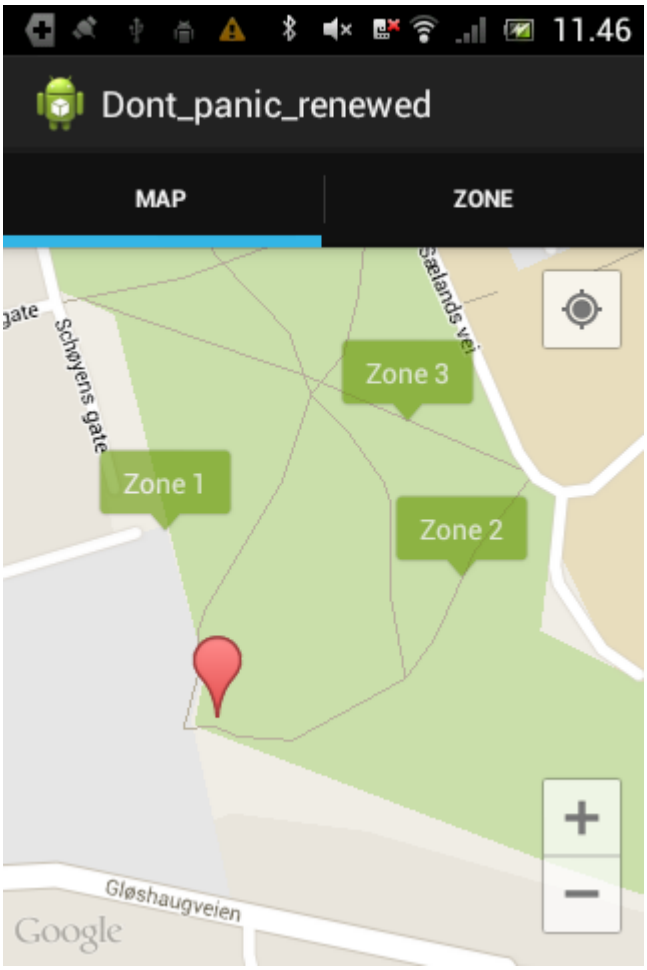

Figure 8.4: Screenshoot of the introduction map

The player mission was to:

1. Unlock all the zones
2. Calm all the civilians and restore them to full health

The only information the players were given for this scenario, was the mission detail and what equipment to pick up at the secure camp.

The medic was instructed to pick up the following:

- Fire extinguisher
- Medical kit
- Megaphone

The firefighter and the volunteer was instructed to pick up the following:

- Fire extinguisher
- Crowbar
- Medical kit

The reason why the medic was instructed to pick up a fire extinguisher and the firefighter was asked to pick up a medic kit, was to ensure that they understood that even if they could pick up a equipment, it didn't necessarily mean that they could use it.

The map had three zones containing three civilians each, and all the zones were blocked by fire. Zone one had a fire hose, while the other zones had no zone bound equipment. The map was created so that the players were placed in a situation where they would be introduced to the limitation of each role, the difference between each role's actions, and the difference between each equipment type. The scenario could have several outcomes, but the blockade action sequence would either be:

1. Players use fire extinguisher at zone 1 instead of the fire hose, then use the second and last fire extinguisher at zone 2, and must return to the secure camp to get a new fire extinguisher.
2. Players use fire extinguisher at zone 1 instead of the fire hose, then return to the secure camp to pick up a new, then proceed to the other zones.
3. Player use fire hose at zone 1, use fire extinguisher at zone 2 and zone 3 without needing to returning to the secure camp.

This was planned to provoke a group discussion about whether the decision was good or not, and how the decision was made.

8.5.3 Map A

For the first map, we used a medium difficult map where the secure camp is placed in a strategical good position. This minimized the distance the players had to run to restock equipment,

and would also encourage the use of the secure camp when moving between the north and south side of the secure camp.

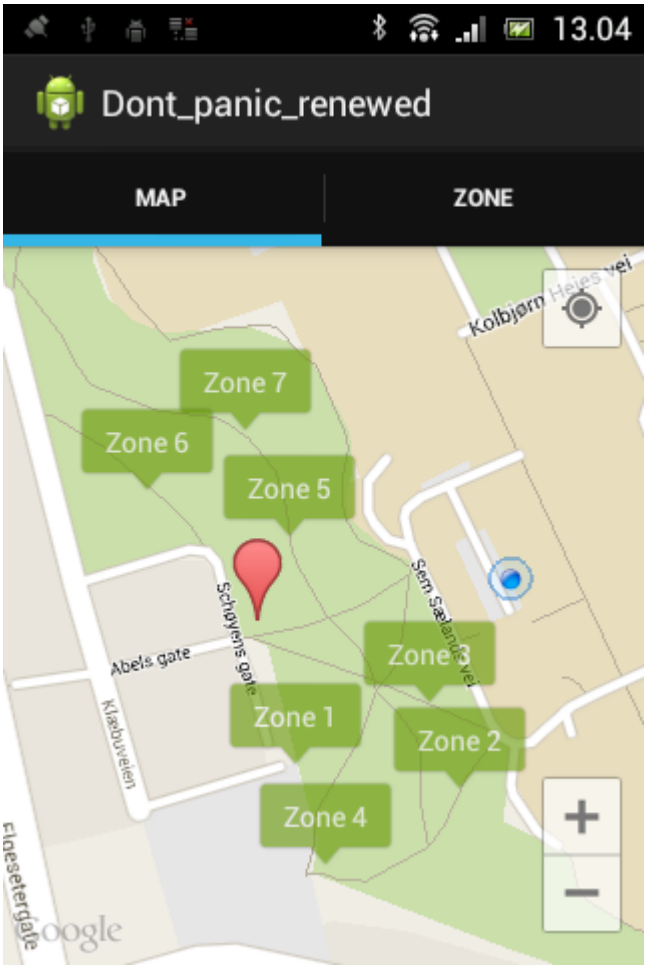

Figure 8.5: Screenshoot of map A

The zones were placed so that there would be a mixed amount of zones which had visible line of sight to each other, and some that did not. This might not be as easy to spot by just looking at the image of the map, however the terrain of the test location contains hills and slopes which blocks the visibility between many points. There are also trees that disturb the line of sight. This created a more dynamic situation where the player could have “face-to-face” communication as well as the need to communicate using walkie-talkies.

Zone	Blockade	Number of civilians	Equipment in zone
1	Fire	5	
2	Jammed	4	
3	Jammed	6	
4	Fire	7	Fire Hose
5	Fire	5	
6	Jammed	8	
7	Fire	12	Fire Hose

Table 8.2: Map A, zones and their attributes

As table 8.2 show, both the northern and southern part of the map had a similar amount of civilians with 25 at the northside and 22 at southside, even if the south had 4 zones and north only had 3. This was done to see if the players were able to maintain an overview of the map as the game progressed and new information was discovered. The map was designed so that at the initial stage, the southern side would seem most attractive, as it had more zones and thus potentially more civilians. This thought process would be encouraged when the players unblocks the closest zones as the civilian count would be similar. However once all zones are unblocked, it would reveal that the northside has most civilians and since it also had the least amount of zones it would be less work to prioritize that side. The big question was if the players would be able to recognize this and adapt to the information.

8.5.4 Map B

For the second map, we used a slightly modified version of the map which was used during the evaluation of the autumn project. While planning and testing the maps, we discovered that the GPS on the smartphone didn't update it's location near zone 5, most likely due to the pine trees which has regrown their leafs. Thus we decided to move the location of zone 5 further away from the trees and closer to the path. Since the season had changed from winter to spring, we also decided to re-distribute the civilians to maintain the same difficulty level. This map was created and modified to have a higher difficulty level than the first map, thus it would require more of the players to obtain a good score at this map.

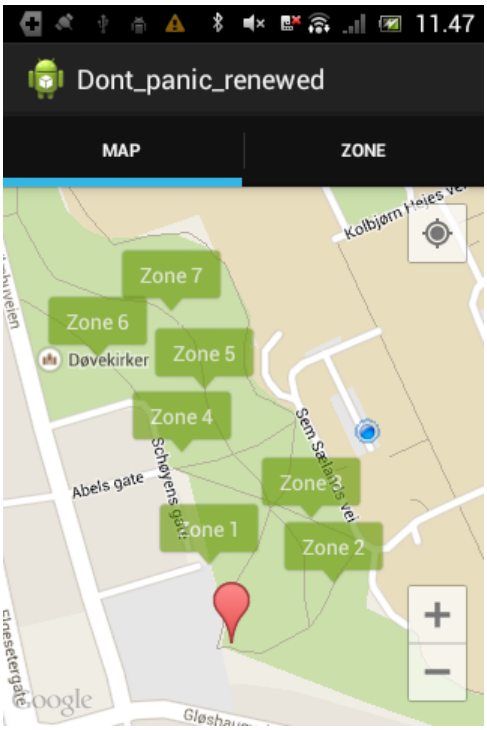

Figure 8.6: Screenshoot of map B

As the image illustrates, we used the same location for the zones as in map A, except that the secure camp and zone 4 have switched place. The zone furthest away from the secure camp, took us a bit more than two minutes to reach with a fast walking pace on a snowy day, and about 1:50 on a normal sunny day.

As the figure show, there are some zones close to the secure camp, so a strategic decision would be to be to run back and forth picking up equipment and using them at the those locations. This was probably also one of the most tempting solutions as it would require little physical effort, compared to trying to rescue civilians at zone 5, 6 and 7. As an attempt to counterweight this decision, we decided to place few civilians at the zones closest to the secure camp, and many at the zones which were further away.

Zone	Blockade	Number of civilians	Equipment in zone
1	Fire	2	
2	Jammed	6	
3	Jammed	3	
4	Fire	5	Fire Hose
5	Fire	8	
6	Jammed	9	
7	Fire	12	Fire Hose

Table 8.3: Map B, zones and their attributes

As table 8.2 show, if the players decide to take the easy way out, they will save a small amount of civilians. There are also so few civilians in the closest zones, that if the players decide to stay in these zones and keep calming and healing the civilians, there should be some downtime between the actions, as the civilians will have max health and minimum panic before the next panic wave hits. Hopefully this should encourage even the most laziest player to do some field exploration.

8.6 The manager and the reflection process

For the manager role we asked some of the participants from the autumn project as they had prior experienece with the game which was a must to fill this role. We didn't expect nor demand that the player would be able to catch all the importants events, which is why we created the guideline for the manager which contained example events which could be useful, as discussed in 6.4. These were only examples and the guidelines was designed to highly encourage the manager to use his past experience and make up his own mind of events which he thought was important. The guideline for the manager can be found in appendix C. To ensure that the manager was familiar with the manager GUI and the evaluation set-up, the manager took part in the final testing done by us. This was done some few days before the real evaluation with real participants.

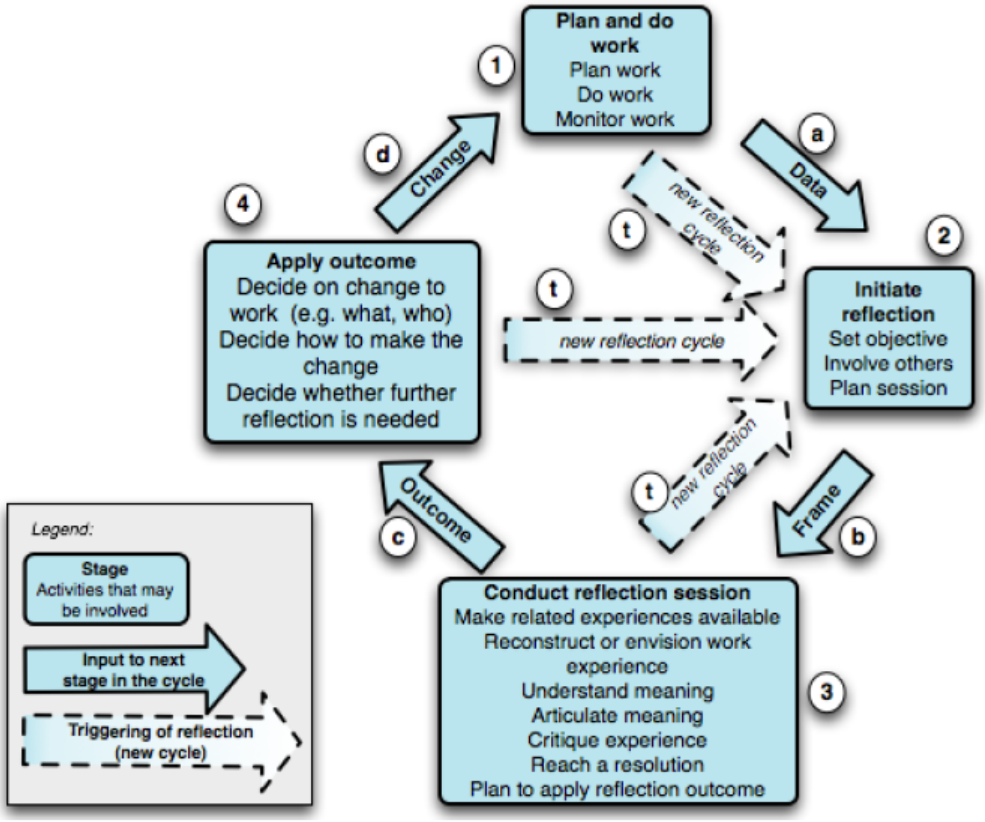

Figure 8.7: The CSRL model

We have previously presented and discussed the CSRL model. We used this model to plan the execution of the evaluation for the team which were to utilize the reflection process.

Starting with map A at the "plan and do work" stage, the players decided upon which role they were to play as and enter the game. Once the players had entered the game, they had 5 minutes to view the map and make a plan for the game session, including what equipment to pick up. Once they were ready, the game timer was started. While the players were playing the game, the manager used his past experience and the guidelines in order to observe the session and took notes of events which could be useful for state 2 and 3 of the CSRL-model. This was done using the manager application as well as the Android game application. During the game session the players were also asked to submit their emotions at the 5, 10 and 15 minute mark of the game, in addition to answering questions at the end of the game session using their devices. These questions along with the players' answers were submitted and revealed to the manager.

At stage two the active players were told to take a rest and that they would have a reflection about the game session in order to improving their performance for the next map. They were also told that they had up to 30 minutes to use for this stage , but it was up to them how long time they wished to use, except the time for mandatory questions.

At stage three the reflection was started by discussing the score that the players estimated and what they actually scored. This was followed up with the rest of the mandatory questions which were supposed to trigger additional discussions. The players responded by giving their opinion and explaining their thought process thus giving information which could not be captured using the manager application. The manager followed up these responses by giving the players his opinion.

At stage four, and after the mandatory questions, the players were allowed to discuss freely. Once the players were satisfied with the discussions they got ready to play the second map of the session. This time between the reflection session and the start of the next game map allowed the players to discuss how to engange the second map, as well as air other thoughts.

At map B, stage one, the player again decided their role and enter the game. Once again they were given 5 minutes where they were allowed to see the map and make a plan for how they wished to engage this game map, including what equipment to pick up.

8.7 Observation method

Besides the manager, we also observed players. One of us remained with the manager and observed the active players using the same tools as him, while the other one was in the field alongside the active players. This was done because during the autumn project we attempted to use two GoPro-cameras to film the players from their point of view. But due to the nature of the game, which caused the players to run and move in rough terrain, the camera kept sliding of position and barely capturing anything useful. In addition, the players reported that it was disturbing their performance due to having to reposition the camera several times. One of the reason why we wanted to capture the game play from this point of view, was to record any issue which could lower the usability of the application. Since we haven't added any new interactable functions, just patching and bug fixing, we didn't equip the players with cameras this time. However for analysis purposes, the player who was out in the field with the players filmed both teams during both maps. Thus the players were filmed during the planning stage of the map, the playing stage of the map and the pause or reflection process between first and second map. However as there was three players and only one observer, filming the entire team was not possible. But by capturing the walkie-talkie conversations, important teamwork and decisions were still recorded.

Chapter 9

Evaluation result

In this chapter we will present the result from the evaluation for team one and team two.

9.1 Team one (with reflection)

Team one is the team which played using the reflection process, thus we will present the information from the reflection process as well as the game sesson data.

9.1.1 General information about equipment, game settings and issues

Volunteer	LG Nexus 4
Medic	HTC One M7
Fire fighter	LG Nexus 4 - Sony Ericsson ST51i

Table 9.1: Phone models used by team one players

The firefighter had issues getting the GPS to work properly on his phone, and after trying to configure his phone for a while, without any improvement, we decided to let him use the Sony Ericsson ST51i which we have been using for testing purposes and knew had few issues with GPS connectivity. This issue occurred while playing the introduction map, so the event had no impact on the score from map A or map B.

Weather conditions	Sunny and overclouded
Panic wave settings	45s between each panic wave
Game ticks	5s between each game ticks
Civilians start state	80 health and 20 panic
Issue experienced	The medic and firefighter sometimes experienced a slow location update on the GPS at map A and two.

Table 9.2: Team one game settings

9.1.2 The introduction and the introduction map

The players were introduced to the game as planned and received the game FAQ (Appendix B). The players used 15 minutes before they were satisfied and table 9.3 show the questions they asked and the answers which we gave.

Question	Answer
Can we be whatever role we want to?	Yes, but you will have to have one of each role. So the team have to decide who plays which role..
Does the items stack?	No, each piece equipment requires one slot, even if they are off same type.
Can you carry multiple equipments of the same type?	Yes, you have three slots and can, if you want, carry 3 medic kits or 2 medic kit and a mega phone, etc.
Is there a cooldown timer on equipment?	No, it requires time to use the equipment, but once its done you can immediately use other.
Can you use multiple equipment at the same time?	No, when you're using equipment you cannot perform another action until it's done.
Does the equipment usage stack? Can multiple player use equipment in the same zone?	Equipment which is used to remove blockades doesn't stack, and the first to complete the equipment usage will remove the blockade, but if there are others who are trying to remove the blockade at the same zone, their equipment will be used as well so don't do this.Items and action that calms and heal the civilians stacks, if two players uses a medkit at the same time, both will affect the civilians and restore 20 health, 10 for each.
Can we start using the equipment and move to the next zone?	No, you have to remain in the zone until the action is complete.
Why does it say that the firefighter is second best at calming when he only require 3 sec and the other require 5 sec?	He's second best as he requires the default 5 seconds, but a 3 second penalty time is added on top, while the volunteer is worst with a default 5 seconds, plus a 5 second penalty. (Physically points out that there is no "+" mark in the text description of the medic, compared to the other two roles).

Table 9.3: Questions from team one before the game session

The introduction map went without any technical difficulties beside the previously mentioned GPS issue for one player, and the action sequence went as following.

1. The firefighter used fire extinguisher at Zone 1. This was done as a group decision after comparing the time needed to remove the blockade between the firefighter and volunteer. The medic also attempted to remove the blockade, but was met with the "Your role cannot remove this blockade" message.

2. The volunteer used fire extinguisher at Zone 2. This decision was taken mostly by the volunteer and the medic as it was here the firefighter had his GPS issue. During the time it took to solve the issue, Zone three "turned red" because of the panic level in the zone.

3. When proceeding to Zone 3 the team realized that they had to return back to the secure camp to pick up new items. They decided to go back as a group as the medic and volunteer wanted to pick up equipment to deal with the civilians.

We also triggered the pause functionality during the introduction map in order to explain to the players what to do when it occured and what it ment, so that they wouldn't be surprised when it happened while playing map A.

9.1.3 Map A

Map A started off with some technical issues with the manager application. A user interface scaling bug was discovered which made it impossible to se all three players if they all were in the secure camp at the same time. An attempt was made to correct this which gave the players a break of about 20 min. Sadly we didn't manage to correct this bug during this time, but decided to continue on with the testing as the players was getting impatient, and because the bug was non critical and would be corrected as soon as a player would leave the secure camp. As there were no other time that the players were all gathered at the secure camp, this bug was only visible at the very start of the game session.

Goal	Save all the civilians
Time spent planning	2 min, 30 seconds (Did not use up the 5 min free time)
Planned strategy	Prioritize calming civilians and removing blockades.Volunteer handle the northern blockades.Firefighter handle the southern blockades. Medic will initially follow the firefighter, but bounce back and forth between north and south depending on where he is needed.
Volunteer starting item	2x fire extinguisher, 1 x megaphone
Medic starting item	2 x megaphone, 1 x meditkit
Firefighter starting item	2x fire extinguisher, 1 x crowbar
Player's movement speed	All players were running
End score	5/47 civilians alive
Connection issues	None

Table 9.4: Team one, map A gameplay info

Although the players were very motivated and set as their goal to save every civilian, they didn't manage to do so in the end. This result was a bit surprising, as the player maintained a running speed throughout the entire game session, which led us to believe they would score better than they did. As the game progressed and new information arrived, the players seemed to ignore much of it and chose to stick with their initial plan and goal. They prioritized zones with highest danger colors, and kept at it even when other zones went into the critical black stage and civilians died off. Their decision making was mostly about where the medic should go, and the remaining was about what equipment to pick up. It wasn't before the very end that they changed their strategy and focused on keeping civilians in just zone 1 alive. This was a forced decision, as by the time the decision was made only zone 1 was left with living civilians.

Regarding communication, the volunteer used the walkie-talkie more and broadcasted more information than the other two players, but this was also due to that the medic was helping the firefighter more and thus they could communicate with each other face-to-face. However the firefighter seemed very reluctant to use the walkie-talkie, which was more visible when the medic went north to help the volunteer. Even now the firefighter was reluctant to update his team mates about the status of the southern zones, which forced the medic and the volunteer to ask the firefighter often throughout the game. A negative part regarding all the players and communication was that they never mentioned the specific amount of civilians in any off the zones. Instead they used words such as "*shitload, many, some*".

We also noticed that the firefighter never asked for any help, although the southern side, in which he had his focus, was in danger of dying first. This caused both the volunteer and the medic to head south for damage control on their own decision, but by the time they could help out, two of the zones was already past the point of redemption. This left the northern zones exposed, which caused the volunteer to panic and he decided to quickly return to the north. As he was alone in the north the civilians here eventually died off as well.This was definitely the critical point off the game, as before the medic and volunteer decided to head south, the north zones which had the most civilians overall were under control. If the team would have decided that the medic and volunteer should remain in the northern part, and abandon the south, the team result would have been much higher.

Some of the negative things which we noted:

- Firefighter didn't broadcast the state of the zones unless asked directly.
- Firefighter was reluctant to ask for help.
- The team didn't take any active team decision, at most they took individual decisions but these decision was taken so that their initial plan would succeed, which in the end caused them to get a bad result.
- There was no sign of re-evaluating their plan during the game.
- There was no sign of prioritizing zones over others, even when it was clear that they would not be able to save everyone.
- Medic and firefighter decided to run back to the secure camp to restock equipment, instead of one remaining in order to keep the zone alive using single actions.
- Volunteer decided to head south on his own, without inquiring the team about the decision.

The players was unsatisfied and frustrated with the result, and blamed the game difficulty and the lack of team members while we were walking toward the room where we had planned to perform the reflection process.

9.1.4 The reflection process

Once map A was done, the players took a break to recover some strength and get some water, giving the manager about 12 min to prepare the reflection session. Once all the players was ready, the reflection session was carried out in a private room as we wanted the players to have privacy during the reflection process. The manager started with the mandatory questions as stated in the guidelines, which started with the estimated civilians alive. The players was quite close with their guess and guessed 6, 6, 5. Their estimation on how many civilians that existed in the map was quite mixed with the three guessing on 30, 70 and 50 civilians in total. This was however not directly used by the manager during the reflection process, he instead tried to provoke a discussion about their strategy and if they had any plan on getting an overview of the state of the map. The players repeated the strategy they used. This was followed up by the manager asking them if they would have done the same again. They all agreed they would, except if they had more players, in which case they would have spent more time in zones instead of running between them.

The manager wanted to know more about their strategy and asked once again if the players had a strategy or if it was more “try and fail” tactic. This time around, the group had different responses, where the medic responded with “try and fail”, which was quickly interrupted by the volunteer who repeated the strategy and added that they would focus on health once the strategy failed. The manager responded “So it was try and fail?”. This provoked the firefighter to speak his mind, but was quickly interrupted before he could finish his sentence by the medic, which again spoke his mind about it being more “try and fail” than a proper strategy. The volunteer and medic settled with it being a 50/50 mix between a proper strategy and “try and fail” approach, leaving the firefighter out of the discussion. The manager was still unsatisfied and followed up by asking them if they could play as they planned, which they responded to with a hesitated “yes”. The firefighter added that they could, at least until the civilians started dying. This made the volunteer elaborate and explain that it worked fine until the pressure got higher, where he forgot the meaning of the color indicators, thinking at first that a black label meant that the civilians was dead, before remembering from the introduction round that it represented the panic level and not the civilians health. This again triggered the firefighter to ask about how to

interpret the health text, if 100 ment dead or fully healed. The volunteer responded that that 0 meant that the civilians was dead, which again triggered the medic to mention that he was also confused on this and used two medic kits on civilians with 100 health, yet he noticed that the zone marker was still red, which was when he realized that the color labels indicated the panic level.

Once the players had responded and the manager was satisfied with the discussion around the strategy he changed the subject and asked the players if they failed due to the physical factor. The players quickly answered no, but was followed by the medic saying perhaps if he had workout clothes instead of jeans and another pair of shoes. The manager then asked if the players failed due to the mental factor, to which again the players answered no. The firefighter had a follow up question, and asked the manager if he meant that they had failed, due to how he used the word failed in his question. The manager responded he meant failed as in how their initial plan didn't work out. The medic jumped in and said that he didn't feel like that they had failed, which the volunteer agreed upon and mention that they did after all manage to save all the civilians in one zone, and that also that if they didn't get confused about color of the zone, they would have managed to save everyone. The medic responded that he didn't think it was possible to save everyone, but that they would have done much better without the confusion, which the firefighter agreed upon, and made a joke about that they failed because they had gotten a bad introduction. The manager responded by asking again if the pressure had any effect on the matter, which the players responded no to.

The manager shifted subject and asked a new question about how the players felt about their team mates effort. The firefighter responded quickly with *"It was suuuuuuuuuuuuuuuper..... bad"*, which was another joke. The medic followed up with stating that the firefighter reported too little, while the volunteer was always reporting in the walkie-talkie. The volunteer also mentioned the lack of communication from the firefighter. The manager followed up by asking if there was anyone who did more than others. The firefighter quickly responded with another joke claiming *"Yes, I did quite more than the other players"*. Then the firefighter stated that the players used about the same amount of effort, which the two other players agreed upon. The firefighter continued with stating that there was some dead time while attempting to get into a

zone, because the GPS didn't update the location quickly enough. The volunteer said he also had this issue once or twice, and the medic also said he had to wait for the GPS to update when entering the secure camp.

The manager then asked if the roles had any impact on the effort used, which the players responded with a hesitated "no" to. The volunteer followed up by adding that since he used double the amount of time using actions and equipment comparing to the medic, he could slack off a bit more while waiting for the action or equipment to be done. The manager followed up and asked if they could have done anything different to balance out the workload, and the players responded that the workload was balanced. The firefighter then asked if they had to be one of each role, which we confirmed that they had to. The medic then made a joke about if they were all playing as a medic, which the firefighter interrupted,and stated that they would have done better with a firefighter and two medics, which he corrected to a volunteer and two medic as he thought the firefighter became useless, once the blockades was removed. This statement triggered a big discussion about the roles, their benefits and so forth, where the medic thought the firefighter role was one of the most important roles, and the volunteer thought it was better than his role. The manager then asked them if they thought there was a balance between physical and mental effort, which they all responded that they thought the game was much more physically demanding.

The manager then changed subject, asking the players on how they felt about the communication. The firefighter responded that he had gotten some bad feedback earlier, which was also mentioned by the volunteer and medic. The volunteer stated that at least two of the players communicated well. The manager then followed up by asking if there was any changes on the communication throughout the various stages of the game, which the medic answered a short no on. The firefighter thought his communication increased as the game played out and the volunteer thought his communication was consistent throughout the game. As another follow up question, the manager asked how important communication is and if they changed their opinion on the matter during the various stages of the game. The medic took the lead and stated that communication was important as they needed to know the state of zones as well as what their teammates planned to do next. The firefighter had a bit different opinion and stated that

communication wasn't important at the beginning as they had a plan, and it was first important later on the game.

The manager then changed the subject to decision making, asking the players what factor they tock in mind when making decisions. The medic answered intuition, the volunteer answered stomach feeling, and the firefighter answered statistics. The response from the firefighter made the volunteer and medic ponder, before understanding it was another joke. The firefighter then stated the situation of the zone and where he could save the most, but now that they are more familiar with the game concept, it will be easier to perform better. The medic agreed and stated that they should let some civilians die so they could save more and the firefighter stated that they should just focus on the closes zones and make sure those make it. The volunteer stated that it would be impossible to save everyone when they are only 3, which the firefighter agreed upon and stated they had to prioritize, and also stated that this is also something which also have to be done in the real world. The medic agreed on the firefighter reasons, but added they should focus on where there are most people, but also consider the distance between the zones and the secure zone. The volunteer added they should perhaps focus on the area which has most zones close to each other.

As a followup question, the manager asked if the players would have done it better if they had more information about the situation in the game, which the players answered a yes to. The manager then asked if the decisions would have been taken differently if they had more time to think. This question split the group and the firefighter instantly answered "no", while the volunteer and medic reasoned that if they had more time, then perhaps. The firefighter then said they had enough time before the game started due to the waiting time, and didn't need any more. The volunteer disagreed and thought they would have done it better with more time. The medic then stated that they had enought time to plan, but once they were playing, the civilians died too fast, which caused quick decisions. The volunteer agreed, while the firefighter stood his ground on his previous answer.

The manager then shifted subject to emotion, and asked the players how their feeling affected their performance. The group initially joked about the question saying their feelings got hurt when civilians died. Eventually they agreed that their performance wasn't affected by their

feelings. The manager followed up by asking if there was anything they could do to control their feelings, which again sparked some joking responses before implying that it was a non-issue.

The manager then changed subject, and asked the players about three things which they thought they did well. The volunteer responded that the initial plan on how to unlock the zone was good. The medic added that at least they managed to save 5 civilians. The players struggled to give a third answered, and after a while the firefighter added that they had a good cardio workout. The manager then asked what three things they thought they could have done better. The medic stated that they could have had a better strategy, the firefighter stated that they could have saved more civilians, and the volunteer stated more communication.

As the last part of the reflection process, the manager explained to the players that he would give them some feedback about their performance from his point of view. The firefighter was skeptical and quickly questioned if these feedback was just based on him watching the screen. The manager answered that he had been listening to them using the walkie talkie, kept track of them using the game application and used the manager application. The answer removed the firefighter skepticism, and the manager continued.

The manager started of with communication, and praised the volunteer for having good communication, especially since he kept informing the other once he had removed a blockade. He then continued to praise the teamwork between the volunteer and the medic at the start of the game session. He then commended the firefighter for asking for help once the panic was starting to get high at zones. A negative feedback was that the communication got worse and worse as the civilians kept dying, but since he couldn't listen into the face-to-face communication and that the players was clumped together toward the end, he wasn't sure if the players was just communicating face-to-face. The players responded that it was mostly face-to-face communication toward the end, as they were either in the secure camp or zone 1 to keep the civilians there alive, making face-to-face communication better. The manager then changed the subject to decision making, and commented on the firefighter choice on using a fire extinguisher instead of the firehose. The volunteer interrupted and commented he used the firehose at his side of the map, and didn't have to return to the secure camp. The firefighter struggled to remember the exact situation, but recalled that it required more time to use than the fire extinguisher

and explained that he didn't have time to wait that long. The game FAQ was again given to the players, so they could re-read the description of the firehose.

The manager continued with complimenting the medic's decision on picking up several megaphones and head to the volunteers location once the volunteer reported high panic level at zone 6. He also complimented teamwork of the volunteer and the firefighter at the end, where the firefighter only picked up megaphones while the volunteer only picked up medic kits and worked together to save the last zone.

The manager then neutrally commented on how the players prioritised the zones which had higher panic color without indicating if it was a praise or a negative feedback. This caused the players to again discuss how they were confused about the color indication at the beginning, and ended with the volunteer explaining to the other plays how the color labels work, to make sure that everyone understood it for the next round. At the end, the manager remember a communication event, where the volunteer was asking about the situation in zone 3, and didn't get any response. The firefighter reasoned that he most likely replied to this face-to-face, but the manager commented that the volunteer was at the other side of the map, making face-to-face communication impossible. The firefighter then stated it must have been later on in the game then, as he remember telling the volunteer about it when running past each other.

9.1.5 Map B

Role switches?	None
Goal	Save as many civilians as possible.
Planning time	3 min, 26 seconds (Did not use up the 5 min free time)
Planned strategy	Focus only on zone 1 to 4.Volunteer handle zone 1 and 4, Firefighter handle zone 2 and 3. Medic helps volunteer at start and bounces between helping the firefighter and volunteer when needed.
Volunteer starting item	1 x fire extinguisher, 1 x crowbar, 1x megaphone
Medic starting item	3x megaphone
Firefighter starting item	2x fire extinguisher, 1 x crowbar
Player's movement speed	All players were running
End score	14/47
Connection issues	None

Table 9.5: Team one, map B gameplay info

The players played as they had planned except during one occasion were the volunteer decided to prioritize zone 4 over zone 1 when he had established an overview of number of civilians in both zones. This was a decision he broadcasted over the walkie-talkie, while also mentioning the specific number of civilians. The medic agreed upon this decision, while the firefighter gave no response. About halfway through the game session, the other zones were under control so the medic decided to prioritize zone 1 again and convinced the volunteer to do so as well. The volunteer decided to restore the civilians health to full, but did nothing to the panic levels. This decision caused zone 4 to enter a red stage, causing the volunteer to call for help over the walkie-talkie. The medic responded and decided to move to zone 4 to help the volunteer, letting the firefighter deal with zone 2 and 3 alone. This caused zone 3 to enter the red stage, but the firefighter remained confident that he could cover these two zones alone. The medic disagreed with the firefighter, and decided to shift his focus back to zone 2 and 3, a decision which the volunteer agreed to. This again caused zone 4 to enter a red stage, and the firefighter decided to head over to help the volunteer out. Zone 1 was again not prioritized, and by the time the volunteer could spare some time, the civilians died while he was waiting for the megaphone equipment usage to complete.

Some of the negative things which we noted:

- The players never planned to establish a proper overview of the game map
- The volunteer wanted to go check the other zones furthest away from the secure camp after unlocking zone 1 and 4, but the medic told him to not prioritize them

This was the improvements we noted, compared to map A:

- The players broadcasted info more often and had more detailed information about the zones.
- Decisions was more often broadcasted and discussed over the walkie-talkie so everyone could contribute with their own opinion.

- The players prioritized, although we didn't really like how they decided to do so.
- The players were less stressed.
- The volunteer and medic broadcasted when they needed help.

The players was semi-happy about the result. They were pleased that they did it better than last time, but also annoyed that they lost zone 1 so close to the ending of the game.

9.1.6 Other feedback

At the end of the session, we had a little debriefing where the players could express whatever they wanted.

Regarding the android application, the players gave the following feedback:

- It was annoying to have to tap the screen multiple times to close all the dialog windows. For example on map B, when you ran pass zone 1 to zone 4, you had to tap the screen 3 times to first remove the "you have entered zone 4", then "you have left zone 1" and then "you have entered zone 1".
- The pauses were really annoying and took the focus away from the game.
- It was annoying when the GPS didn't work properly. Perhaps use another technology which is more reliable.
- It was not clear enough that the color of the zone represented the panic level.
- Have a different color indication for zone which only contain dead civilians.
- An itemlist which can be used to check what items a player was carrying outside of the safety zone could be useful.
- The civilians died too fast, which made it too difficult.
- Not enough time to think properly because civilians died too fast.
- To not be able to save everyone was demotivating.

Regarding the manager application:

- Listening on communication via walkie-talkies was the best way to gather information.
- Manager application provided information which the other tools didn't, but the manager found himself keeping an eye on the game application to track the players more than he used the manager application.
- A suggestion was to integrate everything into the map, so that the information provided by the manager application would show up directly in the map

9.2 Team two

Team two played without the reflection process and was instead given a break/pause between map A and map B. The pause could last up to 30 min, and the players was given the option to continue to map B, whenever they wanted. For discussion and comparison purposes, the content of the pause and the map session will be presented in this section.

9.2.1 General information about equipment, game settings and issues

Volunteer	Sony Ericsson ST51i
Medic	Samsung Galaxy S3 Mini
Fire fighter	HTC One M7

Table 9.6: Phone models used by team two players

The medics regular phone was an iPhone, and thus borrowed the Sony Ericsson for the purpose of this test.

Weather condition	Overclouded
Panic wave settings	45s between each panic wave
Game ticks	5s between each panic wave
Civilians start state	80 health and 20 panic
Issue experienced	The firefighter had two disconnection during map B. Players had some minor issue with GPS not updating fast enough.

Table 9.7: Team two game settings

9.2.2 The introduction and the introduction map

Just as team one, the players were introduced to the game as planned and received the game FAQ. Due to one of the players being late, the two other players used 20 minutes while he used 15 minutes before being being done. The following questions were asked.

Question asked	**Answers given**
Do we have to be one of each role?	Yes
How long does it take for the firefighter to remove blockades?	10 second when removing using fire extinguisher or crowbar, while 30 second while using the firehose.
What is the difference between a firehose and a fire extinguisher?	fire extinguisher is an item which you are carrying with you, while a firehose is an item which exist in the zone. If you use the fire extinguisher, the item is consumed. If you leave the zone, the firehose remains at the zone.
Can you carry more of the same item?	Yes, up to 3.

Table 9.8: Questions from team one before the game session

The introduction map went without any major issue, however when walking from inside the building and out toward the starting zone, two players lost their connection to the server. Once the players were at the secure zone and started their mission, there were no issues with the connectivity or the GPS. The action sequence went as following:

1. The firefighter used a fire extinguisher at zone 1. This was done as a group decision after comparing the time needed to remove the blockade between the firefighter and the volunteer. The medic was also instructed to try to remove the blockade, just to make sure that he medic understood that his role could not remove blockades.

2. The volunteer used a fire extinguisher at zone 2. This decision was also taken as a team decision after comparing the time needed to use a fire extinguisher and a firehose.

3. When proceeding to zone 3, the team realized that they didn't have the needed item, and had to return to the secure camp. The group went back together, to restock equipment and to get the last fire extinguisher they needed.

The players was told about the pause functionality, and that they should just remain still and didn't need to fill in their emotion for the purpose of the introduction.

9.2.3 Map A

Goal	Save all the civilians
Planning time	6 minutes, 10 seconds (Timers was started 5 minutes into the planning)
Planned strategy	Their initial plan was to go to the zone with the worse state, but they quickly realized that all the zones were green at the start of the game. Thus they changed the strategy to head north as a team, remove all blockades, calm and heal the civilians and then head south. They also decided in advance to use a firehose instead of a fire extinguisher if any zones had a firehose available
Volunteer starting item	1 x fire extinguisher, 1 x megaphone, 1x crowbar
Medic starting item	2 x meditkit, 1 x megaphone
Firefighter starting item	2x megaphone, 1 x fire extinguisher
Player's movement speed	All players were running
End score	13/47 civilians alive
Connection issues	None

Table 9.9: Team two, map A gameplay info

The team started with a goal to save all the civilians and held a running speed while moving between zones. Their initiale plan surprised us a bit, as the group decided to stay quite grouped during the first third of the game. However once zones started to shift color indication, the players decided to split up and cover different zones and prioritized zones with the highest panic indication. Once the two first zones went into black color indication and died off, the players re-evaluated their strategy and decided to let the firefighter handle zone 1 while the medic and volunteer took care of zone 6. These two zones was selected without much discussion as they was closest to the player and the secure camp. Regarding communication, the players seemed to prefer to communicate face-to-face, which sometimes ended up with them shouting at each others instead of using walkie-talkies. However the players often reported to each other where they were going next using the walkie-talkie to ensure that all the team members got this information, as well as coordinating item usage if multiple players were at the same zone. Unlike team one, the team often stopped up completely and discussed what to do next. This may be a result of the grouped style of playing they decided upon.

This was the following negative things which we noted:

- When two players were physically close to each other, they could decide to take a "team"

decision and just broadcast the conclusion of the discussion to those who were far away.

- Some discussion got sidetracked/lengthened due to the firefighter's strong opinion.
- The firefighter got unsure about some game elements, such as how to read the panic level and the color indication when the pressure was high.
- The medic had to keep track of the game state and communicate it through the walkie-talkie to the other players.
- The players didn't seem to communicate anything regarding the amount of civilians in a zone.
- It was mostly the medic who kept track of the game state and broadcasted it to the other players.

The end score was 13 civilians alive out of 47. This was a result which the players had a mixed feeling about, but they settled with that it was a good score.

9.2.4 Player discussion during the pause between sessions

The medic started the discussion regarding the use of walkie-talkie. He stated that he thought it was better and easier to have a face-to-face communication when they were close by, which the firefighter agreed to, but stated this was because they didn't specify whom they were speaking to when using the walkie-talkie. The volunteer agreed, and thought that they should be more specific when communicating over the walkie-talkie. The volunteer then change subject to delegation of resources, where he thought that the players had to split up more, but also that there were situations where they had to be two players at the same zone. The medic which was unsatisfied with the brief communication discussion changed the subject back and told the other players that he thought it was important that when a player arrives to a zone, that the person would broadcast the state of the zone as well as the number of civilians. The discussion then changed focus into the game elements, such as role benefits, limits, and how to handle panic. This discussion revealed that the firefighter and the volunteer had events where they got confused due to how the health and panic description is used. As the discussion started to sidetrack

to none game or crisis relevant topic already after 8 min, we and the players decided to play map B.

9.2.5 Map B

Role switches?	None
Goal	Save as many civilians as possible.
Planning time	5 min, 10 seconds (Timers started at 5 min into the planning stage)
Planned strategy	Big disagreement on strategy. The team ended up with prioritize the unlocking and full calming and healing of the civilians at zone 1 to 4. Afterwards the other zones was to be unlocked and dealt with.
Volunteer starting item	2 x crowbar, 1x fire extinguisher
Medic starting item	2x megaphone, 1 x medic kit
Firefighter starting item	2x fire extinguisher, 1 x crowbar
Players movement speed	All players were running
End score	11/47
Connection issues	The firefighter lost connection to the server twice at zone 2, this caused the firefighter to be out of the game for a total of 25 seconds

Table 9.10: Team two, map B gameplay info

After seeing the map, the first thing the players noticed was the long distance between the the secure camp and zone 5,6,7. The volunteer however, stated that although the distance is longer, due to how the secure camp is placed, it will be easier to stay close and communicate. The medic agreed and together with the volunteer they wanted to split the duty of removing the blockade giving the west side to one and the east side to another. The firefighter disagreed and thought that they should just prioritize zone 1, 2 and 3 since the other zones were so far away. The volunteer stated if they were going to prioritize that way, zone 4 should also be included. The medic however, disagreed and stated that it would be better to unlock the zones first and get an overview before deciding which zones to prioritize. The firefighter then stated that they should prioritize the closest zones first, restoring their health and reducing their panic, then if the zone was under control, they could head out to the zone farther away. Before the medic could jump in the discussion, the firefighter continued by asking the other players about how long time it took them to use single action. The players repeated the time it took for their role to use the single action, which made the firefighter conclude that it was a waste of time to use

these actions and that they should prioritize equipment instead. The volunteer disagreed and said it was better to use a single action to calm down civilians if they were on the verge of dying as the time difference between using a equipment or using a single action would be critical. As the time started to run out, the player shifted focus to which equipment they should pick up.

Once the game started the players played using their strategy, where they choose to send the firefighter and the medic to the west side to handle zone 1 and 4, while the volunteer took the right side. Once discovering the number of civilians in zone 1, the firefighter wanted them to un-prioritize it, but the medic disagreed. The medic bounced between the right and left side of the map to the zones closest to the secure camp, in order to aid in calming and healing the civilians in these zones. On the right side, the volunteer wanted the medic to focus on zone 2, as there were more civilians in that zone than in zone 3. Once the players had zones 2, 3 and 4 under control the players decided to proceed to the outer zones, agreeing to not prioritize zone 1. However by the time they got to zone 5, 6 and 7, the zones where already lost, which caused the team to focus on zones 2, 3 and 4. The firefighter and the medic went to zone 4, leaving the two other zones to the volunteer. This caused zone 3 to enter a critical stage and eventually die off before any help could arrive. During the game session we noticed more disagreement between the team members, especially the medic and the firefighter.

This was the following negative things which we noted:

- The firefighter took the final decision on the strategy alone.
- The medic and firefighter disagreeing on what to do with zone 1.
- The team communicated the amount of civilians in the first two unlocked zones, but after that, they stopped reporting numbers.
- The communication started to break apart towards the end of the game due to physical exhaustion.
- The players never unlocked zone 6 or 7, thus the team never got a complete overview of the game map.

- Making the volunteer, who uses the longest amount of time to calm civilians, to handle two zones while using both the firefighter and medic to handle a single zone.
- Just as in map A, the player preferred to take team discussion and decision through face-to-face communication, which again caused some decisions to be taken by only 2 players. But unlike on map A, the conclusion of the decision wasn't broadcasted to the player who was away from the other two.

This was the improvements we noted, compared to map A:

- The firefighter and volunteer had a clear split of zones which they were responsible for unlocking.
- The firefighter wanted to continue on to the next zone, after unlocking zone 1 and discovering the low amount of civilians
- The strategy was quite interesting and would perhaps have worked, if the medic would have stopped prioritizing zone 1 as the firefighter requested, and the team had dropped calming and restoring health completely before heading to the outer zones.
- The players had a clear plan on when to use single action and when to use equipment instead

9.2.6 Other feedback

At the end of the session, we had a little debriefing where the players could express whatever they wanted. As this team didn't utilize the reflection process, the feedback was all about the game application.

This was the following feedback we got:

- Dialog windows as an alert for exiting a zone could be to much. It was especially in the events where a player ran pass a zone due to it was unprioritized, it was quite annoying.

- Perhaps use vibration as a message of entering zones since its hard to keep watching the phone while running fast.
- Would be nice with more color indication on the zone, so that it would be easier to take proper decisions. It was especially between red->black the player wanted another color level.
- Show the item which are carried in the backpack. Make it easier to know when to return to the secure camp.
- Change the civilian description so that 100 means the same for panic and health, player was confused that 100 in health was positive, while 100 in panic was negative.

Chapter 10

Result discussion

In this chapter we will discuss the result gathered from the evaluation, as well as disussing the research questions. Section 10.1 is directed to RQ1 and section 10.2 is directed to RQ2.

10.1 Discussion - Don't Panic Renewed as an alternative tool for learning crisis management

The learning benefit of the game is quite hard to measure, as we don't have any way to test if the players soft crisis management skills have increased or not. Instead we are reliant on observation of game events and the participants own opinion whether the game can be used as a teaching tool. Thus we will go through various aspect of the game, starting with if it succeeds as a serious game, before moving to crisis management skills. Based on the pre-game questionnaire answers, we havent found any signficant difference in the players ability or motivation which could impact the score, thus it won't be included in the discussions.

10.1.1 Game engagement

As a serious game, it was important that the game was perceived as fun/engaging for the players. This wasn't without challenges, as the game concept require us to place the player under physical and mental pressure. According to the players answers, team one found the game less stressful than team two, with an average score of 6,3, while team two had an average score of

	Team 1					**Team 2**			
Questions	V	M	F	AVG		V	M	F	AVG
The game was stressful	7	5	7	6,3		10	9	9	9,7
The game was engaging	10	8	9	9		10	10	9	9,6

Table 10.1: Players' rating of game engagement

9,7. However, when looking at the questionnaire result regarding the game's engagement, both teams rated it quite high with avg score of 9 for team one, and avg score of 9,6 for team two. We consider both scores extremely good, and had expected a lower result due to the stressful nature of the game. When observing the active players, both team seemed very engaged, both team held a running speed the entire game duration and gave sign of frustration and anger when failing to save civilians. We were quite surprised that all the players decided to keep a running speed the entire game session during both maps, as the test was done during normal school hours and all the participants was to resume school work once the test was done. So based on observing the active players and by the score on their questionnaire, we are quite sure that the game was very engaging.

10.1.2 Game usability

	Team 1					**Team 2**			
Questions	V	M	F	AVG		V	M	F	AVG
The game concept was easy to understand	10	5	7	7,3		8	7	7	7,3
The application was easy to use	9	6	5	6,3		8	9	4	7
SUS score	82,5	50	52,5	65		80	82,5	57,5	73,3
External factors (Weather/GPS/Network) had a negative effect on my enjoyment	1	8	6	5		1	4	6	3,7
The pauses had a positive impact on the usability of the application	2	2	2	2		8	10	3	8
The pauses made me more engaged with the game	1	1	1	1		5	10	3	6

Table 10.2: Players' rating of game usability

As an application, it's important for us that it has good usability, but getting a great usability can also be in conflict with the game concept. E.g Team one wanted another color than green for

zones which only contains dead civilians, as it would be easier to notice the difference between a zone with low panic and a zone with only dead civilians. However by keeping the same color for both situations, it requires that the players need to keep the game state in mind, as well as communicate more to keep that state updated. This is one of the few game designs choices which are meant to place more mental demand on the players, but at the cost of usability. When looking at the questionnaire result of how easy the game concept was to understand, the avg score for both team one and team two was 7,3. When considering the complexity of the game with different roles, equipment, benefit, limitation, etc, we are quite happy with that score, but think it can be improved by changing the introduction process to include more detail about zones and perhaps restructure the current game FAQ.

When looking at the application's ease of use, team one gave an average score of 6,3 while team two gave an average score of 7. This match quite well with the score from the SUS questionnaire where team one had an average score of 65 and team two had an average score of 73,3. Both ratings were quite split within both teams, and the score given seems related to questions regarding external factors as well as game pauses. At both teams, players who rated the usability lowest, also rated the question regarding if pauses had a positive impact on the usability of the application quite low. Especially team one found the pauses very disturbing, which is reflected in the score of the questionnaire as well as in observation. During the game sessions and after the game session, players vocally expressed their hate toward the function and strongly recommended the removal of it. The question regarding if the pauses had a positive impact on the usability of the application scored a low 2, and the question regarding if the pauses made them more engaged with the game, scored a bottom low 1. Team two overall had a less negative attitude toward the pauses, rating the questions if the pauses had a positive impact on the application with an 7, where only the firefighter rate it negatively. And the question regarding if the pauses made the players more engaged with the game scored a 6, where once again the firefighter rated it negative while the volunteer rated it neutral. We think the difference in attitude toward the pause functionality is caused by a combination of personality, physical condition and mental effort. Unlike members of team one, members of team two didn't have any angry outbursts during the pauses, instead most of them either used the pause as a chance to dis-

cuss or relax/recover. However, unlike team one, team two didn't have to submit their emotion, which gave them more "free time". This could also have affected the difference in the attitude, but if we look at the firefighter rating at team two, he was also quite negative to the use of pauses even if he didn't have to submit his emotions. Thus we are leaning more toward the first hypothesis, which fit the observation of team two. Thus a possible way to increase the usability would be to remove the pause functionality, which would also remove our way to gather emotions. This is a tradeoff which we don't think is smart to take, as the potential usefullness of the emotion data, far outweight the potential increase in usability.

In addition when looking at the question regarding if external factor had a negative effect on the players enjoyment, the same players rated it high. This we think can be traced to the issue with the slow GPS location update for team one, and the firefighter disconnection in team two. These two issue has been focused on quite much during the master thesis, but yet we cannot guarantee a 100% stability or 100% on time GPS location update due to the technology used. We will discuss this more in length in 11.2. However, the feedback from the users also reveals issues which are possible to improve without being constricted by the technology or the game concept, which we think if fixed, would increase the usability ratings. But even with a rating of 6, 3 and 7, which we consider slightly positive, when observing the players playing the game, both teams seemed to enjoy the game as well as handling the application quite well. Thus we think that the usability of the application as is, is good enough for its purpose, but that it can be improved as well.

10.1.3 Decision making and prioritization

	Team 1					**Team 2**			
Questions	V	M	F	AVG		V	M	F	AVG
My decision making skills were challenged	7	3	4	4,6		7	8	9	8
My prioritization skills were challenged	8	4	10	7,3		10	9	9	9,3
By playing the game one can train their ability to make decisions better	7	4	4	5		10	10	9	9,7
By playing the game one can train their ability to prioritize better.	7	7	9	7,7		10	9	9	9,3

Table 10.3: Players' rating of the game's effect on decision making

As we have mention earlier, we consider prioritization as a part of of decision making, but also a special case of decision making as it is not a necessary factor in all decisions. Since we were worried that the players might not consider prioritization when answering the question regarding decision making, we included prioritization as its own questions, which in retrospect was quite good, as it seemed that the players found it harder to prioritize than taking decisions.

Starting with team one and the question if the players decision making skills were challenged, the average result was slightly negative with a rating on 4,6 with only the volunteer giving a positive rating. The negative rating somewhat matches with our observation, as in that the players didn't show any sign of active team decision making during map A, and although improved on map B, it was significantly reduced amount of decisions which had to be taken during the game session due to their strategy of just prioritizing zone 1,2,3 and 4. When looking at the question regarding if the players think the game can be used to train one's ability to make better decisions, the avg score ended on a neutral score of 5. Yet again, it was only the volunteer who rated it positive. This is definitely not a score which we are happy about, as decision making is an important skill and also a big part of the game concept. However, when looking at the question regarding if the players prioritization skills was challenged, the avg score was 7,3 with only the medic giving a negative score. Based on observation, there wasn't more prioritization than other type of decision making, yet the score between the questions are quite large. We think this is becuase the players realized the importance of prioritization and decided to put it to use in a way which suited their play style the best, which was to make a static plan which would allow them to follow the plan throughout the entire game, avoiding the need to make big decisions. With the team focus on prioritization, the question regarding if the game could be used to train ones prioritization skills also scored high, with an av score of 7,7. Although we think these scores are good, we are not pleased with how the team prioritized, which we will discuss later in 10.2.2.

As discussed earlier, team two's playstyle differed from team one, and instead of acting fast, they sometimes stopped moving at all to discuss and take decisions as a group. This is reflected well in the questionnaire results, starting with the question about if the players decision making skills were challenged. The question scored an average score of 8, which seemed reasonable with the observation. We had thought it would be a bit higher due to how decisions making got

more challenging at map B due to disagreement and such, creating even more pressure when taking these decisions, however 8 is still quite a strong score which we are happy with. Moving to the question regarding if the player thought that the game could be used to train one's ability to take better decisions, the avg score was 9,7 which is almost as high as it can be. We think the difference in score between the previous question and this, was due to the disagreement which perhaps reduced the potential in the quality and quantity of decision which they took at map B compared to what they wanted to do. When looking at question regarding if the players prioritization skills was challenged and the question regarding if the game could be used to train ones prioritization skills, both scored high with an average score of 9,3.

It's clear that both teams are positive regarding the use of the application to improve prioritize skills, however at different levels. When looking at decision making, the result is more split, with team one being slightly negative while team two being very positive. This can be traced to the teams play style, where a dynamic play style will give more challenge as well as many more event which require prioritization and decision making. Thus the amount of learning benefit regarding decision making and prioritization heavily depends on how the players decide to play the game.

10.1.4 Communication

	Team 1					**Team 2**			
Questions	V	M	F	AVG		V	M	F	AVG
My communication skills were challenged	8	4	8	6,7		10	9	9	9,3
By playing the game one can train their ability to communicate better	7	7	9	7,7		10	10	9	9,7

Table 10.4: Players rating of the game's effect on communication

Starting with team one and the question about if the players communication skill was challenged, the players gave it an average score of 6,7 where only the medic gave it a negative rating. We are surprised that the medic rated it negative, as communication was a factor which we found lacking in team one, even if it improved from map A to map B. When looking at the question about if the player thought the game could be used to train one's communication skill, it scored an average score of 7,7. The difference between the scores could indicate that the players

thought that their communication was good enough, and thus wasn't as challenging as it could be for those who has lesser communication skill.

Moving to team two and the first question about if the players communication skill was challenged, the players gave it an average score of 9,3, a much higher score than team one, even thought we observed more communication from team two. On the question regarding if the players thought the game could be used to train one's communication skill, it scored 9,7, which also is higher than team one. The difference in score is again most likely caused by the different playstyle, which we discussed in 10.1.3. The scores indicate that even with a static playstyle, most of the playesr felt that their communication skills was challenged and had a positive view on using the game as a teaching tool in relation to communication. While those with a dynamic playstyle was very positive to both. Thus we are positive to the communication learning potential by playing the game, but at the same time also worried about the possibility of players not recognizing the importance of communication due to playstyle.

10.1.5 Pressure handling

	Team 1					**Team 2**			
Questions	V	M	F	AVG		V	M	F	AVG
How well do you handle stress/pressure?	9	7	8	8		5	7	6	6
The game was stressful	7	5	7	6,3		10	9	9	9,3
I have a better understanding of my limits while being pushed physically and mentally by playing the game	6	6	3	5		9	10	9	9,3
By playing the game one can train their ability to handle pressure better	6	6	8	6,7		10	10	9	9,7

Table 10.5: Players' rating of the game's effect on pressure

Starting with team one, the pre-game questionnaire shows that the players rated their stress and pressure handling quite high, with an average rating of 8. When looking at the question regarding if the game was stressful, the players rated it 6,3. With a high pressure handling skills, it's not strange that the game is percepted less stressful, but in this case we are doubting the players ability to handle the pressure due to our observations. During map A, the players didn't re-plan their strategy or take any active decisions as new information arrived and instead uti-

lized more physical effort as a reaction to the increasing pressure. We believe this experience highly contributed to the strategy which they ended up with for map B, as it removed much of the pressure from the game. Sadly when looking at the questionnaire regarding if the players have a better understanding of their limits while being pressed, the question scored avg 5, with the firefighter rating it negative. This indicate that the players aren't able to recognize how the pressure is actually affecting their ability and choice of action, by just playing the game. Even so, according to the questionnaire the players seems slightly positive to the use of the application to train pressure handling ability as they rate it 6,7.

Team two pre-game questionnaire reveals that the players was more pessimistic of their pressure handling abilities as they rated it 6. When looking at the question regarding if the game was stressful, the players rated it 9,3. With a low pressure handling abilities, its natural to experience the game as more stressful, which in this case seems correct. Although we thought team two pressure handling was superior compared to team one, there was several game events which indicated that the team struggled with the pressure, where the most obvious was perhaps the decision making event which left the volunteer with too much responsibility as discussed in 9.2.5. Unlike team one, the players seemed to think that they gained a better awareness of their limits while being pressured as they rated the question 9,3. The players was also more positive on the question about the use of the game to train one's ability to handle pressure better, giving it a score on 9,7.

Again, there is a big difference between team one and team two, which we think is caused by the players personality which we will discuss in 10.2.6. The result so far, indicate that the game has potential as a learning tool which allows the players to train their pressure handling abilities, as well as getting a better understanding of their limits while being under pressure, but it heavily depends on the personality of the person. For players such as members of team one, the game might not be able to accomplish these task.

10.1.6 Summary

As a serious game, it was important for us that the players experienced the game as fun/engaging, and judging by the questionnaire score and observations, the players did find the game very fun/engaging. We were especially surprised over the physical effort the players put into the

game, and that all players beside one, ended up using more physical effort than what they were initially willing to do simply because they desired to rescue as many civilians as possible. We placed no pressure on the players to use more effort than they wanted, and even told them that using walking-speed is ok, and there was no team discussion regarding the lack of effort from any team members on either team, beside the desire of more communication from the fire-fighter at team one. What more was that the evaluation was done during school hours, so that the participants were wearing their normal clothes, meaning jeans and sweater or t-shirt, and by the end of the map B, both teams were covered in sweat. This we take as a good sign, as the players were clearly so immersed with the game, that they didn't bother to worry or act on the worry about having to remain in school for the rest of the day in sweaty clothes.

Another important requirement of a serious game is usability, which with the game concept and technology used is hard to gain top score on. However the result shows an above average SUS score, and the observation of the players showed that the players could perform their desired actions, although there could be some minor delay sometimes depending on the GPS speed or the need to close dialog windows. The feedback from the players indicate that by removing the pause & emotion gathering function, the usability would be higher, but as it's an important function for the reflection process and that the SUS score is high enough, we think it's better to keep it than to remove it. The prototype is also considerable more stable than the last version, with only one person experiencing a disconnect from the server with minimal down-time. With the use of mobile network, we cannot guarantee a 100% uptime which we will discuss in 11.4, but with the recovery functionality the game has, the player will only have to restart the application to continue the game with the same game state, including equipments in the back-pack, which he had before the disconnection. For larger issues, there are also safety measurse from the server side, giving the possibility to manually pause the game session for all players for an unlimited desired time.

The last part and the reason for the existence of the game application in the first place, is the learning. The evaluation result was quite different due to the different playstyles of the two teams, but in both cases the players was generally positive to the use of the game to learn crisis management skills. The main difference was in what degree the players found it useful, where

team one which had a physical dominating play style, gave an average score between 6-8 on question regarding training of decision making, prioritization, pressure handling and communication using the application. While team two, which had a balance of physical and mental playstyle, rated the same questions with an average score between 9-10. With the observation done during the game session, we definitely agree with the difference in score, as team one utilized prioritization and decision making mostly at the planning stage, and only made minor decisions/priorizations during the game. Team two, also used the planning stage to take big decisions and prioritization, but unlike team one, they also made big decisions/priorizations during the game as new information arrived. The difference in playstyle, gave team two more challenges and more opportunity to practise crisis management skills, which we believe is the main reason for the difference in the score. Thus the difference in playstyle reveals two things, firstly that the players thins the game can be used to learn crisis management skills no matter if they play using a static and physically dominated play style, or with a dynamic and physically and mentally balanced playstyle. Secondly, that the learning benefit is higher when playing with a dynamical and a balanced physical and mental playstyle.

10.2 Discussion - benefit of using a reflection process

In this section, we will discuss the impact the reflection process have had on the players by looking at the questionnaire result, our observations notes and comparison between team one and two.

10.2.1 Comparison of team one and team two

If we are to compare the score development on team one and team two, it's clear that team one had a better growth in result, as team one scored a higher score than team two at map B, and also that team two scored a lower score than themselves at map A. Although the reflection process revealed that the players in team one were confused about the color indication and the health text during map A, which could be interpreted that it was the better understanding of the game element which contributed to the increased score. The discussion which team two had during the pause also revealed that the players had some confusion about the health and panic description, as well as the color indication during map A. If this was truly was the factor which cause the difference in the score, it would be more likely that both team would have had a similar score at map A, as well as a similar score development. This was not the case, and by looking at the teams play style we are pretty sure that neither game understanding or learning speed had anything to do with the difference in score. While team one had an improved teamwork, decision making and communication at map B compared to map A. Team two struggled with maintaining the teamwork, communication and decision making they had utilized in map A, however unlike team one, team two showed a good utilization of proper prioritization at both maps. We are not sure what caused the negative trend on team two, but perhaps there was some unresolved issue from map A, which was not brought up during their discussion and thus impacted their performance during map B. Unlike the reflection process used by team one, the discussion session used by team two had no structure and it was up to the players to trigger discussions themselves, which meant that they had to bring forth subjects which may be uncomfortable, such as negative feedback to team mates. This theory could explain the absence of uncomfortable topics in their discussions, which again could indicate that the reflection process at least improved the quality of the discussion. To investigate if the reflection process aided team one

or not, we will go through each factor which we believe is important to perform well in the game as well as in a real crisis situation.

10.2.2 Reflection process and team one prioritization

Team one had a major improvement in score between map A, and map B. As the physical effort remained the same for both maps, this factor should not have affected the score outcome. Map A was also less physically demanding because of the central position of the secure camp. Instead it was most likely other factors such as the change of goal. At the first map, their goal was to save every single civilian, but at the second map, their goal had changed to save more than at the first round. This was most likely due to the revelation of the lack of resources to save every zone in map A. This was something which the medic and firefighter understood by analyzing the game session on their own before entering the reflection process, but the magnitude of the importance of prioritization was not as clear, nor how prioritization should occur. It seemed like it was not until the reflection process, the volunteer also realized that they lacked the resources needed to save every civilian in map A. Prioritization was a repeated topic throughout the reflection process, but it was first when the manager asked the players on how the players took decisions that the discussion sidetracked and lead to a meaningful discussion about prioritization. We found it quite interesting that the firefighter drew a connection between the need of prioritizing to a real world crisis situation, as there had been no triggers nor was there any triggers regarding the game concept and the tie to the real world. Although the players considered all the elements which we thought was important during their discussion on how to prioritize, we were a bit disappointed by how they decided to prioritize during map B. As we described in section 9.1.5, the volunteer and firefighter decided on a strategy where the team was to only prioritize zone 1-4, leaving the rest to die. This was decided only by considering the distance between the zones and the secure camp, and that they were only 3 players. This strategy was in our opinion a cheap way out, which reduced the pressure and the required mental effort considerably. By prioritizing the zone without considering the amount of civilians in a zone, the players no longer had to worry about re-evaluating their strategy, make new priorization, or any big decisions, etc. Even without the reflection process, we think the players would have managed to come up with a similar strategy, since both the medic and firefighter noticed the importance of

prioritization by just playing map A.

Questions	V	M	F	AVG
The reflection process helped me to become better at prioritization	7	4	6	5,7
The reflection process made me more aware of the importance of prioritization	8	7	7	7,3

Table 10.6: Players' rating of the reflection process' prioritization skill benefits

This can be traced and strengthened by the score given in the questionnaire, which indicates that the medic and the firefighter learned more about prioritization by playing the game, while having an almost neutral opinion on the increased learning benefit regarding prioritization using reflection. However, when looking at the result of the volunteer, it's clear that he thought he got a high benefit from using the reflection process regarding priorization. And although the team was only slighty positive to the use of the reflection process to become better at priorization, it's clear that all off them thought the reflection process made them more aware about the importance of priorization.

10.2.3 Reflection process and team one decision making

Decision making and the execution of the strategy was also an important factor to their improved score, and something which became a heated topic during the reflection process. The manager was attempting to provoke the team into reconsidering their initial strategy and how they executed it, but the team was still fixed on the thought that the strategy was viable, but that the execution failed once the pressure got too high. The reason why, wasn't discussed, but based on observing the players, we would say that the players was very focused on the idea on acting fast and use physical effort to achieve a good score, instead of focusing on acting smart and use mental effort. This was quite easy to spot during a high pressure state of the game and can be traced back to several game events, such as the decision of the volunteer to head south without consulting with his team mates, the lack of requesting for help by the firefighter, the choice of both the firefighter and medic to return to the secure camp to pick up equipment instead of leaving one to keep the civilians alive, etc. However in the reflection process, when the players were asked directly if the game pressure contributed to a low score, all of them answered no, but once asked indirectly regarding decision making and time, both the medic and volunteer agreed

that if they had more time in the playing phase, better decisions would have been made. This can be seen as a sign that the players aren't able to directly recognize how the pressure affected their decision making abilities, which may explain the score on the question about if the player had gotten a better understanding of their limits while being physically and mentally pressured, the medic and the volunteer rated it slighty positive, while the firefighter rated it a negative.

Questions	**V**	**M**	**F**	**AVG**
I have a better understanding of my limits while being pushed physically and mentally by playing the game	6	6	3	5
The reflection process helped me to become better at decision making	7	4	8	6,3
The reflection process made me more aware of the importance of decision making	7	5	5	5,7
My decision making skills were challenged	7	3	4	4,7
By playing the game one can train their ability to make decisions better	7	4	4	5

Table 10.7: Players' rating of the reflection process' decision making skill benefits

The firefighters low result may be traced to the firefighter disagreeing with the medic and volunteer regarding the relationship between the decision making and time, and meant that the time they had to discuss while waiting for the game to start and in the planning stage was more than enough. This statement strongly indicate that the firefighter did not recognize the importance of re-evaluating the strategy depending on the information change. This was sadly not an issue which the manager decided to press on, leaving the issue undiscussed. Although the firefighter remained stubborn during the reflection process, by looking at the questionnaire score, it seemed like the firefighter got the most out of the talk regarding decision making. On the question about if the reflection process helped the players become better at decision making, the firefighter rated it with it the highest of the team.

With the failure to adress the players pressure handling ability, the strategy ended as we explained earlier, which we believe affected the questionnaire score regarding the game application and decision making. We believe that if this issue would have been discussed and resolved, the strategy used for map B would have been different, and that the players would have played the game with more focus on the importance of re-evaluate and proper decision making.

10.2.4 Reflection process and team one communication

Another important factor which we believe affected the result was the communication. The lack of communication from the firefighter was well highlighted and discussed during the reflection process, but also the reason on why communication was important. The difference between the communication in map A and map B could easily be heard, and not only did the player report the state more often, they also included the amount the specific amount of civilians.

Questions	V	M	F	AVG
The reflection process made me more aware of the importance of communication	8	8	9	8,3
The reflection process helped me to become better at communication	8	9	8	8,3
By playing the game one can train their ability to communicate better	7	7	9	7,7

Table 10.8: Team one players' rating of the reflection process' communication skill benefits

This can be traced back to the reflection questionnaire regarding to the questions about communication, when looking at the first question which ask the players if the reflection process made them more aware of the importance of communication, all the players rated it quite high, with the firefighter rating it highest. This didn't come as a surprise, as the firefighter was the one who got most feedback regarding communication. The players also rated the second question quite high, but surprisingly it was the medic who rated the question highest. Although we noticed an improvement in communication of all players during map B, when comparing the changes from map A to map B, it was definitely the firefighter who showed the most changes. But with score given on the last question, it can be interpreted that the firefighter thought the game application provided more value than the reflection process regarding communication, and the medic the opposite. We think this can be traced to their personality, where the firefighter perhaps learn better by practical work, while the medic prefer theoretical work. Either way, based on observing the players and the score which they rated in the questionnaire, we strongly believe that the reflection process had a big impact on the communication. If the players had taken a break where they could discuss whatever they wanted, we don't think the players would have given each other negative feedback. We will discuss this matter later in section 10.2.6

10.2.5 Reflection process and team one stress/pressure handling

Sadly, this factor was something which we didn't see any improvement on. In map A, the players kept pushing themselves harder as a way to deal with the increasing pressure. In map B, the strategy which they planned and used, eliminated much of the pressure elements in the game concept. Yet once the panic level increased in the game, mistakes were easily spotted, and the players way to deal with it was still to push themselves harder physically. Game events to support these claims was easy to spot, such as the medic, volunteer and firefighter running and using equipment constantly, even at zone 1 which would have benefited more from single actions, as the time required to use the equipment and returning to the secure camp to pick up more equipment, costed much more time than remaining at the zone and use single actions. This strongly indicate that the team members had a big issue with recognizing how the pressure affected them, and also that neither the game nor the reflection process manage to deal with the issue.

In section 10.2.3 we have already discussed the score on the question regarding if the player had a better understanding of their limit while being pressured by playing the game, and there were no indication that the reflection process helped in this matter. The player quickly dismissed discussion about their emotion, and also quickly agreed that feelings didn't affect their performance. The answers given in the emotion/pause functionality wasn't to much help either, as most of them was of type *"Ok, I guess"*, *"Ready to win"*, etc. We think this was due to the combination that the team consisted of just guys, and the broadness of the words emotion and feeling. Perhaps we would have had a better discussion if the questions regarding emotions and feelings, were more specific and used the word stress instead.

Instead of direct triggers, it seemed that the question which was closest to address this issue, was the question regarding time and decision making as discussed in section 10.2.3. With the response given by the players, there was opportunity to help the players connect the line between decision making, time, effect of the pressure, and how to handle the pressure. This was sadly not recognized by the manager.

10.2.6 Reflection process and team one player discussions, feedback and team bond

This category didn't impact the improvement in score directly, but instead impacted it through other factors such as communication. This is something we are sure the reflection process contributed to, and that if the players were to just take a break between map A and map B, they would have not have discussed anywhere near as much.

Questions	V	M	F	AVG
The reflection process helped to increase/strengthen the team bond	8	7	9	8
The reflection process allowed me to give feedback to other players, which I would not have given otherwize.	9	6	3	6
The reflection process provoked many discussions (Started discussions which would not occur if you were just to wait until next round)	9	5	7	7

Table 10.9: Team one players' rating of the reflection process ability to aid in giving teammates feedback

The question regarding improved team bond due to the usage of the reflection process, scored a high score. The score indicates that the players understood the criticism and feedback given from and to each other, as well as perhaps getting a better understanding of each others way of thinking. We are glad that the players didn't argue, and instead focused on improving their score. The question about if the reflection process allowed them to give feedback which they would not have otherwise, had a bit more mixed result. The volunteer rated it 9, the medic rated i 6 and the firefighter rated it 3. The large variation can be traced back to the discussion in the reflection process, where the firefighter didn't have any direct feedback to the other players, while the medic and volunteer had direct feedback for the firefighter. The big gap between the medic and volunteers score was a bit more surprising, as both gave more or less the same feedback to the firefighter. Perhaps this is due to their personality, where the medic may be more outspoken than the volunteer, and thus felt more natural and unafraid to give feedback. It was after all the medic who started giving feedback to the firefighter, while the volunteer followed after. If we look at the rating on the question which ask the players about if they thought the reflection process started discussion which would not have occurred if they where just to take a pause between the maps, the score seems to back up the hypothesis. The volunteer rated it 9, the medic rated it 5 and the firefighter rated it 7.

If we look at the team development for team two, the teamwork at map B was considerably worse than the team work at map A. This could have been caused by the increasing difficult from map A to map B, but since the disagreement could be spotted already at the planning stage at map B, we don't think that was the reason. Instead we believe it was the quality of the discussion which they had in the pause between map A and map B. Although the player did have some discussions, there was a lack of negative topics such as player criticism/feedback which we believe surged in the gameplay instead. Thus based on the difference between team one and team two development, as well as the observation and questionnaire result from the reflection process. We strongly believe the reflection process succeeded in creating a safe zone, which allowed players whom are not outspoken to give negative feedback, as well as allowing the members to discuss various topics without negatively affecting the team bond.

10.2.7 Manager role and additional learning

One of the idea of using a player as a manager was to see if the manager could get any learning benefit by "playing" the game from another perspective. Instead of actively playing the game and directly affect the outcome of the game, the manager was to indirectly affect the outcome of the game, by attempting to improve the active players soft crisis management skills. This was our approach to Schon's idea about reflection-in-action and reflection-on-action, giving the players the chance of not only stepping out of the situation, but also see in real time how other players dealt with various events, which he could use to compare his own approach to theirs. Thus, not only could he help the other players improve their soft crisis management skills, but also improve his own. Judging by the score of the questionnaire, he was quite positive toward his contribution to increase the soft crisis management skills for team one. Judging by the discussions in the reflection process, we agree with his answers, but judging by the observation done during map B, we somewhat disagree regarding if he had contributed to increasing the players understanding of how their action are affected by pressure. Since the questionnaire was filled after the manager observed map B as well, it indicates that either the manager disagree with us on the connection about team one lack of proper pressure handling and the strategy which they used at map B, or that he didn't recognize this.

Looking at the questionnaire, the manager also thought that he had gained further learning

benefit with soft crisis management skills by playing as the manager compared to active roles, except for decision making and importance of pressure handling, which he remained neutral on. This is something we agree upon based on our observation, as the connection between pressure handling and decision making was sadly not noticed and discussed in the reflection process. If this subject would have been discussed, we believe that the manager would also have gotten more out of leading the reflection process, especially regarding decision making and pressure handling.

The failure to recognize this issue by the manager raises an important question. Would the manager ever notice this issue and address it if the players kept playing? This is not something which we have the answer too nor can we properly predict the answers. However, we think this issue may be prevented by adding details about this subject into the guidelines provided to the manager. This should raise the awareness about the subject, and hopefully ensure a discussion about the subject.

10.2.8 Summary

The implementation of a reflection process yielded a mixed result. With a manager which has only played the game once, and with no experience in managing debriefing session, combined with a team who prefered to act fast instead of act smart, the reflection session was somewhat a perfect storm producing a result which we think can be seen on as “worse case”. However, the result was far from grim. By looking at the average score on the question regarding the reflection process aid in learning prioritization, decision making, communication, and strengthening the team bond, they are all positive. Sadly the score was in most case only slightly positive with score between 5,7-8,3, which we had hoped would be better, but which we still consider good when considering the limited experience of the manager and the personality of team one. Our observation of the players also showed an improved gameplay from map A and map B, which is perhaps normal as they have more game experience in map B, but team one also had a better score than team two score-wise at map B. The big disappointment was the lack of result when it came to pressure handling, where any direct attempt to trigger discussion using the questions in the manager guidelines failed to do so. Instead what triggered the biggest discussion about it,

came indirectly when the team was discussing if they had enough time to take decisions. Sadly, the manager didn't attempt to involve emotions/pressure handling into that discussion, which with his limited experience he can't be blamed for, as there was also no follow-up questions specified in the manager guideline he could follow/use either. With the issue unresolved, the playstyle of team one remained the same, with heavy focus on strategy, decisions and prioritization during the planning and little during the game session. This is an issue which we are not sure can be fixed using the same reflection routine and the same manager, but since the game is not supposed to be a "one time play" only, there ispotential for both the manager and the active players to improve their skills and deal with this issue eventually. Afterall, the information needed is there, and only require the manager or the player to acknowledge it.

What we can say based on the questionnaire result and observation is that the manager and the team was overall slightly positive to the use of reflection process to learn crisis management skills, which seems to be the case as map B had higher utilization of various crisis management skills than map A, and that the team had a much higher score growth than team two. Since neither team was even close to achieve what was possible to score at map B, we are fairly certain that the reflection process gave a strong benefit to the players, compared to just a break.

Chapter 11

Technical and non technical issues

In this chapter we will discuss issues which may limit the usage of the product.

11.1 Overview

As we are reliant on Android smartphones, a server, and walkie-talkies, normal issues which affect the use of the product will also affect the use of the application. For example common issues are raining weather, radio interference, no cell phone coverage, network problems etc. As we consider issues like these self explanatory, we will not discuss them, and instead discuss issues which may not be so clear.

11.2 GPS

Although the smartphone GPS does work, the speed of triangulation and the accuracy could cause some issues. We found two things particularly strange, the first was that weather conditions seemed to affect the efficiency of the smartphone GPS, even though the technology is supposed to be "weather-proof", except for space-weather such as solar flares[23][21]. However, this was measured with a non-scientific test, which basically consisted of us taking the time required for the application to recognize us entering a zone while walking and running from a fixed spot to a fixed zone, at different days with different weather conditions. Thus there could be another explanation of the issue, which we have not been able to uncover. The second strange thing was

that even if two participants had the same phone and the same carrier, the GPS on one of the phones had such a bad accuracy and location update speed, that the participant had to borrow another phone to carry out the test.

This means that we cannot guarantee that the application will function properly with all type of smartphones, even if they support GPS, and in addition since GPS require a relative clear line of view to the sky, the application can not be played inside buildings or at outside location that does not provide the necessary line of view, such as a city street surrounded by skyscrapers.

11.3 Wifi

Although, there is nothing in the code which prevent the usage of Wifi instead of mobile network, the issue with using it is the Wifi coverage. As the game require several zones to make it challenging, the area required will usually be larger than what a normal Wifi transmitter can broadcast. A common solution used often by corporations, colleges, and universities is to use multiple Wifi transmitters to provide a broad coverage as well as seamless connectivity. The idea behind seamless connectivity, is to ensure that the user has a good Wifi connection by changing the Wifi transmitter which the client is communicating with automatically, based on the signal strenght. In most cases, this works perfectly fine, with a small interruption in wireless applications.

```
wpa_supplicant          nl80211: Event message available
wpa_supplicant          nl80211: Delete station 00:1e:f7:55:ca:f2
wpa_supplicant          nl80211: Event message available
wpa_supplicant          nl80211: MLME event 39
wpa_supplicant          Event 12 received on interface wlan0
wpa_supplicant          Deauthentication notification
wpa_supplicant           * reason 4
wpa_supplicant           * address 00:1e:f7:55:ca:f2
wpa_supplicant          WPA: Auto connect enabled: try to reconnect (wps=0)
wpa_supplicant          Setting scan request: 0 sec 100000 usec
wpa_supplicant          Added BSSID 00:1e:f7:55:ca:f2 into blacklist
wpa_supplicant          Another BSS in this ESS has been seen; try it next
wpa_supplicant          BSSID 00:1e:f7:55:ca:f2 blacklist count incremented to 2
wpa_supplicant          Setting scan request: 0 sec 100000 usec
wpa_supplicant          WAPI: Supplicant port status: Unauthorized
wpa_supplicant          wlan0: CTRL-EVENT-DISCONNECTED bssid=00:1e:f7:55:ca:f2 reason=4
wpa_supplicant          Disconnect event - remove keys
wpa_supplicant          wpa_driver_nl80211_set_key: ifindex=24 alg=0 addr=0x0 key_idx=0 set_tx=0 seq_len=0 key_len=0
wpa_supplicant          wpa_driver_nl80211_set_key: ifindex=24 alg=0 addr=0x0 key_idx=1 set_tx=0 seq_len=0 key_len=0
wpa_supplicant          wpa_driver_nl80211_set_key: ifindex=24 alg=0 addr=0x0 key_idx=2 set_tx=0 seq_len=0 key_len=0
wpa_supplicant          wpa_driver_nl80211_set_key: ifindex=24 alg=0 addr=0x0 key_idx=3 set_tx=0 seq_len=0 key_len=0
wpa_supplicant          wpa_driver_nl80211_set_key: ifindex=24 alg=0 addr=0x60570 key_idx=0 set_tx=0 seq_len=0 key_len=
wpa_supplicant             addr=00:1e:f7:55:ca:f2
wpa_supplicant          State: COMPLETED -> DISCONNECTED
```

Figure 11.1: The image shows the traced network event which lead to the disconnection from the server

However, when testing the application using Wifi at the NTNU campus an issue we experienced when the smartphone picked up multiple Wifi transmitters, was that the smartphone attempted to connect to the newly discovered transmitter and failed, this was then followed up by removing the keys and disconnecting from the network entirely, which caused the application to terminate the socket connection which it had to the game server. Searches on the web showed that there are others who have experienced the same issue, and the solution seemed to be to reconfigure the security policy of the network. Since this was something which we didn't have access to, we could not confirm if it was true. Thus, when can only conclude that when using Wifi, the application is limited by the wifi range as well as potentially the security settings of the network.

11.4 Stability and robustness of mobile network

We have mentioned earlier on several occasions that the technology used cannot guarantee a 100% stable gameplay. This is mostly due to stability of the mobile network, which sadly is still far from perfect, at least here in Norway. An extensive test was done by CRNA during 2013 [19] to measure the the stability of the mobile network in Norway. The test revealed some serious stability issues with the mobile network in several categories.

- Between 15% and 37% of the connections failed in such a way that the network connection was down for more than 10 minutes on average per day (Depending on the company).
- Between 18% and 49% of the connections had an average package loss of 1% (Depending on the company).
- A download test where a 1MB file was attempted downloaded 504 times over 3 weeks, revealed that 7,4% of the attempts failed during the download due to connection loss at the largest tele company in Norway (Telenor). While the “best in class” had a 1,1% failure rate (Ice).

Chapter 12

Conclusion and future work

In this chapter we will present our conclusion as well as propose future work which may improve upon the product as well as improve the reflection process.

12.1 Summary

In this master thesis, we set out to improve the early prototype created during the autumn project as well as creating a reflection process which would better immerse the player with the game concept, making it easier to practise crisis management skills. The goal was to evaluate if a serious game using real time gameflow and GPS could be used to learn crisis management skills, and if it was possible to add a reflection process to the game which encourage further learning. We improved upon the first prototype by making it more stable to ensure that the players who tested the game during the evaluation would have a similar experience not hindered by any technical issues. We also designed a reflection process as well as a manager interface and guidelines to support the reflection process. The system was evaluated by two teams, one playing the game without the use of the reflection process, while the other played and utilized the reflection process.

12.2 RQ1: Can a mobile location based game with real time gameflow be engaging and teach relevant skills for crisis management?

To answer the first research question, we first looked into its success as a serious game which revealed that although the game concept required us to create a physical and mentally tiresome game environment, the participants still found it fun/engaging. The SUS score also indicated an above average usability which we are satisfied with, but we also recognized the potential to increase the usability score by changing and implementing some of the suggestions from the participants. To measure the learning benefits from the game, we listened to the participants thoughts about what they had gotten out of playing the game and what they felt was possible to achieve in regards to learning decision making, prioritization, pressure handling and communication. The score indicate a positive result for team one which used a static playstyle, and a very positive for team two who had a more dynamic playstyle. Although, we haven't been able to test the game with expert users nor more than 6 people, based on the results and observations, we are confident that the game created can be used to teach relevant skills for crisis management.

12.3 RQ2: Can a reflection process be added to this sort of game to further stimulate learning?

To answer the second research question, we compared the score growth from map A to B, between the teams, as well as asking the players what and if they thought they had gotten any learning benefit from using the reflection process. The result showed that the team which used the reflection process had a positive growth in score, even if map B was designed to be harder than map A, while the team which didn't use the reflection process had a negative score development. Both the manager and the active players were overall slightly positive to the use of the reflection process to increase the learning. Since the manager used, didn't have any experience with managing debriefing session or was had any extensive knowledge about reflection, we consider the outcome quite good, but remain a bit curious on the potential of the reflection

process. Although the reflection process was only tested with one team, we consider the positive result gained by using an inexperience manager, as a good indication that the reflection process indeed provides learning benefits.

12.4 Future work

In this section we will discuss the changes and potential work which we think will further improve the system.

12.4.1 Game application

To further explore the potential to increase the usability of the game application, we recommend to implement the following changes:

* Change health and panic description so that 100 is positive and 0 negative.
* Removal of dialog window as message container for entering and exiting and implement a non intrusive container which does not require player interaction to close, such as Android.toast.
* Implement vibration on zone entering so that the player doesn't have to keep eye on the screen to know when they have entered a zone.

In addition, alternative options to GPS should be explored which provide a more consistent and faster reaction time, but which does not require user interaction. After all, one of the reasons to why we decided to use GPS was because of the negative feedback to the solution MoDo used, which was a PIN code solution which required the users to enter a 4 digit code to enter a zone. This solution was perceived as tiresome due to the need of repeated interaction.

12.4.2 Manager application

The feedback from the manager also indicate the potential in combining the map used in the game application with the manager application. As one of the issues the manager experienced, was that he subconsciously focused on the map, which made it harder to properly register events

as it occurred. However, as the manager application contains quite a lot of data, this can be quite a challenge.

The last possible task, would be to create a user interface for creating maps and changing game settings. This has not been prioritized so far due to the stability issue with the application, but now that it is stable, this option would allow users to create their own map without coding knowledge.

12.4.3 Reflection process

The result from team one's reflection session revealed that the current set-up may not be enough to get the players to properly reflect over how the pressure is affecting their performance. This we have earlier concluded with that there is a good chance on improving with future use of the game application and the reflection process, but to better the odds, the guideline could be extended/re-structured to focus more on this subject.

Appendix A

Acronyms

API Application Programming Interface

CM Crisis management

CVA Cerebrovascular Accident (stroke/brain attacks)

FAQ Frequently asked question

GPS Global position system

IDE Integrated Development Environment

MoDo Mobile Don't Panic

PIN Personal identification number

POV Point of view

RQ Research question

SA Situation awareness

Appendix B

Game FAQ

There are 3 roles:

- Medic - Cannot remove any blockade, but is best at both healing (5s) and calming civilians (5s)
- Firefighter - Best at removing blockade, and second best at calming civilians (+3s), but cannot heal any civilians
- Volunteer - Jack of all trade, can remove blockade (+5s penalty time), heal (+5s penalty time), calm civilians (+5s penalty time) and use , but require much more time than the medic and firefighter, to perform these tasks.

There are several game items that a player can carry around:

- Medical kit - restore 10 health on all the civilians within a section/zone (10s) (+penalty time)
- Megaphone - reduce panic by 10 on all the civilians within a section/zone (10s) + (penalty time)
- Fire extinguisher - remove blockade of type “fire” (10s) +(penalty time)
- Crowbar - remove blockade of type “jammed” (10s) +(penalty time)

In addition there are other game items that belong in a section/zone that a player can use to remove blockade but it require more time than the normal items

- Fire hose - remove blockade of type “fire” (30s) +(penalty time)

Note that medical kit and megaphone require the same amount of time to use, but remember that firefighter cannot do any healing and thus not use the medical kit!.

There are no limitation on which item a role can pick up, but its a limitation of what item a role can use:

- Medic can use:
    - Medical kit
    - Megaphone

- Firefighter can use
    - Megaphone (+5 second penalty time)
    - Fire extinguisher
    - Fire hose
    - Crowbar

- Volunteer
    - Medical kit (+10 second penalty time)
    - Megaphone (+10 second penalty time)
    - Fire extinguisher (+5 second penalty time)
    - Fire hose (+5 second penalty time)

- Crowbar

The goal of the game is to prevent as many of the civilians which can be found inside the marked geolocations, from dying. A civilians panic level will increase for each panic wave, and once it reaches 100, they will start losing health every 5 seconds.

Appendix C

Guidelines for the manager role

Guidelines for the manager role

Intro

As the manager, your role is to use your previous game experience and detect events which in your opinion could have been done better. Your opinion of these events will be presented once the game complete and your job is to trigger discussion around these events. Incase you don't detect any events during the game session, we have prepared some questions which you will ask the players once the reflection process is started.
But first, below we will present some example of events which we believe can be useful to look out for.

Observation example

Communication:

- As walkie-talkie only allows one person to talk at once, efficient use of the channel is therefore important. If a player uses "um, eeeh" etc, he/she is using the channel inefficiently.

- In the heat of all the action, players may get too focused on their own situation and stop processing incoming messages from their team members. This can be spotted by looking at the item usage, e.g if player X is in a zone with 3 civilians and player Y is in a zone with 10 civilians, if player Y calls for help to calm or heal these 10 civilians, and player X still proceed on using his items in his zone with less civilians, this can be an indication of bad active listening skills.

- Since the players are often spread out during the game, communication of events are important. Lack of communication about number of civilians in a newly opened zone is a good example.

- Radio silence over a long time is an indication of lack of communication. Even if everything is going great the team should still communicate with each other.

Decision making

- A sign of decision making can be seen on the item usage. If the zone contains a zone bound item and the player has a normal equipment which is more efficient but will be discarded when used, the player will have to make a choice on which to use. There are several factors which can impact this decision, but we can't see which factor the player is taking in concern. Thus, events like these can be useful to note and discuss during the reflection process.

- Another sign of decision making is when the player decides to return to the secure camp to pick up more equipment than pressing on. Especially when the player still have more equipment in his backpack, yet still decides to return to the secure camp. This could be caused by the player predicting the need of X item at next zone, while only having Y item, or simply that he has forgotten that he still has more item. Either way, these events are also useful for the discussions during the reflection process.

- Another situation which could occur is if a team member is asking for help and no one responds, or the others decide to instead finish what they are currently doing. This is not necessarily a bad or good decision but the reasoning behind it is interesting to know about.

Prioritization

- Prioritization can be tricky to spot, as it is intertwined with many of the actions which occurs during the game, and may be the cause in many of the example we have given so far. The communication example nr 2, could indicate a prioritization issue and not necessarily a communication issue. This can't be uncovered until asking the player about the specific event, thus it's important to note down such events.

- An easier prioritization event to spot, is when the players decides to sacrifice a zone. This can be a team decision, which will most likely be communicated through the walkie-talkie. Or an individual decision, which can be spotted by the player ignoring it when the color indication is showing high danger level.

Summary

By reading the example which we have presented, you have probably noticed that it is quite hard to categorize an event and place it in a specific category. Some of the communication example could be caused by prioritization which again could indicate decision making, or decision making example which could be caused by communication or prioritization and so forth. It is therefore important to note down these events and ask the player/players about the thought process, as it is only them that can shed light on the matter.
It is also important that you keep in mind that the examples are just examples, even if we think they are important, it will be up to you to decide what event you wish to note down and discuss with the players. Keep in mind that, there may be events that has not been covered by the examples, which you found important while playing as medic/firefighter/volunteer.

Mandatory task and question to be asked during the reflection process.

To help you out, we have prepared some task and question which you are to ask the players. (feel free to join the discussion with your own opinion)

1. Your first task, is to ask the players how many civilians they thought are still alive and how they got to that number (You can see this in the manager application, but the other players doesn't know what their team mate answered). After this is done, you are to reveal the actual number of remaining civilians.

2. A follow up question (if they did not already explain it after the first question) is if they made a decision to establish an overview over the zones.
    a. If so, did anyone get delegated this task?
        i. Would they do this any different for the next round?
    b. if not, was this something they thought about as unimportant or did they just not think about it?
        i. Would they do this any different for the next round?

3. Did the player have a strategy for the game or was it more "try and fail"?
    a. if they answer strategy: follow up with the following questions:
        i. Did the strategy change as new information arrived?
        ii. Did they fail to play as planned due to physical limits?
        iii. Did they fail to play as planned due to mental limits?
        iv. Did they fail to play as planned due to stress?
        v. What can they do better for the next round?
    b. if they answered "try and fail", follow up with the following questions
        i. What was the reason for the choice of this tactic?
        ii. Do they think that they would have scored a better score if they would have had an pre-planned strategy
        iii. What can they do to do better at the next round?

4. How does the player feel about their team mates effort ?(remind the players that they can view and share their zone history by entering the zone tab)
    a. Was there an unbalanced workload (did some feel like they had to do more than others)?
        i. Followup question: was this difference due to physical limits or game factor such as difference in roles?
        ii. Followup question: are there any actions the team can take to balance out the workload?
    b. How does the player feel about the ratio of physical effort versus mental effort to do well in the game?

5. How well do the players feel like they communicated ?

    a. How was the communication at the various stages (stages as in the the time between pauses)
        i. Was there any factor which reduced or hinder communication?
        ii. How important do the player feel communication is?, did this change during the different stages?
        iii. Do you feel communication is more important now than what you felt before you started the game?

6. When making decisions during the game, what did they base their decisions on?
    a. Would some decisions had been made differently if:
        i. Players were more informed about situations in the playing field?
        ii. They had more time to think about their decision?

7. How did their emotions affect their performance?
    a. is there anything they can do to keep their emotions controlled?

8. What three things do the players feel like they did well

9. What three things do the players feel like they did poorly

10. Is there any other issues which they want to discuss?

Appendix D

Team one questionnairs

In this chapter you can find the questionnaires given to the players

D.1 Pre-game questionnaire

1 = lowest, 5 = avg, 10 = highest.

V = volunteer, M = Medic, F = Firefighter.

Question	**V**	**M**	**F**
Rate your endurance	8	8	8
Rate your communication skills	7	7	7
Rate your teamwork skills	8	7	7
Rate your strategic skills	7	7	8
How much gaming experience do you have?	9	2	10
How fast do you learn new things?	8	6	8
How well do you handle stress/pressure?	9	7	8
How much experience do you have with Android smartphones?	10	10	6
How much experience do you have with walkie-talkies?	9	5	8
How much physical effort are you planning to use?	9	3	10
How much mental effort are you planning to use?	9	5	10

Do you have any leadership training?

Volunteer : Assistant coach

Medic: Project management class at NTNU

Firefighter: Yes

Have you been in the military?

Volunteer : No

Medic: No

Firefighter: Yes

Do you have any other experience which may be relevant for the work of crisis management?

Volunteer : No

Medic: No

Firefighter: Yes, security guard course and job

D.2 Post-game questionnaire

1 = lowest, 5 = avg, 10 = highest.

V = volunteer, M = Medic, F = Firefighter.

Question	**V**	**M**	**F**
The game concept was easy to understand	10	5	7
The application was easy to use	9	6	5
The map was easy to understand and use for navigation	10	9	8
The pauses had a positive impact on the usability of the application	2	2	2
The pauses made me more engaged with the game	1	1	1
The game was engaging	10	8	9
The game was stressful	7	5	7
The game was frustrating	3	3	9
External factors (Weather/GPS/Network) had a negative effect on my enjoyment	1	8	6
The game was physically demanding	4	8	8
The game was mentally demanding	4	4	3
My decision making skills were challenged	7	3	4
My communication skills were challenged	8	4	8
My prioritization skills were challenged	8	4	10
I have a better understanding of my limits while being pushed physically and mentally by playing the game	6	6	3
Team work was important to perform well	10	8	10
The game made me more aware of the importance of crisis management.	5	6	7
By playing the game one can train their ability to handle pressure better	6	6	8
By playing the game one can train their ability to communicate better	7	7	9
By playing the game one can train their ability to make decisions better	7	4	4
By playing the game one can train their ability to prioritize better.	7	7	9
How much physical effort did you use during the game?	10	7	9
How much mental effort did you use during the game?	8	3	4

D.3 Reflection process questionnaire

1 = lowest, 5 = avg, 10 = highest.

V = volunteer, M = Medic, F = Firefighter.

Question	**V**	**M**	**F**
The reflection process was easy to perform	7	7	9
The reflection process was engaging	7	2	2
The reflection process made me aware of mistakes	8	7	6
The reflection process helped to increase/strengthen the team bond	8	7	9
The reflection process allowed me to give feedback to other players, which I would not have given otherwize.	9	6	3
The reflection process provoked many discussions (Started discussions which would not occur if you were just to wait until next round)	9	5	7
The reflection process made me more aware of the importance of decision making	7	5	5
The reflection process made me more aware of the importance of forward thinking	7	7	5
The reflection process made me more aware of the importance of prioritization	6	6	7
The reflection process made me more aware of the importance of communication	8	8	9
The reflection process helped me to become better at decision making	7	4	8
The reflection process helped me to become better at forward thinking	6	7	6
The reflection process helped me to become better at prioritization	8	4	6
The reflection process helped me to become better at communication	8	9	8

D.4 Manager questionnaire

1 = lowest, 5 = avg, 10 = highest.

Question	Manager
The manager application was easy to understand	7
The manager application was easy to use	6
The manager application and the map provided enough information for me to perform my tasks	3
The manager application, the map and the walkie-talkie provided enough information for me to perform my tasks.	8
I think my role contributed to increase the players motivation	3
I think my role contributed to increase the players learning benefits regarding communication	7
I think my role contributed to increase the players learning benefits regarding forward thinking	7
I think my role contributed to increase the players learning benefits regarding decision making	8
I think my role contributed to increase the players learning benefits regarding strategy and tactics	8
I think my role contributed to increase the players learning benefits regarding teamwork.	8
I think my role contributed to increase the players understanding regarding how their action is affected by pressure.	8
By playing as the manager, I have further learned the importance of communication than when playing as the other roles.	7
By playing as the manager, I have further learned the importance of forward thinking than when playing as the other roles.	7
By playing as the manager, I have further learned the importance of decision making than when playing as the other roles.	5
By playing as the manager, I have further learned the importance of strategy and tactics than when playing as the other roles.	7
By playing as the manager, I have further learned the importance of teamwork than when playing as the other roles.	8
By playing as the manager, I have further learned the importance of dealing with pressure than when playing as the other roles.	5

D.5 SUS questionnaire

Questions	**V**	**M**	**F**
I think that I would like to use this system frequently.	4	3	3
I found the system unnecessarily complex.	1	1	2
I thought the system was easy to use.	4	3	2
I think that I would need the support of a technical person to be able to use this system.	1	3	3
I found the various functions in this system were well integrated.	4	4	3
I thought there was too much inconsistency in this system.	1	2	1
I would imagine that most people would learn to use this system very quickly.	4	3	3
I found the system very cumbersome to use.	2	2	3
I felt very confident using the system.	3	2	3
I needed to learn a lot of things before I could get going with this system	1	3	4
Converted using SUS rules	**82,5**	**60**	**52,5**

Appendix E

Team two questionnairs

In this chapter you can find the questionnaires given to the players

E.1 Pre-game questionnaire

1 = lowest, 5 = avg, 10 = highest.

V = volunteer, M = Medic, F = Firefighter.

Question	**V**	**M**	**F**
Rate your endurance	7	7	6
Rate your communication skills	5	8	8
Rate your teamwork skills	8	9	8
Rate your strategic skills	6	8	6
How much gaming experience do you have?	8	10	6
How fast do you learn new things?	9	6	6
How well do you handle stress/pressure?	5	7	6
How much experience do you have with Android smartphones?	6	5	8
How much experience do you have with walkie-talkies?	4	4	8
How much physical effort are you planning to use?	9	8	8
How much mental effort are you planning to use?	9	8	8

Do you have any leadership training?

Volunteer : No

Medic: Yes, informal

Firefighter: no

Have you been in the military?

Volunteer : Yes

Medic: Yes

Firefighter: no

Do you have any other experience which may be relevant for the work of crisis management?

Volunteer : No

Medic: Course in security management from the military and course in security management from NTNU

Firefighter: no

E.2 Post-game questionnaire

1 = lowest, 5 = avg, 10 = highest.

V = volunteer, M = Medic, F = Firefighter.

Question	**V**	**M**	**F**
The game concept was easy to understand	8	7	7
The application was easy to use	8	9	4
The map was easy to understand and use for navigation	5	9	8
The pauses had a positive impact on the usability of the application	8	10	3
The pauses made me more engaged with the game	5	10	3
The game was engaging	10	10	9
The game was stressful	10	9	9
The game was frustrating	4	8	3
External factors (Weather/GPS/Network) had a negative effect on my enjoyment	1	4	6
The game was physically demanding	10	7	9
The game was mentally demanding	8	8	9
My decision making skills were challenged	7	8	9
My communication skills were challenged	10	9	9
My prioritization skills were challenged	10	9	9
I have a better understanding of my limits while being pushed physically and mentally by playing the game	9	10	9
Team work was important to perform well	10	8	7
The game made me more aware of the importance of crisis management.	10	8	9
By playing the game one can train their ability to handle pressure better	10	10	9
By playing the game one can train their ability to communicate better	10	10	9
By playing the game one can train their ability to make decisions better	10	10	9
By playing the game one can train their ability to prioritize better.	10	9	9
How much physical effort did you use during the game?	9	8	9
How much mental effort did you use during the game?	8	9	9

E.3 SUS questionnaire

Questions	**V**	**M**	**F**
I think that I would like to use this system frequently.	4	4	2
I found the system unnecessarily complex.	1	2	3
I thought the system was easy to use.	4	5	3
I think that I would need the support of a technical person to be able to use this system.	1	4	1
I found the various functions in this system were well integrated.	5	5	3
I thought there was too much inconsistency in this system.	2	2	3
I would imagine that most people would learn to use this system very quickly.	4	4	4
I found the system very cumbersome to use.	2	1	3
I felt very confident using the system.	4	5	3
I needed to learn a lot of things before I could get going with this system	3	1	2
Converted using SUS rules	**80**	**82,5**	**57,5**

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