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Department of Computer Graphics and Interaction**

# Surveillance center UI for in-hospital navigation system

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# ZADÁNÍ BAKALÁŘSKÉ PRÁCE

Student: Dominika Palivcová

Studijní program: Softwarové technologie a management
Obor: Web a multimedia

Název tématu: UI dohledového centra pro navigační systém pro nemocnice

Pokyny pro vypracování:

Na KPGI probíhá vývoj navigačního systému pro interiéry nemocnic [1]. Tento systém využívá množství navigačních terminálů, které poskytují personalizované navigační instrukce na základě video-detekce osob. Propojené terminály je možné využít pro zvýšení efektivity dohledových center i jiných rozsáhlých budov, než jsou nemocnice. Seznamte se se současnou verzí navigačního systému a s platformou UIP (User Interface Platform) [2]. Proveďte uživatelský výzkum cílové uživatelské skupiny - operátorů dohledového centra. Analyzujte potřeby ostatního personálu nemocnic z hlediska dohledu a bezpečnosti. Pomocí metodiky User Centered Design navrhněte UI pro dohledové centrum. Navržené UI implementujte s využitím platformy UIP.
Realizované řešení ověřte s cílovou uživatelskou skupinou prostřednictvím testování použitelnosti (minimálně 6 participantů).

Seznam odborné literatury:

[1] Macík, M.; Malý, I.; Lorencová, E.; Flek, T.; Míkovec, Z.: Smartphoneless context-aware indoor navigation In: 7th IEEE International Conference on Cognitive InfoCommunications PROCEEDINGS. Budapest: IEEE Hungary Section, University Obuda, 2016, pp. 163-168. ISBN 978-1-5090-2644-9.

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# Acknowledgement / Declaration

I would like to thank my supervisor, Ing. Miroslav Macík, Ph.D., for giving me the opportunity to participate in this project, for his valuable advice and encouragement throughout the work on the project. Finally, I would express my gratitude to my family for supporting me during my studies — especially to my mother, for spiritual support throughout writing this thesis and in my life in general.

I hereby declare that I have written the submitted thesis myself and I quoted all used sources of information in accord with Methodical instructions about ethical principles for writing academic theses.

In Prague on May 25, 2017

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# Abstrakt / Abstract

Na Katedře počítačové grafiky a interakce na FEL ČVUT probíhá vývoj navigačního systému pro nemocnice. Principem tohoto systému je poskytování personalizovaných navigačních instrukcí s využitím video detekce osob. Uživatelé jsou detekováni pomocí terminálů rozmístěných po areálu nemocnice. Tato bakalářská práce se zabývá využitím audiovizuálních informací z těchto terminálů. V práci je vytvořen návrh další součásti navigačního systému – dohledového centra, konkrétně jeho uživatelského rozhraní. Proces návrhu se řídil metodikou User-centered design a při řešení byl kladen důraz na co nejvyšší použitelnost produktu pro cílovou uživatelskou skupinu. Výsledkem práce je high-fidelity prototyp dohledového centra implementovaný na základě stejné platformy, jako ostatní části navigačního systému. Prototyp byl otestován s cílovou uživatelskou skupinou a je připraven na integraci do navigačního systému. Dohledové centrum přináší nové funkce, které by měly přispět především ke zvýšení bezpečnosti v nemocnici.

**Klíčová slova:** dohledové centrum, navigace v interiérech, navigační systém, User-Centered Design, uživatelský výzkum, testování použitelnosti, zdravotnictví, bezpečnost

**Překlad titulu:** UI dohledového centra pro navigační systém pro nemocnice

An indoor navigation system for hospitals is being developed at the Department of Computer Graphics and Interaction at the CTU FEE. In this system, personalized navigation instructions are provided by terminals installed at appropriate spots in a hospital. The system uses a video detection for identification of navigated users. This bachelor thesis looks into the utilization of video streams from terminals and suggests another part of the navigation system — the Surveillance Center, specifically its user interface. The design process employs the User-centered design methodology, and thus it is focused on the usability of the product for the target user group. The result of the thesis is a high-fidelity prototype of the Surveillance Center implemented on the basis of the target platform of the navigation system (UIP protocol). The prototype has been tested with the target user group and is ready for integration into the complex navigation system. The Surveillance Center brings new features that should primarily contribute to improving hospital safety.

**Keywords:** surveillance center, indoor navigation, navigation system, User-Centered Design, user research, usability testing, healthcare, safety

# Contents /

# Tables /

# Chapter 1
## Introduction

The bachelor thesis follows the research project of the Department of Computer Graphics and Interaction of the CTU FEE that is focused on the development of the navigation system for interiors [1]. The system is designed primarily for usage in healthcare facilities such as hospitals to navigate visitors with special orientation and navigation needs. The navigation process is performed with the help of various terminals placed in the interior that provide personalized navigation instructions based on video-detection of the users.

The objective of the thesis is the design of Surveillance Center that will use video streams from terminals of the navigation system to enhance the efficiency of the hospital. Moreover, the Surveillance Center will provide support for existing navigation system. In the design of the system, we focus on usability and user experience of the final product. Therefore, UCD as suggested by [2] is used.

In this chapter, we define employed methodology and basic terms, present a motivation behind the idea of realization of the Surveillance Center and so the goals of the project. The Chapter 2 is dedicated to the analysis of the target domain, user research, and definition of target user groups. In Chapter 3, we present the design of the system and the solution of the user interface for the operators of Surveillance Center in the form of prototypes. In Chapter 4, the implementation of created prototypes is discussed and in Chapter 5, the evaluation of each prototype is described. Finally, Chapter 6 concludes this work and offers suggestions for future development of designed system.

## 1.1 Methodology and basic terms

In this section, a methodology and basic terms used in the thesis are described.

### 1.1.1 User-Centered Design

The term *User-Centered Design (UCD)* [2] refers to a methodology of such product design and development process that is focused on aiming and understanding needs, requirements and limitations of the target user group of the product. UCD methodologies are based on international standard ISO 9241-210:2010 [3] that defines methods recommended to use during the design process. Individual phases of the UCD design process can be seen on Figure 1.1. The whole process is iterative — it is repeated until the designed solution meets requirements of the target user group.
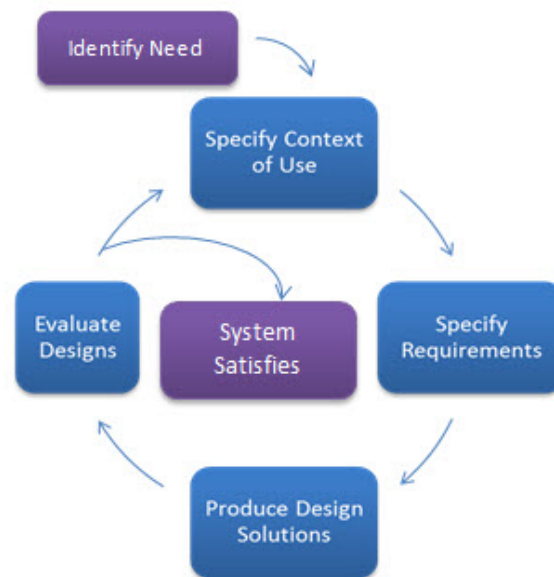
**Figure 1.1.** Design process according to UCD methodology. From [4].

According to the illustration, three phases of the process can be derived.

- **Phase 1: Analysis.** In this phase, the goal is to understand the domain in which will be the product used, and then, the target user group and its requirements are defined.
- **Phase 2: Design of solution and its implementation.** Based on data acquired in the phase of analysis, the solution is designed and implemented. There are several forms of the implementation:

  a) Low-fidelity prototype — sketch of essential characteristics of the system used for rapid evaluation mainly in first cycles of the UCD process,
  b) High-fidelity prototype — a prototype very similar to the final product with many details and functionalities,
  c) real implementation on a target platform — final product.

- **Phase 3: Evaluation.** Finally, the verification of the designed solution follows. The prototype can be evaluated using expert analysis or using usability studies with target user group.

## ■ 1.1.2 Usability

*Usability* is a qualitative attribute that defines how difficult is for the user to use the UI. By Jakob Nielsen [5], the usability is defined by following quality components of the system:

- **Learnability.** How difficult is it for the user to accomplish a basic task the first time they use the system?
- **Efficiency.** Once users have learned the design, how quickly can they perform tasks?
- **Memorability.** When users return to the design after a period they did not use it, how easy they will be able to use the design efficiently again?
- **Errors.** How many errors user make and which severity do they have? How easily can the user recover from the errors?
- **Satisfaction.** How pleasant is to use the design?

### ■ 1.1.3   Situational Awareness

According to [6], *Situational Awareness (SA)* is defined as the perception of elements in an environment of the context of time and space, understanding of their meaning and projection of their state to the near future. By [7], there are three phases in the SA:

1. Perception of elements in an environment — In the first phase, the goal is to percept the state, attributes, and dynamics of relevant elements. The relevant elements are specified by a particular a type of activity, and they are often followed by many other data that are competing for the focus of the user. Therefore, when designing for situational awareness, it is necessary to present displayed data clearly — in such way that will be for the user easy to understand.
2. Understanding of the meaning of the elements — The goal in the second phase is to understand the data and process them into the form of information. After that, the information is prioritized on their possible effect on the actual goal. In the design, we focus on a simplification of this process.
3. Projection of the state of the elements to future — Once we have the data and we know their meaning on our goal, in the third step, we foresee what such information will mean in the future.

## ■ 1.2   Motivation

In this section, the motivation behind the idea to design the Surveillance Center is discussed. The source of motivation is mainly the environment of hospitals, that is specific in many aspects.

### ■ 1.2.1   Violence in the workplace.

A hospital is a place where various personalities meet every day, mainly by negative reasons. The stress of examination, ill health or an influence of drugs or psychotropic substances that are the main causes of violence by the visitors of the hospital. According to [8], 16.2 % of doctors (per 1000 employees) and 21.9 % nurses (per 1000 employees) face physical violence. By the spokeswoman of Faculty Hospital in Brno [9], they deal with aggressive or conflict behavior up to four times a week.

### ■ 1.2.2   Stagnant quality of healthcare services

According to [10] the healthcare suffers from a lack of knowledgeable and enthusiastic employees. This fact is reflected in the Czech health care even more, due to insufficient pay packet of the employees that is demotivating. Thus, the employees are overloaded, and the quality of the healthcare stagnates.

### ■ 1.2.3   Organising of crisis plans

Evacuation of a hospital is a complicated process that requires robust strategy and cautious execution [11]. When activating the crisis plan, a good situational awareness plays a crucial role. However by [12], in many hospitals, there is not any central point from which could be such process launched and managed.

### ■ 1.2.4   Support of the navigation system

Even thought the in-hospital navigation system is designed to be autonomous, serious tasks (e.g. activation of evacuation or crisis plan) can not be performed without approval of a person in authority. Another reason for the development of Surveillance

Center is cases when the algorithm used for face recognition identifies a user of the system with insufficient confidence. We expect that this situation could happen in up to 15 % of cases (in the worst case. It depends on the number of navigated users and lighting conditions).

## 1.3 Goals of the thesis

The main goal of the thesis is to design a surveillance system and the user interface of the Surveillance Center in such way that the system will be useful and the user interface will be usable and intuitive for the users. In this process, the UCD methodology will be employed as it is one of best practices regarding the development for a particular user group. Following the UCD methodology, we define several intermediate goals:

- **G1: Analyse the current status of existing navigation system.** As the design of the Surveillance Center strongly relies on the existing navigation system, it is necessary to know the basic principles behind it.

- **G2: Analyse related solutions of surveillance systems and the legislation behind their operation.** The analysis of related surveillance systems could help us to orient better in the domain of monitoring systems. We can draw inspiration from them, decide which features are appropriate for the design of our system and consider a possibility to use an existing solution instead of developing our own. We will focus on the perspective of legislative that is related to surveillance systems in the Czech Republic to avoid potential problems with deploying of the system.

- **G3: Employing user research, analyze needs and requirements of potential users of the system.** According to the UCD methodology, we will conduct a user research to acquire information about the target audience of the system.

- **G4: Regarding the results of the user research, define the user groups of the system.** The results of realized user research will be reflected in the definition of the target user groups. So, we will be aware of who the users of our system exactly are and which requirements and needs they do have.

- **G5: Define functional requirements.** As a step further to the design, we will define functional requirements of the system. The requirements should be specified based on the results of the analysis phase.

- **G6: Define functionalities offered by the system and describe particular tasks.** As a ground for implementation of the UI in prototypes, we will describe the functionalities provided by the Surveillance Center formally using scenarios, use cases, and storyboards. Again, according to UCD, we will employ the results of the phase of analysis to ensure that the final product will be satisfactory for the users.

- **G7: Create prototypes of the UI of the Surveillance Center that meets defined requirements.** We will create prototypes to put the functionalities defined formally into practice. The prototypes will allow us to present our design to the users and get their feedback.

- **G8: Describe the implementation of particular prototypes.** To get an insight of the realization of particular prototypes, implementation of each prototype will be described.

- **G9: Evaluate the developed solution with the target user audience.** We will perform an evaluation of each designed solution, so we may recognize defects that our design has and remove such issues in the following phase of design.

# Chapter 2
## Analysis

In this Chapter, we followed the first phase of the UCD process. We focused on the analysis of target domain, and we described the background for designing the solution. Primarily, the navigation system is analyzed as the design of the Surveillance Center strongly relies on it. Next, we describe related solutions of surveillance systems that could be used as an inspiration for our solution. The last part of the Chapter is dedicated to a research of target user group of the Surveillance Center.

## 2.1 Smartphone-less context-aware indoor navigation

The design of the Surveillance Center follows existing system for navigation in interiors - the In-hospital navigation system [1]. Unlike in other indoor navigation systems, the navigation process is realized without the necessity to carry any device (smartphone, pager) that would detect the location of the user. The target user group of the navigation system are people with specific navigation and orientation needs, namely senior users and visually impaired users.

### 2.1.1 Navigation process

In this section, we describe fundamental design principles behind the navigation system. According to [1], the navigation process is illustrated on Figure 2.1.

The most important steps from the perspective of the future surveillance system are described below.

- **Hospital check-in on Smart Kiosk.** The first terminal the user deals with is Smark Kiosk that allows the user log into the navigation system to be navigated. To select the desired destination, the user can prepare himself or herself for a visit in advance (Step 1 in Figure 2.1) or he/she selects the destination using Smark kiosk. What is more, the user can specify personal navigation needs or limitations. Smart Kiosk uses integrated camera to capture the face of the user for purposes of identification at other terminals in the hospital. The UI of the Smart Kiosk can be seen on Figure 2.2.

- **Step-by-step navigation by Simple terminals.** The core building blocks of the navigation system are Simple Terminals (Figure 2.3). All over the hospital, there are several Simple navigation terminals placed at corridor junctions as well as at other places where a user may need a navigation instruction. Each terminal is equipped with a camera and propagates video stream to the server. Individual users of the navigation system are identified using a face recognition method performed on the server side. The recognition is processed as follows. Firstly, the motion of a potential user is detected. In the next step, on the captured image, fast face detection algorithm is performed. If there is a face present in the capture, the frame is sent to the server that carries out advanced face recognition, resulting in the identification of

the particular user. After successful recognition of the user, Simple terminal provides the user with personalized navigation instructions. There are two ways of giving out the instructions. For most users, a showing an arrow on the display of Simple terminal is sufficient. However, visually impaired users are provided with detailed voice instructions.
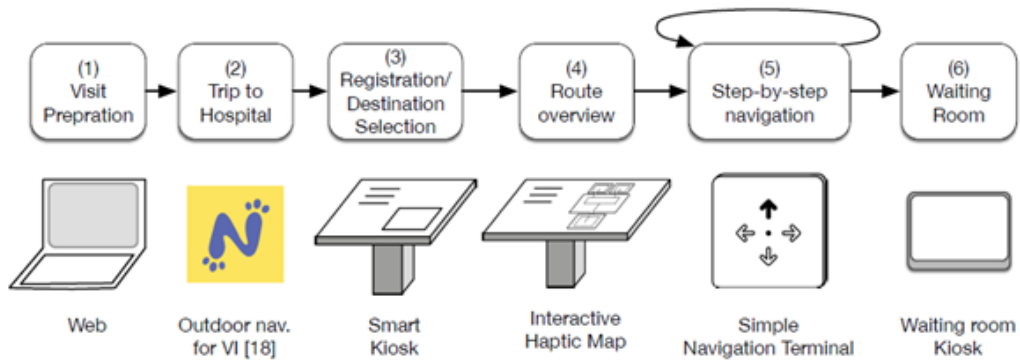


**Figure 2.1.** Navigation pipeline of the in-hospital navigation system, from [1].



**Figure 2.2.** UI of the Smart Kiosk.
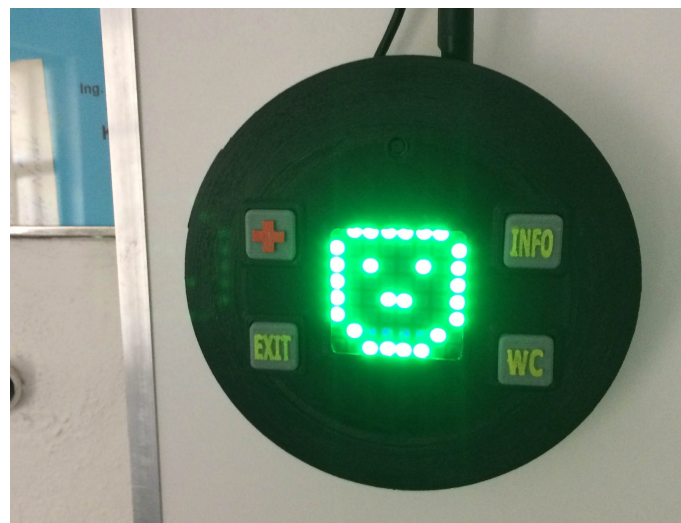


**Figure 2.3.** UI of the Simple Terminal.

## ▢ **2.1.2 UIP platfrom**

For both network communication and UI description, all the components of the navigation system use UIP protocol. Figure 2.4 shows the client-server architecture of used UIP framework applied in the navigation system. The clients, e.g. Simple terminal, Smart Kiosk, are thin by their design, and the application logic persists on the server side. From server to clients, *Models* and *Concrete User Interfaces — CUIs* are sent. CUIs describe the structure of the interface rendered by the client. Every CUI is identified by the `class` attribute of `interface` element, and its structure is composed of UIProtocol elements, such as containers, labels, inputs, buttons, and so forth.

*Models* store the data that are presented to users, and they control UIP Clients, too. To visualize data in Models, model-wide binding is used in CUIs.

In the direction from a client to a server, Events are sent. Events are triggered by user's interaction with the client, and Handlers subsequently process them.
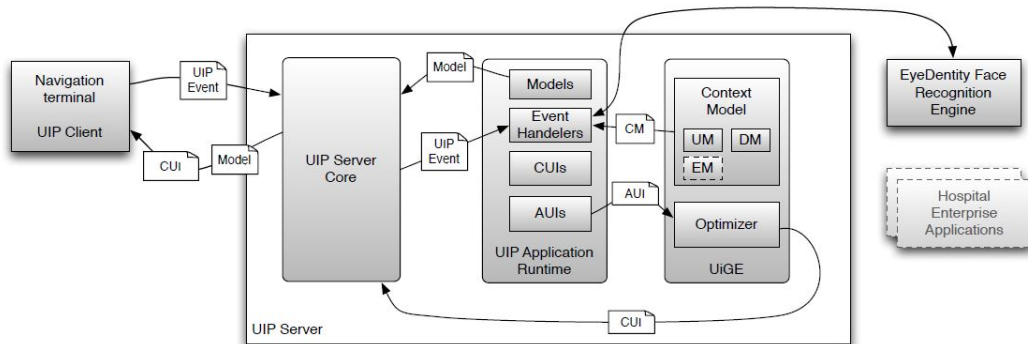


**Figure 2.4.** Client-server architecture of distributed navigation system [13]

To summarize the analysis of the UIP platform, we list pros and cons of the platform in Table 2.1.

| Pros | Cons |
|---|---|
| Easy integration of a new client to the system. | The platform is still in development, and there is no version to be proved fully stable and tested. |
| Platform independence. | Poor documentation of the implementation of the platform and no community support. |
| Native look of elements. | |

**Table 2.1.** Pros and cons of the UIP platform

## 2.2 Analysis of existing solutions

In this section, existing solutions of surveillance systems are discussed to consider their possible usage in the navigation system and to discover their benefits and disadvantages.

### 2.2.1 SARA (Situational Awareness and Response Assistant)

SARA [14] is a framework used to ensure situational awareness that integrates alarm and communication systems. The system collects data using various sensors, analyzes them and generates notifications that are spread on selected devices, e.g. mobile phones, computers, public systems.

The system offers technology *Video paging* that provides situation awareness thanks to the distribution of notifications. The notifications contain video record from the particular place together with tools intended for reaction to the newly-emerged situation, see Figure 2.5.

The user interface offers:

- Live video stream from the surveillance camera near the source of the event,
- instruction video that illustrates possible resolution of the situation,
- a capture with description,
- the map of near emergency exits.



**Figure 2.5.** UI of notification used in SARA from [14].

### 2.2.2 The Dynamic Object Tracking System

The system DOTS [15] is real-time surveillance system designed for interiors. DOTS integrates several surveillance cameras with sensors and offers a user interface that allows tracking of movement of people present in the building, analyzing of activity and recognizing movement patterns. The UI of the system is adapted to the primary purpose of the system, that is by clicking a person on a record from a surveillace camera, the operator is allowed to track his/her move on camera records. When tracking a person, displayed streams are switching automatically as the user reaches enters different locations. One of the elements in the UI is a timeline that shows events notified by the operator or events that are set to be notified automatically. Another functionality offered by the UI is switching between records using map, see Figure 2.6.
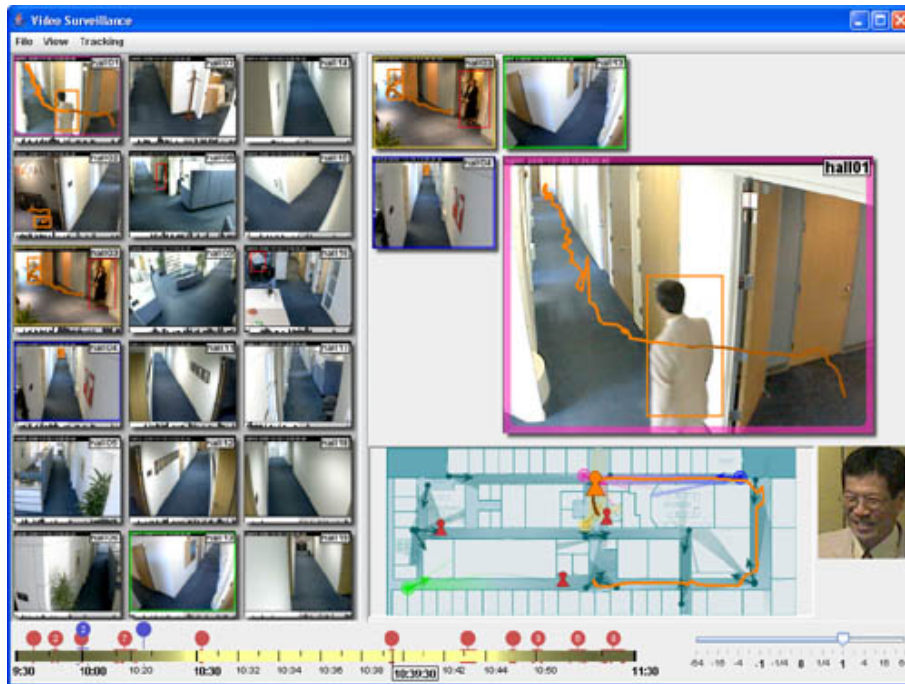
**Figure 2.6.** UI of system DOTS from [16].

### 2.2.3 Surveillance Station 8.0

Surveillance Station 8.0 [17] is a desktop and mobile application that provides UI for surveillance system. In the program, the user can switch between cameras, zoom records, view a map, and so forth. There is a built-in and in-camera event detection support that allows the user to monitor suspicious events, e.g. motion detection, missing object, foreign object, no-idle zone; and offers relevant event detection features.

When an event occurs, it is automatically recorded and displayed on a live view or E-map, see Figure 2.7. Such recordings can be locked and archived for future analysis.



**Figure 2.7.** Event detection and the UI of Surveillance Station 8.0 from [17].

### ■ 2.2.4  Comparison of existing systems

In this Subsection, we compare the features available in the surveillance systems described above. The comparison shows Table 2.2.

| Feature | SARA | DOTS | Surveillance Station 8.0 |
|---|---|---|---|
| Accessing records via map of areal | no | yes | yes |
| Tracking of people | no | yes | no |
| Integration with sensors | yes | yes | yes |
| Generating notifications in defined situations | yes | no | yes |
| Face-recognition | no | yes | no |
| Custom notification settings | no | no | no |
| Evidence of present people | no | yes | no |
| Possibility to contact people in the building | no | no | no |

**Table 2.2.** Comparison of listed existing solutions of surveillance systems.

The comparison of existing solutions of surveillance systems showed interesting features that may improve the design of our solution, namely: *Tracking of people, Accessing video streams via a map of the compound, Generating notifications in defined situations*. However, none of the systems supports custom configuration of notifications that may be used heavily in our system because of the unique environment of the hospital. What is more, the systems that provide notifications do not support tracking of people, and none of the systems makes possible to contact people present in the building.

For reasons enumerated above, we decide that we should design custom solution of the Surveillance Center.

## ■ 2.3  National legislation related to surveillance systems

Accordingly to [[18]], operation of the monitoring system is considered as processing of personal data if

- the video streams from the cameras are recorded,
- the purpose of the acquired records is to use them for identification of individuals in context with their actions.

In such cases, using a surveillance system is restricted mainly by Law for Protection of Personal Data.

According to [19], the operation of surveillance systems is regulated by Office for Personal Data Protection of the Czech Republic. The monitoring system should have:

- its purpose clearly defined,
- monitoring areas distinction to keep sufficient amount of privacy in appropriate areas,
- angle of vision set to minimalize intrusive surveillance,
- the number of cameras based on previously realized risk analysis,
- retention time of the record set to time required for processing,
- mode settings (some area might not be monitored at day, but only at night),
- fulfill information obligations.

11

## 2.4   User research

In this section, we describe user research realized using semi-structured interviews with both employees in healthcare and security.

The objectives of the research were:

- Acquiring of data for definition of the primary user group of the surveillance system.
- Definition of needs, requirements, and abilities of the possible users.
- Exploration of the healthcare and security domain.

### 2.4.1   Interviews with healthcare employees

To learn more information about the culture in a healthcare facility such as a hospital, we conducted semi-structured interviews with six representatives of healthcare employees in Masaryk Hospital in Rakovník (service area: 60 000 inhabitants).

**Participants.** Six participants (P1 — P6), four female and two male, were interviewed. Their age ranged from 22 to 61 years (mean = 43.1, standard deviation = 12.67). Participants P1 — P4 work at Radiology Department (a senior consultant, three radiology assistants), P5 (assistant) and P6 (nurse) work at Surgery Department. Mean length of practice on their actual position was 22.7 years (SD = 14.27).

**Procedure.** Qualitative semi-structured interviews were conducted with six employees (P1 — P6) in healthcare. We focused on general topics related to technology use, resolving of crisis situations and activities to be possibly supported in our system. One interview took approximately 40 minutes (5 min. briefing, 30 min. interview execution, 5 min debriefing).

**Results.**

- **Technology use.** All the participants (P1, P2, P3, P5, P6) have positive or neutral (P4) relationship to software technologies, *"It saves time. It is not even comparable to the usage of paper notebooks and constant rewriting,"* stated P6. Participants P2, P3 and P6 also stated that they would appreciate a system for on-line appointments of patients.

- **Communication at the workplace.** On the workplace, the professional staff (P1, P3 — P6) does not have any mobile device dedicated to communication. *"On the department, we solve everything verbally. Eventually, we use fixed telephone line, if there is a need to communicate with other departments".* A mobile phone is used more often by the senior consultant, but only for communication with other doctors.

- **Usage of information systems.** Participants P1 — P3 use system *"PAX"* to exchange patient information between hospitals. The next system they use is called *"NIS"* and records information about inpatients present in the hospital and about hospital operations. The last system used, *"RIS"*, supports processing and sharing radiological images.

- **Communication with visitors and inpatients.** For all the participants except P2 is ordinary to resolve units up to tens questions of both visitor and patients in the hospital every day. *"We resolve questions of patients all the time. Visitors often want to know for example the visiting hours, where should they go, what should they do, what will happen now. It is at least eight questions a day,"* stated P1.

■ **Violence in the workplace.** Participants P1, P3, P5 and P6 face violence daily, mostly the form of verbal violence. P3 sain *"The visitors are nervous. They are afraid of examination, perhaps they do not feel well, and they have to wait for a long time. The stress plays its part."*

It turned out that the staff (P1 — P6) do not have good experience in treating patients with socio-pathological behavior. *"It is always escalated with drunks, especially on night shifts. To the treatment room, they are escorted by assistants, which are frequently subtle women. Women have to care about aggressive men twice of their size,"* mentioned participant P1 that works at Radiology Department. Exacting treatment of drunks continues in the bed department because according to P6, it is very likely that the drunk would escape and it is tough to watch over them.

Not only drunks are problematic for the employees. The staff also evaluated seniors to be very troublesome. *"The older inpatients, let's say, 65 years and older, are behaving normally by day, but at night, they are living in their world. They are leaving their rooms, demanding things they have at home, and they are often aggressive. We are used to it, therefore we know how to act in such situations, but we are dealing with this constantly, and we have to be always on alert."*

Participant P3 shared a worrying personal experience of dealing with aggressive senior inpatient. *"I was working in Pilsen as a nurse, and I was punched in the face by a senior. It was an inpatient from Neurology Department, and he was older than 65 years. I met him in the entrance hall of the hospital, and he was kind of confused. So I tried to explain to him that he should go back to the department. He did not budge, and he punched me in the face. Surprisingly, though the incident lasted longer than five minutes and we were near the office of security guards, even after calling for help it was years until the security guard came."*

P6 informed about her experience with a senior lady at the age of 72. *"A woman being confused and angry suddenly started to throw things at me once. I tried to calm her down and although it does not seem like that, she being berserk was pretty strong and punches by the skinny bony arms quite hurt."*

■ **Crisis situations.** Participants P1, P3, P4 and P6 stated that more or less once a month they are dealing with situations when health conditions of a patient are worse suddenly, and it is necessary to intervene quickly. In such cases, they are giving the patient first aid immediately and call for help from colleagues verbally.

Such situations are resolved more often by P5: *"That happens very often. Especially when a patient waits for an examination, he is scared of."*

P2 had a different experience: *"As a senior consultant, I do not spend too much time with visitors. Most of the time, I am in my office. It is very exceptional that someone faints, I deal with such situations about three times a year."*

None of the participants experienced a crisis of a larger scale (e.g. evacuation, partial evacuation). Participant P6 underwent an activation of the traumatological plan: *"A bus had an accident, it was not far from here. The traumatological plan was activated, but for a reason, we are a not large hospital, in the end, only three patients with minor injuries were brought in."*

All the participants unanimously stated that preparation for large-scale crisis situations is rather theoretical. *"Theory only. We have regular training on safety, and there we discuss such situations, but in practice, we do not rehearse anything."*

## ■ 2.4.2 Interviews with security guards and officers

As a possible target group of the surveillance system was defined employees in security, that is safety guards and other employees, who experienced using a surveillance system.

**Participants.** In total seven participants (P1 — P7), one female and six male were interviewed. Their age ranged from 27 to 70 years (mean = 47, SD = 17).

**Procedure.** Qualitative semi-structured interviews were conducted with representatives of employees in the security sector. In this phase, we focused on general topics related to technology use, experiences of using a surveillance system and activities to be possibly supported in our system. One interview took approximately 40 minutes (5 min. briefing, 30 min. interview execution, 5 min debriefing).

**Results.** Following findings are organized by our points of interests.

- **Technology use.** All of the participants (despite the quite high age of the oldest participant) claim that using modern technologies, e.g. various informational systems, smartphones, digital cameras, and so forth, is a great advantage of our age. However, P5 says that he now prefers not to learn how to use new systems for doing his job, because in his opinion they could not be more helpful than it is now.

- **Common problems.** P1, P4, P6, P7 reported that they sometimes have a problem with coordination of activities they have to administer at one moment. *"I have to watch camera records, log arriving car to the paper notebook…open the gate by pushing the button there, pick up ringing telephone elsewhere. This situation happens quite often. As on purpose!"* said P7. P1 reported: *"It is sometimes very hard to coordinate what to do. From time to time it is necessary to prioritize activities and leave some of them for later. However, it is always your problem — you need to remember, what you have missed. Very useful is to know where particular things like telephones, notebooks, and notes are and leave it always in the same place."* P4 reported another problem with activity coordination. *"We do not have any hinterland near the place where the surveillance system is, and there's always only one guard on duty. So when I need to visit the toilet, I have to walk about five minutes to toilets and then next five minutes on the way back. Even if I was a superhero, there's always time, when no one is watching the system, and there's nothing I can do with it."*

- **Contacting other people.** Participants P1, P5, P6, P7 *"We have written the most important contacts here on the paper. By 'the most important' contacts I mean those which are helpful when some critical issue happens like the police, ambulance service, but also the management and so on,"* reported P1. All of the participants also contact other people from the building they are working in. The majority of them uses paper notes to find a contact to the individuals (only P5 and P4 works with electronic evidence of employees). They agreeably claimed that there could be very helpful and much faster to use an information system. There is also a problem with integration of telephone calls — P1, P6, P7 have to use multiple phones (devices) on different occasions, and that is, by their words, sometimes *"pretty confusing"*.

- **Usage of informational and surveillance systems.** All participants except P2 have experience of using camera surveillance system, but the intensity of the usage varies widely. Participants P1, P5, P6 only watch miniatures of the records on the monitor, and they also can maximize particular record on the full screen. P5 reported a problem with the delay, which causes much confusion. *"This system…sucks, you*

*know. Here on the screen, I see a person in a hall, but this person can be already away in the metro. The delay of view is horrible. Cameras are recording in intervals, but the set interval is too short. What is worse — it is not easy to recognize if the camera is now recording, or what was the time the last picture was taken."* *"The surveillance system is fine, but I would be grateful if it was not just a view of the current situation. The system could be connected to some sensors like heat and smoke sensors, I do not know exactly, and notify me that something wrong is happening somewhere. That would be great!"* reported P1. P3, P4, and P7 are advanced users of surveillance systems — they know tools provided by the systems and use them. They also have access to watch previously recorded videos and process them. However, they face some problems, too. *"The system offers quite useful tools for work with the previously recorded videos, but there's one thing which annoys me. It is always hell to find the record from a particular moment in time. The records are marked in an unpredictable way and the time is different in every file."*, says P4. Another problem causes motion detection settings, claims P4 and P7. *"There is a possibility to set a recording on only when the camera detects motion. I tried it, but it missed a lot of fast moving objects."*, said P7. *"Our cameras are recording only when they detect motion. In many cases, they miss, and we are not able to fix this issue."*. P4 also has a problem with the user interface of the system: *"The windows with records on the monitors are not sorted. It means that if I spot someone in some record and I want to track him, I have to check many record windows and wait where he will appear. It is not even guaranteed it will be on the same monitor! We can change the layout of the windows. I tried it when I started working at this place, but my colleagues were used to the old layout, so they did not like it."* P3 has not any of stated problems — in fact, he praised the surveillance system he uses. *"It is quite good — the tools for video processing are great, and thanks to the layout of the records are easy to track anyone or quickly find a record from the desired place. I appreciate that record window can be maximized."* P2 does not use any surveillance system during his shift, but he has experiences of using an informational system on the business smartphone. *"It is a great advantage to have this gadget and the system in the terrain. Although we are not in the office, we have all needed information. Another benefit of the system is automatization of making reports. Reporting was very tedious activity in the past — now it is super easy and quick. It is also much easier to share information with colleagues in real time."*

## 2.5 User groups

In this section, we define user groups of the surveillance system and their roles when using the system. Based on the analysis of the domain of healthcare facilities and realized user research, two user groups were identified:

1. Primary user group — operators of the surveillance center
2. Secondary user group — employees of the hospital

Both Primary and Secondary user group are described in subsections below.

### 2.5.1 Primary user group

As a representative of the primary user group of the system, we chose an employee of the security sector. In the beginning, we were considering whether a healthcare employee could be the main user of the system. However, having learned more about the work environment of hospitals [10], we decided to reject this option. Hospitals have a lack of staff [20] and actual employees are overloaded. Healthcare employees are always on the move, and they do not have the capacity to watch records from terminals. Also, the user research showed, they have to face many security problems. Moreover, sometimes they fear for their safety.

For this reason, it is appropriate to delegate such problems to a security employee, who will be the operator of the surveillance center, and thus the burden of healthcare staff will be reduced.

The operator will be fully concentrated on surveillance on the hospital and provide support to the healthcare employees.

Also, a central point of the hospital will be created, and there could be made serious decisions like a start of evacuation, see Section 2.6.

A detailed study of the Ministry of Labor and Social Affairs of the Czech Republic [21] and the user research of security employees (Subsection 2.4.2) were used as a basis for defining the needs of this user group.

**Profile.** According to [21], in the group of employees of the security sector in the Czech Republic, 83 % of employees are men. The mean age of an employee of researched group is 43.7 years, and in perspective of education, upper secondary education prevail. That is, the representatives of the group are mainly graduates having passed maturity exam (75 %). Another fact is that in this group, the employees older than 60 years occur significantly more than in other sectors — their number is up to 5.6 percent points higher than total share of employees older than 60 years in the state).

Important factors for employees in security sector are:

- support of their work and social relations,
- independency,
- success of their work.

**Persona: Josef.**



**Figure 2.8.** Persona: Josef. Source [22]

- Man, 39 years old
- High school education in engeneering
- Residence: Prague, Vinohrady

Josef successfully graduated from the Secondary School of Electrical Engineering and Mechanical Engineering in Prague. After school, he joined the company Kovo a.s. that manufactures machinery components. Although Josef likes new technologies, cars and he is a passionate computer user, the work in the production did not fulfill him. He likes to be independent, and he is annoyed when someone constantly tells him what he should do. Therefore, he accepted an offer of his friend to start working as a night watchman at a parking lot near Wenceslas Square.*"It was very tough at Vaclavak. People under the influence of drugs were not afraid of anything. It bothered me that I had to watch the parking in my car that was constantly damaged there."*

After Josef had become a father, he decided to find him a different job. He got employed as a security guard at the Academy if Sciences of the Czech Republic. It was a shiftwork, and his duty was to watch records from security cameras and make rounds around the compound of the Institute regularly. *"At the Insitute, it was a very cool job. Maybe too calm."* He probably would not change his situation, if a directive for recruitment of employees did not change. The Institute joined a programme that offered working places to people with disabilities. *"We had the opportunity to stay and take a lower salary, or leave. I needed a change anyway, so I left."*

After Josef had left the Academy, he applied for a position of the operator of the Surveillance Center in Central Military Hospital in Prague. *"It was an interesting offer. I had to go through many training courses, after all, it is a responsibility, these are human lives. Processes like evacuation are not fun; it is a serious thing.".* A colleague Jaroslav, who use the system for longer than a year, trained him. *"Jarda showed me how things are going around here. A hospital is a busy place, and I have to keep track all its parts. I am glad I share an office with colleagues of the Contact Point of the hospital, so I am informed about all the events that happened here."*

In a spare time, Josef plays computer games, or he goes motocross with his son. *"My wife worries about us, but I soothe her. We are careful, and I have completed a first aid course!"*

*Needs of Josef while using the system:*

- He watches the records from the surveillance cameras all the shift. Therefore, he needs the record windows to be arranged clearly.
- If a problem occurs, he needs to know sufficient information about the place of the problem (location, some people who are nearby, contact to people who are near).
- The opportunity to call help must be quickly available — every second count.
- He would not be afraid that he causes an alarm of a large scale in an inappropriate situation.

17

### ▪ 2.5.2   Secondary user group: healthcare employees

The motivation for the establishment of Surveillance Center is also the poor working culture on healthcare workplaces. For this reason, the user research was focused on needs and requirements of healthcare employees. Based on the results of the research (Subsection 2.4.1), the healthcare employees were chosen as the secondary user group of the surveillance system. The system could improve the efficiency of communication among colleagues in the workplace and between the staff and the visitors of the hospital, too. The system could also help to decrease the workload of the staff when working with problematic inpatients and contribute to the improvement of their safety.

**Profile.** According to data of Czech Statistical Office from the year 2011 [23], 80 % of healthcare employees in Prague were women (the group covers both specialist and professional assistants). The largest representation in the category of professionals in the healthcare has women aged 35 — 39 years, in the category of professional workers women 25 — 29 years. According to interviews with Participant 3 and Participant 6:

*Important factors while working peformance*:

- Social relations,
- good feeling about the work done,
- working conditions — feeling of safety.

*Needs*:

- Quick communication with colleagues and individual departments,
- teamwork,
- minimalisation of burden with the administration.

*Characteristics*:

- Good communication skills,
- empathy, patience,
- organization skills.

## ▪ 2.6   Possible location of the Surveillance Center

Having defined the primary user of the surveillance system, that is the operator of the Surveillance Center; we focused on the location of the Surveillance Center within the hospital.

As a possible solution for placement of the Surveillance Center, we defined so-called Contact Point of Hospital. Following the Law 374/2011, in the Czech Republic, every hospital is required to establish such place if there are provided services of bed department. The main purpose of Contact Point is to ensure a smooth transition from emergency services to the health care. At Contact Point, the hospital shall keep a record of beds available. With the merge of Contact Point and Surveillance Center, there would be a point that would collect all the data about an operation of the hospital, which could positively impact the normal functioning of the hospital and the operation in crisis situations, too.

## 2.7 Functional requirements

This section specifies functional requirements for the surveillance system. The requirements are based on analysis of existing solutions and realized user research.

**The system allows the operator to:**

1. *F1: Watch records from cameras of Simple terminals.*
   The operator should permanently oversee the situation in the hospital and prevent potential threats.

2. *F2: Display details about the area of the particular Simple terminal:*

   a) *its position on a map,*
   b) *number of people near the terminal,*
   c) *other near terminals.*
      Such functionalities would increase the level of situational awareness of the operator.

3. *F3: Speak via Simple terminal.*
   The operator should provide information to visitors of the hospital without forcing them to use any portable device.

4. *F4: To track a user.*
   As a prevention of security issues, the operator should be able to keep an eye on specific visitors.

5. *F5: To resolve a problem when*

   - *the health is threatened,*
   - *the security is threatened.*

6. *F6: To show contacts on employees of the hospital and to contact them.*
   In cases of a health threat, it is necessary to call for help from other staff in the hospital.

7. *F7: Activate evacuation plan.*
   If a serious threat of hospital's visitors occurs, after receiving approval from the hospital's management, the operator should be able to configure the navigation system for evacuation.

8. *F8: Contact security services (Security office of the hospital, the police).*
   If a security threat occurs, it is necessary to call for help from an appropriate safety service.

**The system itself:**
Interviewed security employees (P4, P1) reported that they would appreciate if the system informed them about potential threats.

1. *F9: Recognizes a fall of a person in a record.*
   The system should help the operator to notice possible health threat to increase the number of eliminated health threats.
2. *F10: Recognizes a foreign object.*

The system should help the operator to notice possible security threat to increase the number of eliminated security threats.

3. *F11: Generates notification in case of a problem with face-recognition.*
   The system should notify the operator that his intervention is required.

**The system allows the healthcare employees to:**

1. *F12: Call for help in a crisis.*
   As the user research showed, medical staff face in many cases security issues. In such situations, the system and the Surveillance Center should provide them support.

2. *F13: Track a patient.*
   In conducted interviews, the healthcare employees (P1, P2, P5, P5) mentioned problems with patients that are leaving their rooms. They can endanger other visitors of the hospital and even themselves. For this reason, if the staff recognize potentially problematic patient, they can track them by the Surveillance Center.

3. *F14: Receive requests for assistance in case of a health threat.*
   In the event of health threat, healthcare employees could offer required help for visitors in trouble.

# Chapter 3
## Design

In this Chapter, we present the design of the Surveillance Center. The decisions made in the design process are based on the facts ascertained in the phase of the analysis (described in Chapter 2). Note that in this thesis, we focused on UI for the operators of the Surveillance Center as they are the primary users.

In following Sections, the design is firstly described formally using scenarios, use cases, and storyboards. We created a formal model of the UI using the Hierarchical Task Analysis and Plans, too. Secondly, the paper mockup, the low-fidelity and the high-fidelity prototype of the user interface is described as well as the process of its evolution.

## 3.1 Formal description of user interface

The section describes the interaction between the surveillance system and its users designed on the basis of performed analysis. The needs and goals of the users are firstly showed on examples in scenarios, then generalized in use-cases and illustrated using storyboards.

### 3.1.1 Scenarios

In this subsection, we specify the needs indicated in the analysis of target domains using scenarios. The scenarios describe in detail such situations, whose resolution should be facilitated by the designed system.

#### Support for the navigation system

- **Scenario S1N1: Identification of a navigated user.** For health reasons, Mrs. Eva Novotna (48 years old) had to visit the hospital. Eva is partially blind, and therefore, she decided to get herself navigated to the doctor's office by the navigation system. After she had arrived at the hospital, she checked herself in using the Smart kiosk and set out. Everything went right until Eva reached a hall, where the day before Eva's visit one of the corridor's lamp stopped working. Because of limited visibility in the hallway, the face-recognition algorithm was not able to identify Eva with sufficient confidence. The operator of the Surveillance Center handled this issue and using the system, he decided that the person in the photo from Simple Terminal's camera be Mrs. Novotna. So, Eva received next navigation instructions and arrived at the doctor's room safely.

- **Scenario S2N2: Answering a question of a visitor.** Mrs. Anežka Jirutkova came to the hospital to visit her friend Jiří, who had have a serious incident while motocross and broke his leg. Unfortunately, she did not find information about visiting hours of the Surgery Department on the web page of the hospital. What is more, she did not know, where to go. At first, she studied the map of the hospital, but it did not help too much. After a while, she noticed an announcement of new service available

in the hospital, so she decided to use navigation system. By pushing a button of the Simple Kiosk, she contacted the Surveillance Center and asked the operator for help. The operator told Anežka desired information and he used the navigation system to navigate Anežka to the right place. Finally, Anežka reached the desired destination, and she was delighted by the new service of the hospital.

**Resolving of crisis situations of visitors**

- **Scenario S3E1: Identification of false alarm.** Mrs. Holečková, a mother of three, had to visit Pediatrics with her one-year-old daughter. Because she did not manage a nanny to care for her other children (son Petr - 3 years old, daughter Anna - 5 years old), they have to go to the hospital, too. At the moment Petr and Anna waited alone for their mother and sister to come back from medical examination, they noticed there is a fancy-looking thing with colorful buttons: one of the Simple Terminals. They decided to push one of the buttons and, unfortunately, it was Emergency button. The operator of the Surveillance Center noticed the event, and after he had viewed the record from the terminal, he resolved it as a false alarm.
- **Scenario S3E2: Providing help for visitors, whose state of health suddenly got worse.** Mrs. Věra Malátná visited the hospital because of her problems with chest pain. She has no close relatives anymore, so she had to go there without accompaniment. From the Cardiology Department, she was sent to another department to take her blood samples. On the way, Mrs. Malatna started to feel faint and walk unsteadily. After a while, she fell into a faint. The was recorded by a camera of one of the Simple terminals. In the Surveillance Center, the operator spotted her lying on the floor, and he called a nurse to help her. Hospital staff quickly found Mrs. Malatna and gave her first aid.

**Resolving of security problems**

- **Scenario S5S1: Tracking of problematic patients.** Ambulance service brought Mr. Sivak (22 years old) into the hospital. He had a stab wound, and he was not capable of explaining what happened to him. It was identified that he is a drug addict, he was aggressive, and he was insistent that he be all right and the wound is just a scratch. The nurse added Mr. Sivak to Register of tracked patients of the Surveillance Center, and so the navigation system tracked his activity. After three days of treatment, he tried to escape from the hospital. However, thanks to the Surveillance Center, the security guard arrived promptly and stopped him from escaping.
- **Scenario S6S2: Intervention when a healthcare employee is in an insecure situation.** Ambulance service bring Vaclav Hrozny (38 years old) into the hospital. He was drunk, and although he seemed to be calm in the first moments, he started to be very aggressive in the treatment room later. He attacked the nurse verbally, and he pushed her back by violence when she tried to take his blood sample. So, the doctor call for help to the Surveillance Center. The operator of the center called a security guard that pacified Václav.
- **Scenario S7S3: Evacuation of the hospital.** An anonymous person reported that there is an explosive device in the Emergency Department. In the Surveillance Center, the possible location of the device was detected and so the number of people present in the immediate proximity of it, and in the hospital overall. After consultation with management of the hospital, the evacuation plan was put into action:

Simple Terminals of the navigation system started to show visitors of the hospital way to near emergency exits.

### 3.1.2 Use cases

The use cases generalize scenarios stated above and define the interaction between users and the system.

The detailed description of the section can be found in Sections B.1 — B.9 of Appendix B.

#### UC1: Identification of a navigated user

- Corresponding scenario: S1N1
- *The operator solves such case when the algorithm for face recognition did not recognize the user of the navigation system with sufficient confidence.*

#### UC2: Providing information to visitors

- Corresponding scenario: S2N2
- *A visitor demands information from the operator of Surveillance Center.*

#### UC3: Processing of a request for help

- Corresponding scenario: S3E1
- *A visitor pushes the Emergency button of the Simple Terminal.*

#### UC4: Resolving of a situation when the health is threatened

- Corresponding scenario: S4E2
- *A visitor demands information from the operator of Surveillance Center.*

#### UC5: Tracking of a problematic patient

- Corresponding scenario: S5S1
- *There is an aggressive patient in the hospital, and it is assumed that he will try to escape from the hospital.*
- *There is a patient with problems with orientation in the hospital.*

#### UC6: Stopping a tracked inpatient from escape

- Corresponding scenario: S5S1
- *A patient that is in the Register of tracked patients reached a forbidden destination.*

#### UC7: Resolving of a situation when the security is threatened

- Corresponding scenario: S6S2
- *There is a vandal in the hospital; a visitor acts aggressively; or there is a global threat, e.g. presence of an explosive device.*

#### UC8: Viewing the statistics about the number of people present in a concrete area

- Corresponding scenario: S7S3
- *The operator wants to know how many people there is in a particular area of the hospital.*

### UC9: Evacuation of a hospital

- Corresponding scenario: S7S3
- *There is a global threat in the hospital.*

### 3.1.3 Storyboards

In this Subsection, selected usages of the system are illustrated using storyboards. We created storyboards for two use-cases:

- **UC2: Providing information to visitors**,
- **UC4: Resolving of situation when the health is threatened**.

Both storyboards can be found in Appendix E.

## 3.2 Formal model of user interface

In this section, we define a formal model of the Surveillance Center UI to specify the behavior of the system.

### 3.2.1 Hierachical Task Analysis and Plans

The Hierarchical Task Analysis can be found in Appendix C and created plans can be found in Appendix D.

## 3.3   Paper mockup

A very first low-fidelity prototype of the user interface was created in the form of a paper mockup. The mockup was designed to fulfill functional requirements defined on the grounds of the user and domain research. That is, to provide the operators UI that will allow them to resolve use cases specified in Section 3.1.2.

The paper form was chosen as an efficient tool for the definition of the basic layout and flow in the program because there are no limitations and possible changes can be rapidly integrated.

### 3.3.1   Dashboard

As a main screen of the program, *Dashboard* was designed. Ideas strongly reflected in its design are:

- Most of the time, the operator should focus mainly on the miniatures of records from cameras of Simple terminals. So, the layout of the dashboard should be very simple, let the operator pay attention to events he sees in the records and does not disturb by needless noticeable elements.
- The main screen should serve as a signpost for accessing all other sections available in the program.
- To keep operator's awareness on a high level, the main page should inform him about his recent activity and recent activity of other users of the system, that is about actions that can not be seen on by regarding the camera records.

There is a bar on the top of the screen that displays icon menu for accessing Supporting tools described in Subsection 3.3.4 and actual time. On the right, there is a box that displays recent activity of the operator. Finally, the majority of the screen is dedicated to miniatures of records from cameras, while every record is identified by its unique ID (e.g. Terminal 1, Terminal 2) and its location, see Figure 3.1.
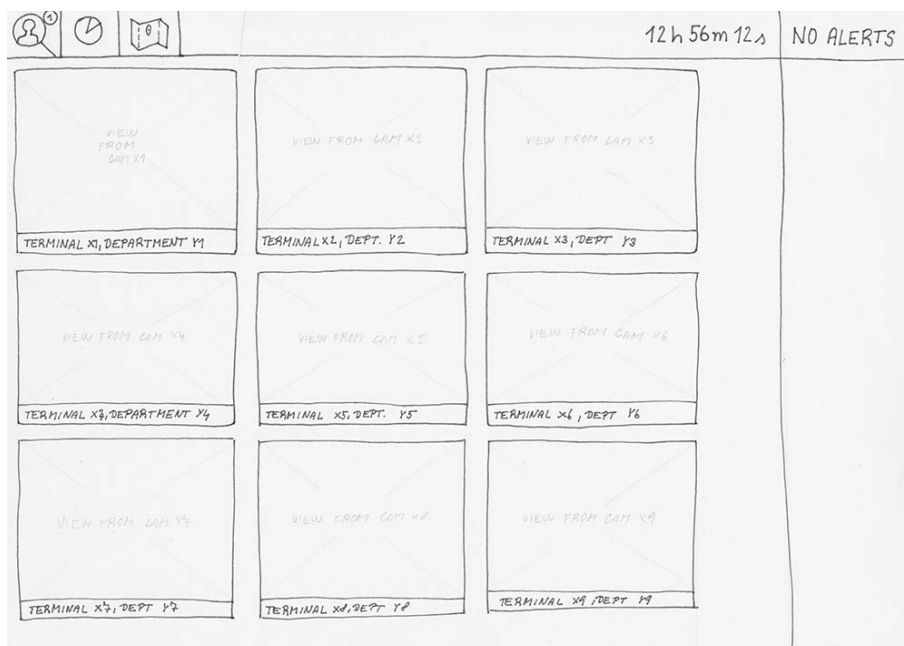


**Figure 3.1.** The main screen of the program: *Dashboard.*

25

### 3.3.2 Detail

To provide the user with tools for analysis of the situation shown on selected video record, *Detail* screen was designed. It is accessible by clicking a miniature of a record and in *Detail*, the user is allowed to:

- rewind the record,
- display a record from near terminals,
- speak via the terminal,
- show the location of the terminal on the map.

What is more, if the user decides there is a problem going on in displayed area, he can create *Alert* to resolve the ongoing situation, see Figure 3.2.
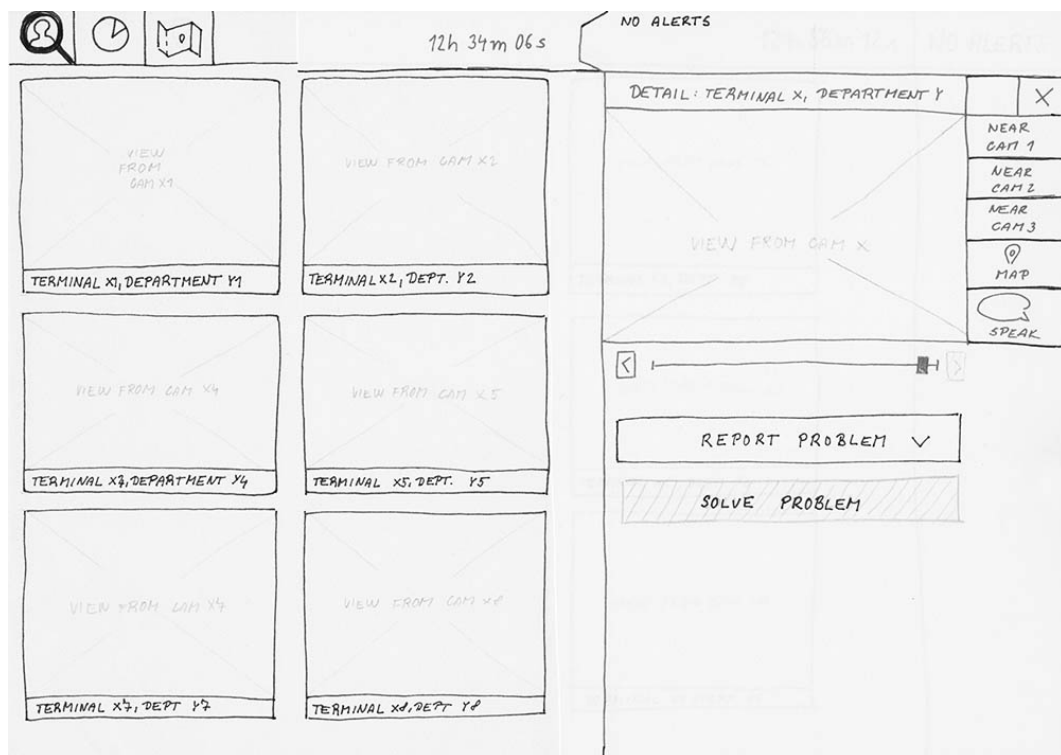


**Figure 3.2.** The layout of *Detail* screen.

### 3.3.3 Alerts and alert-resolving

As a tool for resolving of such cases when an interaction between the operator and other users of the system is required or, there is a threat that has to be resolved, we designed *Alert* screens. The ideas that affected their form were:

- If the operator did not discover the problem by himself, he should be considerably notified that he should focus on resolving of the newly-emerged situation.
- The operator should be provided with relevant information about the ongoing situation, that is where, when and what is happening.
- The operator should have a use of tools that would help him to classify ongoing situation.
- The operator should be provided with tools for easy resolving of the situation and such tools should be suitable for the current problem.
- It should be clear when the operator started to resolve a problem and when he stopped to prevent potential disputes.

According to this, the process of alert resolving is defined as follows:

1. The alert is created.
2. The operator analyzes the situation.
3. The operator takes necessary steps to resolve the situation.
4a. The operator resolves the situation and closes the alert.
4b. The operator does not resolve the situation and closes the alert.

Those steps are reflected in the layout of the screen, see 3.3.
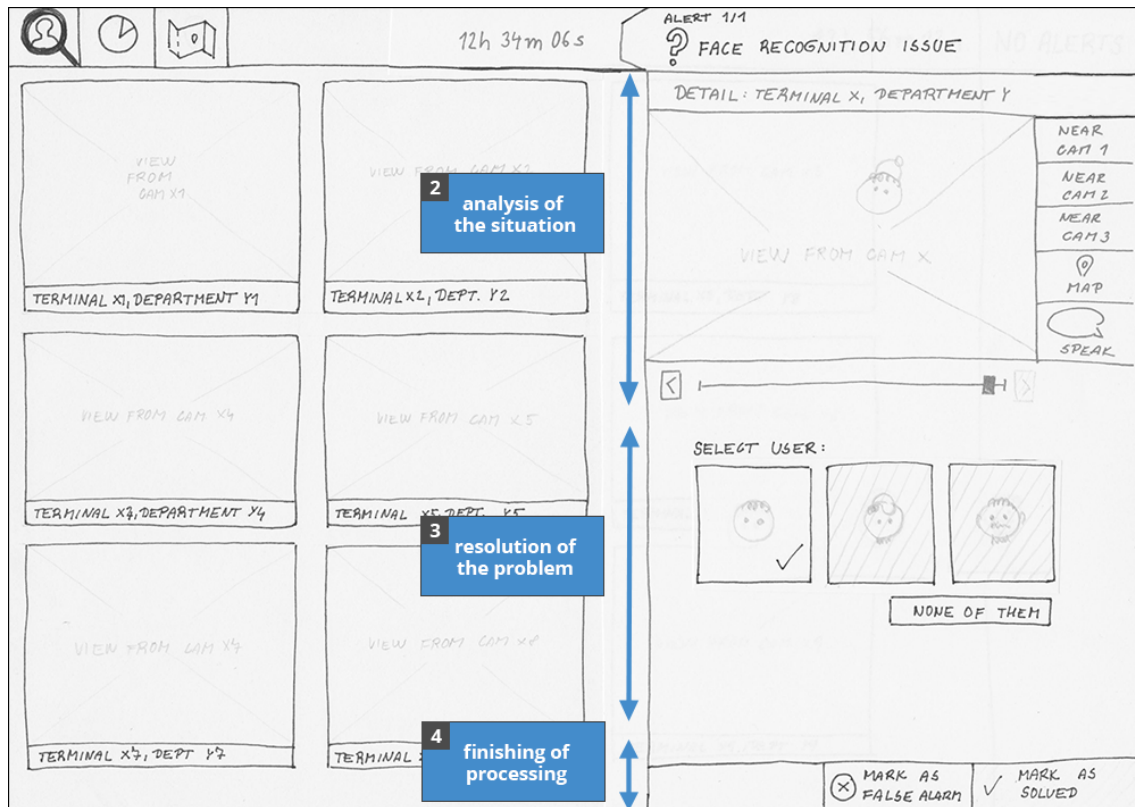


**Figure 3.3.** An example of *Alert* screen.

**Types of alerts.** Various types of *Alers* were designed to ensure that the operator has the use of proper tools for the actual situation. Using this approach:

- The operator instantly knows what kind of problem or request he will be resolving.
- According to the type, the alert can offer different tools for resolving.
- Potential newly discovered problems can be integrated into the system simply by adding a new type of Alert.

There are now six types of Alerts designed, for details see table 3.1.

**Tools for resolving of a problem.** As mentioned before, every type of Alert offers different tools for resolving that corresponds with the current situation. For example in Info request Alert, there is a search input that allows the operator search for information demanded by the visitor, and so forth. Overview of resolving tools of specific alert types can be found in Appendix F. Except for commonly used elements such like buttons, there was designed a feature that needs to be explained:

- *Description of situation using tags.* When Health threat alert occurs, the objective of the operator is to call appropriate healthcare employees that could immediately

27

| Type name | Origin | Covered use-case |
|---|---|---|
| Health threat | Arose by the operator or when the system detects a fall of a person on the hall. Provides *Description using tags*. | UC4 |
| Security threat | Arose by a user of the secondary user group or by the operator when a security threat occurs. | UC3, UC7, UC9 |
| Face recognition issue | Arose by the system in case of indicated insufficient confidence in processed face-recognition. | UC1 |
| Move of tracked inpatient detected | Arose by the system when a tracked inpatient is recognized on Terminal outside defined area. | UC6 |
| Info request | Arose when a visitor pushes *Info* button on Smark Kiosk. | UC3 |
| Emergency button pushed | Arose when a visitor pushes *Emergency* button on a Simple Terminal. | UC3 |

**Table 3.1.** Types of Alerts and their description

help the person in trouble. However, this task requires being perfectly used to the environment of the hospital. What is more, even if the operator knew all the hospital staff, the process of manual selection would be long-drawn-out. For this reason, we let the operator describe the situation using tags and, based on selected tags, the system selects users from the secondary user group that are supposed to be currently available. This feature can be seen in the Tools of resolving of Health threat alert.

**Finishing of processing of an alert.** Processing of Alert can be finished in three ways:

- *Alert is marked as solved.*
- Alert is marked as a false alarm.
- An evacuation plan is put into action *(this option is enabled only after approval by a management of the hospital).*

## ■ 3.3.4 Supporting tools

The purpose of Supporting tools is to keep a general awareness of the operator on a high level. They are accessible by clicking icons in the top bar (Figure 3.4) on every designed screen while a separate window represents each tool and the operator is allowed to drag-and-drop them and to close them. The specific tools are:

a) **Tracking of inpatients**

  • Requests for tracking

- Add patient to the register
- Tracked inpatients

b) **Statistics**

c) **Map of terminals**



**Figure 3.4.** Supporting tools represented by icons in the top bar.

Design of each supporting tool window can be found in Appendix G.

### ■ 3.3.5 Summary of the paper mockup design

In the first design phase, the paper mockup was created to define the layout and elementary interaction between the system, the operator and other users of the system. The mockup was evaluated using expert analysis (for results see Section 5.2) and further developed in the low-fidelity (Section 3.4) and high-fidelity (Section 3.5) prototype.

## 3.4    Low-fidelity prototype

Screens and interaction specified in the paper mockup were implemented into a new low-fidelity prototype using tool Balsamiq Mockups (tool described in Section 4.1). Now, the goal was to create a prototype that:

■ corrects issues found in the evaluation of paper mockup (Section 5.2),
■ resembles more the final appearance of the program,
■ is easier to maintain.

This prototype was evaluated in usability study with three representatives of the primary user group. Because the participants were from the Czech Republic, the prototype has been created in the Czech language. An example screen of the UI of the low-fidelity prototype can be seen in Figure 3.5.

### 3.4.1    Improvements

We reflected the findings of the evaluation of the paper mockup, and we made a few changes in the UI.

■ **Unification of approach to the selection of people to call in an emergency situation.** In the paper mockup, selection of individuals that could help to resolve a problem was realized differently in Health threat alert and Security threat alert. To preserve consistency in the system, in the new prototype is in both types of Alerts used Description of the situation by tags.
■ **Feedback in Face recognition issue alert.** The evaluation showed that in Face recognition issue alert, the user does not receive sufficient feedback when he selects a user that should be navigated. So, in the low-fidelity prototype, when the operator selects a user, label with content *Mark the alert as solved the user will be navigated again* is displayed.
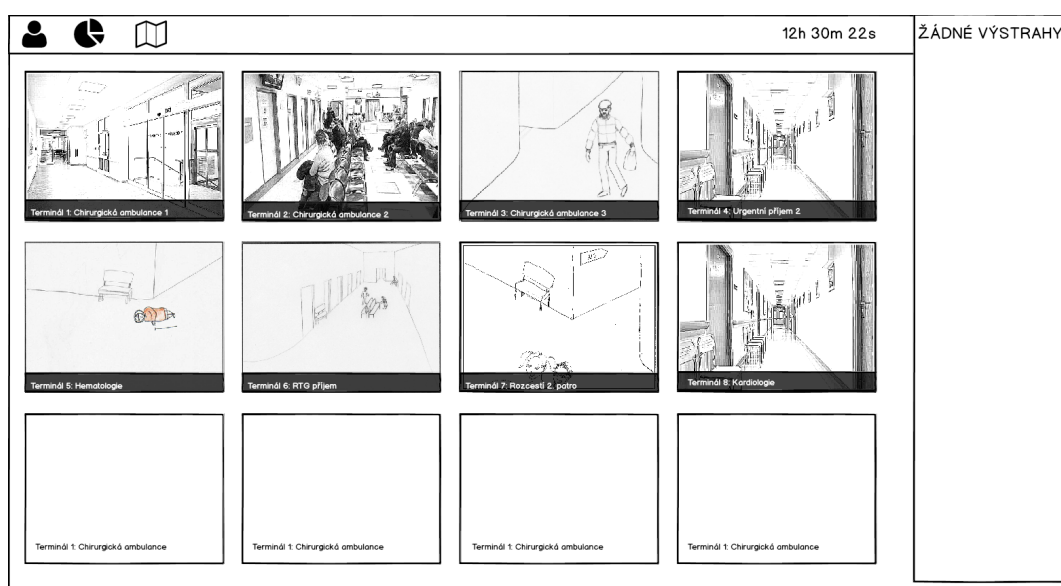


**Figure 3.5.** Dashboard screen in the low-fidelity prototype.

## 3.5   High-fidelity prototype

The section describes created high-fidelity prototype of the Surveillance Center UI. The prototype is implemented in the UIP platform (see the description of the implementation in Section 4.2).

The concept of the UI remains the same as the usability study of the low-fidelity prototype proved that there are no critical issues and the system is usable. Again, there are used screens specified in the very first prototype — the paper mockup (see description in Section 3.3.) In comparison to the low-fidelity prototype, mainly the visual appearance of UI was enhanced. There are implemented a few animations, too. For example, when *Detail* of terminal opens up, x-position of the window is interpolated, so a slide-in effect is created. The color palette used in the UI of the prototype consist of gray, blue and red used as an accent color (used for example in Alerts). Similarly to the low-fidelity prototype, due to evaluation with users from the Czech Republic, the prototype is in the Czech language. Examples of UI of the high-fidelity prototype follows.

### 3.5.1   Examples of the UI

In this Subsection, we present several screens of the UI of the high-fidelity prototype.

**Dashboard.** The main page strongly follows the design descibed in Subsection 3.3.1, see Figure 3.6.
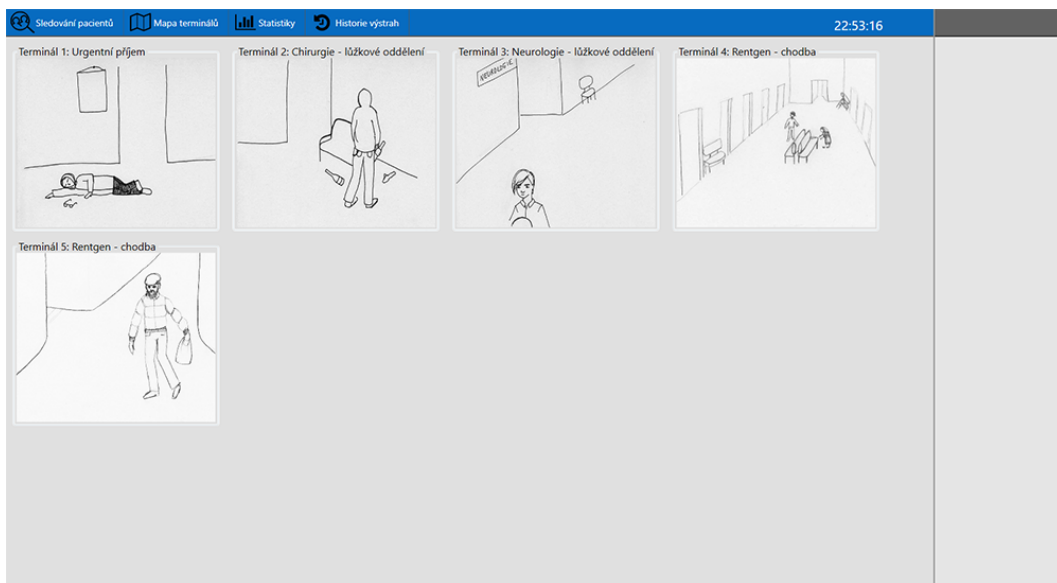


**Figure 3.6.** Dashboard screen in the high-fidelity prototype.

**Detail of a terminal.** The Detail of terminal contains a window that displays the video stream from selected terminal and four buttons offering tools for analyzing the situation — the user can switch between nearest cameras (in case the view is switched, the back button is displayed), speak via the terminal and show the terminal on a map. Below the top part of the screen, the user can report a problem — create an Alert appropriate to an ongoing situation. Figure 3.7 shows Detail screen after clicking on *Terminal on the map* button.
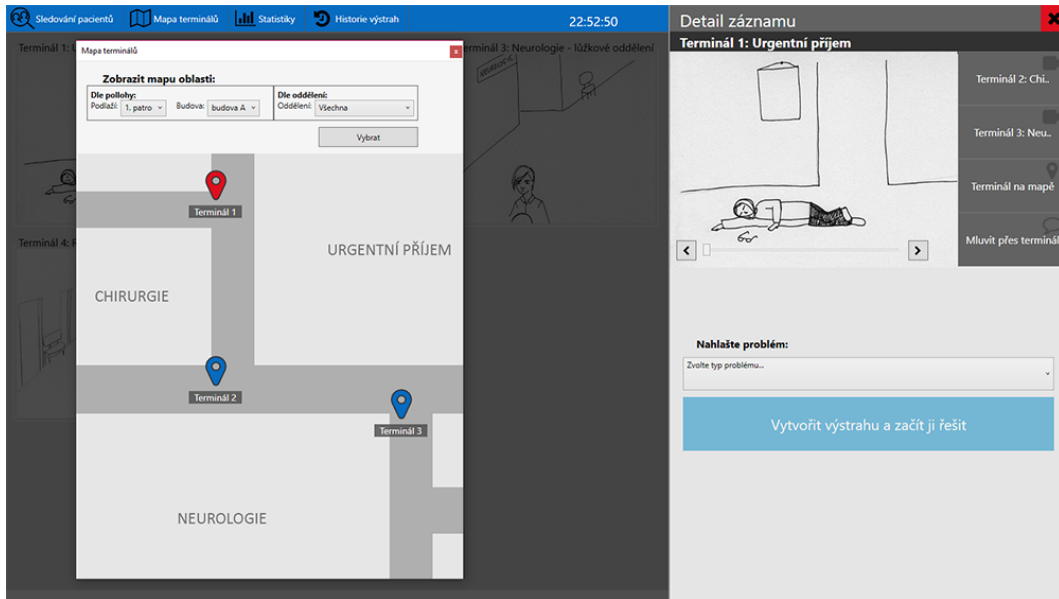
**Figure 3.7.** Detail screen with Map of terminals opened.

**Alerts.** The principal feature in the design is Alert screens. The usability testing of the low-fidelity prototype proved that it is simple for the users to solve various types of issues in this manner. Therefore, the types of alerts stayed the same as described in Table 3.1. Again, in each type of the Alert screen, there are available different Tools for resolving the situation. As an example, we show Security threat alert in Figure 3.8. In Appendix H, there is an overview of Tools for resolving the situation of each type of Alert.
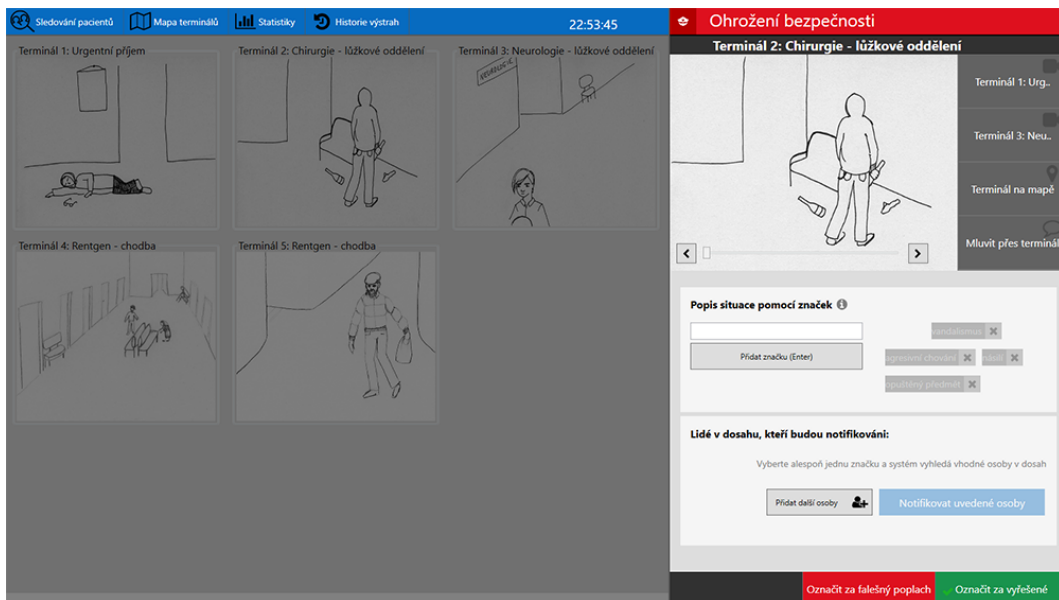


**Figure 3.8.** Security threat alert screen.

### ■ 3.5.2 Improvements

Based on results of the usability study of the low-fidelity prototype that can be seen in Section 5.3, a few improvements were made.

- **Text representation of items in Supporting tools menu.** Because for the participants of realized usability study it was hard to recognize the meaning of icons used in Supporting tool menu, in the high-fidelity prototype, every item of the menu has its text representation, too.
- **Highlighting of the buttons for finishing of processing of the Alert.** In the usability study, the participants have a problem to find *Mark alert as false alarm* button. For this reason, in the high-fidelity prototypes, bottom buttons are highlighted by using of bright colors on their background.

In conclusion, we reflected the findings of the evaluation of the low-fidelity prototype in the newly implemented prototype. The evaluation of the high-fidelity prototype showed that such issues were eliminated and the user interface proved to be intuitive and usable for the users, see Section 5.4.

## ■ 3.6 Summary of the design

In this Chapter, the evolution of the user interface of the system was described as well as the functionality, layout, interaction and visual appearance of each created prototype. According to the UCD approach, we evaluated each prototype and, what is more, two of three prototypes were evaluated with the target audience. The findings of each phase of evaluation influenced the following prototype, so the UI is considered to be adapted to needs and requirements of its users.

For the reason that the formally described functionalities of the system are very complex, in this thesis, we focused mainly on resolving of crisis situations of a minor extent and providing of support to the navigations system. Although we kept in mind that the design should be extensible for situations like evacuation of a hospital, such features are not fully designed yet.

Details about the implementation of the prototypes can be found in Chapter 4; description of the evaluation of the prototypes is summarized in Chapter 5.

# Chapter 4
## Implementation

In this chapter, the development tools used for the creation of the low-fidelity prototype (specified in Section 3.4) and high-fidelity prototype (specified in Section 3.5) are described as well as the implementation of the high-fidelity prototype. Note that the description of the implementation of the low-fidelity prototype is not reported because the prototype was presented to the users as an interactive form of paper mockup without having any computations or written logic behind it.

## 4.1 Development tools

For the purpose of creation of the prototypes, a few development tools were used.

For the creation of the low-fidelity prototype, tool Balsamiq Mockups 3 [24] was used. The tool allows users to create paper-alike mockups of a user interface quickly using the built-in component library. The library contains basic UI components such as buttons, various types of user inputs, shapes, labels, and so forth. To simulate an interaction provided by the application, linking between individual screens is supported in the tool. Therefore, created prototypes are satisfactory for the purpose of early user-interface testing and possible changes in the UI can be integrated effortlessly.

The high-fidelity prototype was implemented as a UIP client of UIP platform described in Subsection 2.1.2. As an environment for implementation in the UIP platform, Visual Studio 2015 was used (having .NET framework installed in the version 4.6.2).

## 4.2 The high-fidelity prototype implementation

To ensure compatibility of the surveillance center with existing impelementation of the navigation system, the high-fidelity prototype was implemented as an application that from the perspective of UIP platform represents a UIP client.

### 4.2.1 Structure of the application

The user interface of the application is realized by CUIs represented by UIProtocol XML files. Because of complexity of the UI, each screen or functional unit of the UI is stored in a file separately and then inserted to corresponding parent interface. This approach helps to avoid the repetition of code and to keep clarity within the application. The hierarchy of implemented interfaces is illustrated in Figure 4.1.
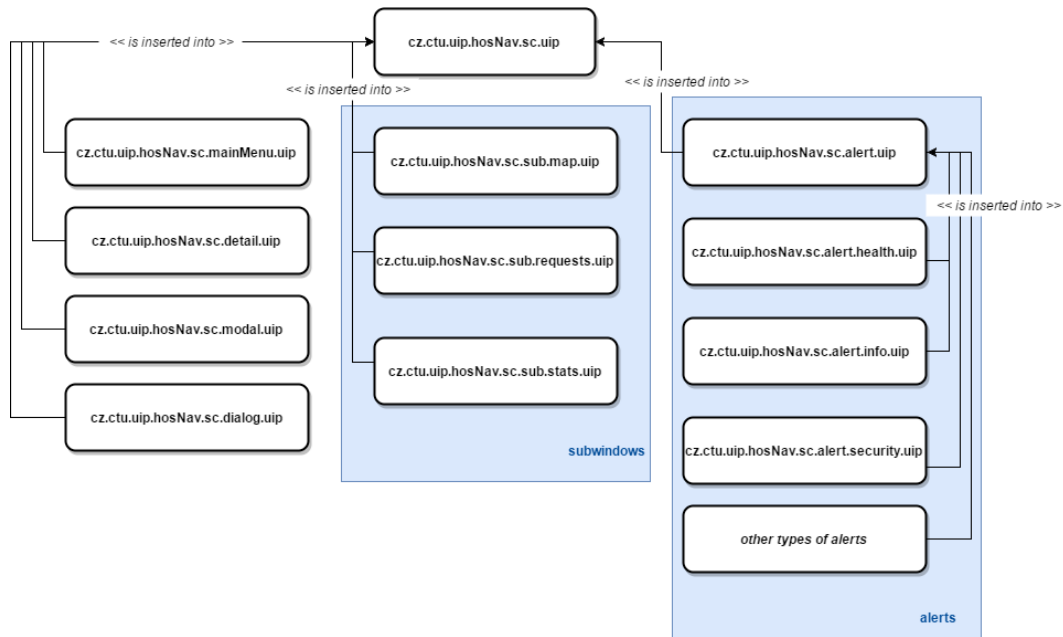
**Figure 4.1.** Hierarchy of implemented interfaces represented by UIP XML files.

### 4.2.2 Layout and appearance

The elements in interfaces are positioned using classes of layout provided by the UIProtocol. For example, for positioning of elements that change their position dynamically, we use layout `public.absolute`.

In model `cz.ctu.sc.dimensions`, dimensions of elementary components of the UI are stored. The colors used in the design can be found in model `cz.ctu.sc.colors`. Values from both models are bound to `position` and `style` properties of the elements.

### 4.2.3 Interaction

The interaction in the program is ensured by application of two features of UIProtocol: data binding and UIP Event handling API.

**Data binding.** The behavior of the program is determined by values of state variables and a *context* of an interface both stored in an appropriate model. Note that by the term *context* we mean a variable or a set of variables that affect the content of displayed interfaces. Context-sensitive screens such as *Detail* or *Alert* have its variable properties defined in the model, and such model values are bound to particular elements in the interface.

**Event handling.** Transitions between different states in the program are provided by interactive elements, e.g. buttons, lists. Every interactive element has its *behavior* specified with a *trigger* and an *action* defined. The trigger causes that a user's action is in the form of *event* processed by the client and eventually sent to a server; the action is an identifier of a handler that should be launched.

To provide a callback to events, various handlers were implemented. There are two types of callbacks in the application:

- handlers written in JavaScript; e.g.

  - `cz.ctu.hosNav.sc.interfaces.dialog.show`
  - `cz.ctu.hosNav.sc.interfaces.request.confirm`

- `cz.ctu.hosNav.sc.interfaces.detail.show`
- `cz.ctu.hosNav.sc.interfaces.alert.health.tag.select`
- ...

■ handlers written in C#.

The C# handlers have full access to the .NET API and they are faster. However, they could not be changed dynamically in the runtime.

In our implementation, the javasript handlers prevail as they ensure only elementary interaction. An example of handler called when *Terminal on the map* button is clicked follows.

```
var sourceTerminal = event.properties['sourceTerminal'];

client.updateModel("cz.ctu.sc.subwindows.maps",
                   "1.A." + sourceTerminal + ".bg", "true");
client.updateModel("cz.ctu.sc.subwindows", "map.visible", "true");
```

**Listing 4.1.** `cz.ctu.hosNav.sc.interfaces.detail.display.map.js` — a simple client-side handler.

Firstly, the handler gets `sourceTerminal` property of processed event, that is, a unique identification of the terminal. Then, the model of *Map of terminals* is updated: the source terminal is highlighted on the map, and the visibility of the subwindow is set to true.

To simulate emergency situations and events produced by the system, which is represented by *Alerts* in the UI, handlers for keystroke triggers are implemented. All the events created on keystroke triggers are processed by handler `cz.ctu.hosNav.sc.interfaces.keys`, which acts as a signpost. An overview of actions launched on keystroke can be found in Table 4.1.

| Key | Description of launched action |
|---|---|
| F1 | Arises new Health threat alert with Terminal 1 as its source. |
| F2 | Arises new Security threat alert with Terminal 3 as its source. |
| F3 | Arises new Face recognition issue alert with Terminal 5 as its source. |
| F4 | Arises new Move of tracked inpatient detected Alert with Terminal 1 as its source. |
| F5 | Arises new Info request alert with Terminal 3 as its source. |
| F6 | Arises new Emergency button pushed alert with Terminal 3 as its source. |
| F7 | Shows responses from notified employees in currently active alert. |

**Table 4.1.** Overview of functionality of `cz.ctu.hosNav.sc.interfaces.keys` handler.

# Chapter 5
# Evaluation

Following the UCD approach, both low-fidelity and high-fidelity prototype were evaluated using appropriate evaluation method to each prototype. Following sections describe the procedure of the tests and the results that affect the design of the next prototypes.

## 5.1 Methodology and basic terms

In this section, a methodology and terms used this Chapter are described.

### 5.1.1 Cognitive walkthrough

According to [25], the Cognitive Walkthrough is a usability inspection method performed by experts in usability field or by the developers of the product. The method is usually practiced in the early phases of the design cycle, and its purpose is to assess the causes of usability problems.

Having a detailed description of the interface, as an input for the method we define a target user group of the product and task scenarios. For each task, there are four questions that we should ask ourselves in the method:

1. Will the user try to achieve the right effect?
2. Will the user notice the correct action that is available in the interface?
3. Will the user associate the right action with the effect they are trying to achieve?
4. If the correct action is performed, will the use receive sufficient feedback?

If there is a negative answer to any question, we should identify a problem in the interface and describe its cause.

### 5.1.2 Heuristic evaluation

According to [26], the Heuristic evaluation is an informal method of usability analysis where some evaluators are presented with an UI design and asked to share their view on it. They are inspecting if the UI observes heuristics that are defined by [27] as follows:

1. *Simple and natural language. Dialogues should not contain information which is irrelevant or rarely needed. Every extra unit of information in a dialogue competes with the relevant units of information and diminishes their relative visibility. All information should appear in a natural and logical order.*
2. *Speak the user's language. The dialogue should be expressed clearly in words, phrases and concepts familiar to the user, rather than in system-oriented terms.*
3. *Minimize the user's memory load. The user should not have to remember information from one part of the dialogue to another. Instructions for use of the system should be visible or easily retrievable whenever appropriate.*
4. *Consistency. Users should not have to wonder whether different words, situations, or actions mean the same thing.*

5. *Feedback. The system should always keep users informed about what is going on, through appropriate feedback within reasonable time.*
6. *Clearly marked exits. Users often choose system functions by mistake and will need a clearly marked "emergency exit" to leave the unwanted state without having to go through an extended dialogue.*
7. *Shortcuts. Accelerators — unseen by the novice user — may often speed up the interaction for the expert user such that the system can cater to both inexperienced and experienced users.*
8. *Good error messages. They should be expressed in plain language (no codes), precisely indicate the problem, and constructively suggest a solution.*
9. *Prevent errors. Even better than good error messages is a careful design that prevents a problem from occurring in the first place.*
10. *Help and documentation. Even though it is better if the system can be used without documentation, it may be necessary to provide help and documentation. Any such information should be easy to search, be focused on the user's task, list concrete steps to be carried out, and not be too large.*

### 5.1.3 Snowball sampling

By [28], snowball or chain referral sampling is a method widely used in qualitative sociological research. The method yields a study sample through referrals made among people who share or know of others who possess some characteristics that are of research interest.

### 5.1.4 Screener

The screener is used to determine if a potential participant matches defined user characteristics.

### 5.1.5 Pre-test

A pre-test is a questionnaire that user fills in before he or she start to complete the test-tasks. The purpose of pre-test is to find out more detailed information about the participant.

### 5.1.6 Post test

Post-test is a questionnaire filled in by the participant after he completes all the task. The purpose of the post-test is to gain user's feedback to the testing session — find out information about the test process and the opinion of the user on the tested product.

## 5.2 Expert analysis of the paper mockup

In the very first phase of the design, created paper mockup (described in Section 3.3) was evaluated using Cognitive Walkthrough method and Heuristic Evaluation as the paper mockup was too complex and too difficult to maintain to be assessed with the users.

In the expert analysis, we tested all defined use-cases (see the description of the use-cases in Subsection 3.1.2).

### 5.2.1 Findings

In this Subsection, the findings made in the testing are specified such as their possible correction in the next version of the UI. As methods for evaluating, Cognitive Walkthrough and Heuristic evaluation were used. Note that by [26], the Heuristic evaluation should be performed at least by four experts to get the most of the defects in the UI. In our case, the tester was only one, and the results of the evaluation can be affected by this fact.

The findings are listed below.

- **N1: Insufficient feedback of the system.**

  - Severity: high
  - Method: Cognitive Walkthrough
  - Use-case: UC1 — Identification of navigated user
  - Description: Having selected an user from suggested people, it was not clear when the user will be navigated again and what the user should do.
  - Possible correction: To add a label with instructions or to add *Navigate* button.

- **N2: Inconsistency in Alerts.**

  - Severity: moderate
  - Method: Heuristic Evaluation
  - Screen: Security threat alert
  - Heuristic violated: Consistency and standards
  - Description: In both Health threat and Security threat alerts, there is a need to contact other people to call for their help. However, the approach to this process is now different in each alert — in Health threat alert, Description by tags is used, and the user clearly sees who he calls, while in Security threat alert, the user is restricted to call only one person — the management or the security.
  - Possible correction: Use Description by tags in Security threat alert.

### 5.2.2 Conclusion of the paper mockup evaluation

In the testing of the paper mockup, two findings were revealed. The former has high severity, so it is crucial to remove this issue in the second version of the system. The severity of the latter is moderate, but it should be eliminated in the second version easily, too. Overall, the evaluation showed that the design should be satisfactory for the users, but it is necessary to realize testing with users to confirm our assumption.

## 5.3 Low-fidelity prototype evaluation

Aiming at early feedback from the users, the low-fidelity prototype created in tool Balsamiq Mockups described in Section 3.4 was evaluated in a usability study.

### 5.3.1 Participants

The prototype was evaluated with three users representing primary user group of the program. Their age ranged from 25 to 65 (P1 — P3, one female, mean age = 42, SD = 19.47).

All of the participants were previously interviewed in the user research. Their experiences of using a surveillance system are various. P1 only monitors screens with live streams from surveillance cameras in her job; P2 and P3 are slightly advanced users — they know how to switch between camera records, how to maximize a window with a record, and so forth.

### 5.3.2 Procedure

The usability study was rather informal. It was conducted in laboratory settings, and it took maximum half an hour. Participants were using a computer (screen size 14 inches) and a computer mouse. Firstly, the navigation system was introduced to them briefly, and they were informed about the purpose of the surveillance center. After that, they were asked to complete a list of seven tasks (Attachment I) focused on intended typical interaction with the program, that is:

- resolving alerts,
- using tools for analysis of ongoing situation,
- using supporting tools (*Map of terminals*, *Register of tracked visitors*, *Statistics*).

Before the participants started to complete the list of tasks, they were asked to speak aloud and reminded to stay relaxed.

After they have completed the tasks, they filled in the post-test and they were asked to share their view on the testing session and the program itself.

### 5.3.3 Results: Participant 1

- Age: 65 years.
- Experience in safety: 15 years.
- Average computer and smartphone user.
- She welcomes innovations and progress.
- She watches camera records in real time on screens, has no further interaction with a surveillance system.

The log of the test and the results of the post-test of Participant 1 can be found in Appendix M.

**Evaluation**

Despite the fact that Participant 1 did not have much experience with using a program related to designed surveillance system, she did not face any serious issue in the test. P1 had a problem in Task 2 because she would search for the number of visitors in particular area in section represented by the icon of a user. There were small hesitations in Task 5, but, again, it was appropriate to the fact that the participant did not receive any user guide or instructions at the beginning.

Lastly, P1 did not notice possibility to mark the alert as solved, because it was not bold enough for her.

The post-test showed that the participant was delighted by *Map of terminals* and did not have any idea for an improvement. Although she was little stressed during the session, she stated that she enjoyed using the system.

## 5.3.4  Results: Participant 2

- Age: 27 years.
- Experience in safety: 5 years.
- Average computer and smartphone user.
- He thinks modern technologies can help a lot in safety, welcomes innovations and praises the surveillance system he has used in his job.
- Slightly advanced surveillance system user.

The log of the test and the results of the post-test of Participant 2 can be found in Appendix N.

### Evaluation

Participant 2 is a relatively experienced user of a camera system, and he did not have any serious issue while working with the designed system. Just as P1, Participant 2 had a problem to guess the meaning of icons in the main menu in Task 2. Another problem the participant had in Task 7 — he did not notice *Mark as false alarm* button.

P2 was relaxed during the session. In the post-test, he reported that he liked the design of the system and put forward an idea to play a voice signal when a new alert appears on the screen.

## 5.3.5  Results: Participant 3

- Age: 35 years.
- Experience in safety: 6 years.
- Average computer and smartphone user.
- He is following trends in modern technologies and likes to play computer games.
- Slightly advanced surveillance system user.

The log of the test and the results of the post-test of Participant 3 can be found in Appendix O.

### Evaluation

While completing the tasks, Participant 3 had same issues as Participant 2. In the post-test, he stated that it would be better to change the icons because he did not understand them fully.

Overall, he found the system well-designed and appreciated the function for tracking of a visitor.

| Severity | Explanation |
|---|---|
| low | Removal of this issue would enhance the user experience. |
| moderate | Elimination of this defect would improve the usability of the program. |
| high | The defect makes the program unusable. |

**Table 5.1.** Severities of findings

### 5.3.6  Findings

In this subsection, we describe all the defects of the high-fidelity prototype that user study revealed. Each finding has defined its ID, type, description and improvement proposal.

**Severities of findings.** For greater clarity, we define three severities of findings: *low*, *moderate* and *high*. Their explanation can be found in Table 5.1.

#### Finding N1: Low comprehensibility of icons in the main menu

- Severity: *moderate*; Participants experiencing the problem: *P1, P2, P3*; Occurrence in tasks: *Task 2*.

**Description.** For all the participants, the menu represented only by icon buttons was not understandable enough. In Task 2, they searched for the information about the number of people present in an area by clicking icon showing a user instead of clicking an icon viewing a pie chart.
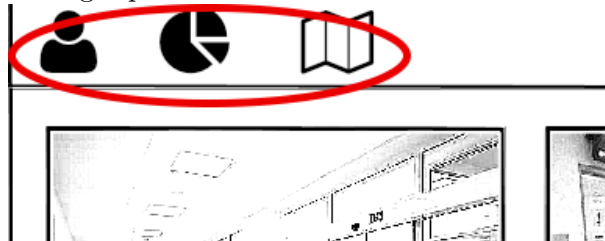


**Figure 5.1.** Icons of the main menu.

**Possible correction.** Change the icons or add a text representation of each menu item.

#### Finding N2: Insufficient highlighting of buttons for resolving of an alert

- Severity: *moderate*; Participants experiencing the problem: *P1, P2, P3*; Occurrence in tasks: *Task 7*.

**Description.** Even the participants assessed that the emergency button was pushed by mistake in Task 7, they did not intend to click *Mark as false* button first, because they did not
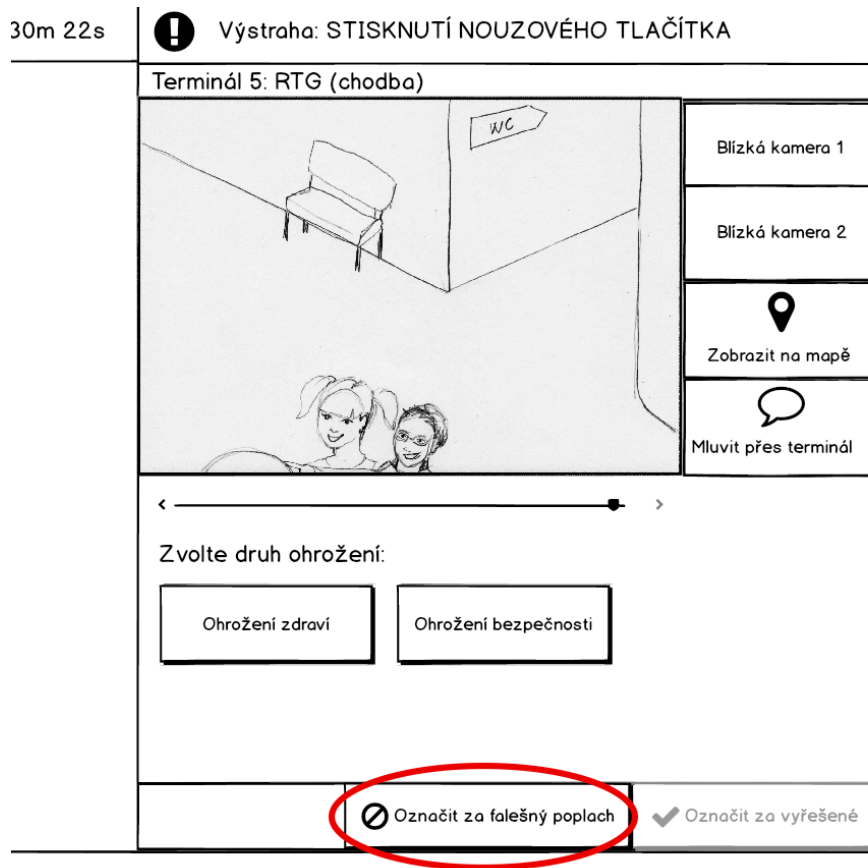
**Figure 5.2.** Position of *Mark alert as a false alarm* button

**Possible correction.** In the high-fidelity prototype, set background of buttons on the bottom of the alerts to bright color.

### 5.3.7 Conclusion of the low-fidelity prototype evaluation

The usability study performed with three members of the primary user group revealed two moderate usability problems described above. All the participants did not understand the icon buttons in the main menu correctly, and in the alert screen, they did not pay attention to the button that allowed them to mark an alert created by mistake as a false alarm. Both the problems are easy to eliminate, and in general, the study proved the layout and flow in the program are intuitive enough for the users.

## ◼ 5.4 High-fidelity prototype evaluation

The high-fidelity prototype was evaluated using user studies with people who have experience of working in the security sector.

### ◼ 5.4.1 Participants

Six representatives of primary user group defined in Section 2.5.1 evaluated the high-fidelity prototype. The participants of the usability study were chosen following a screener (Appendix J) and they were addressed in person and using snowball sampling technique. Age of participants ranged from 27 to 76 (1 female, mean age 45.5, SD = 19 ). Three of the users had previously participated in the user-testing of the low-fidelity prototype.

### ◼ 5.4.2 Procedure

The usability study was conducted in laboratory settings, and it took maximum one hour. Participants were using a computer (screen size 14 inches), a keyboard and a computer mouse. While completing the test tasks, the participants were recorded on a camera in order to log the session afterward.

Firstly, the participants were informed about the process of the testing session. After the briefing, they filled in a pre-test. Having filled in the pre-test, the participants were given a user guide (Appendix K) and asked to scan it. The reason for this step was to introduce them to the role of an operator of the surveillance center better because the system is very complex and it is important to understand the ongoing situation.

In the next part of the session, the participants were asked to complete eight given tasks (Appendix L). On the beginning, they received instruction to speak aloud and informed that the objectives of the test are not their skills, but the program. Again, the first task was introductory and allowed participants to get more familiar with the system. When the participants had finished all the tasks, they filled-in the post-test, and they were asked to share their view on the testing session and the program itself.

**Pre-test questions.**

1. PRE_Q1: How do you rate your computer skills?
2. PRE_Q2: How do you use a computer in your job?
3. PRE_Q3: Which features offer the surveillance system used in your job?
4. PRE_Q4: For how long do you work in the security sector?

**Post-test questions.**

1. POST_Q1: What task was the most difficult for you?
2. POST_Q2: Which function did you like the most?
3. POST_Q3: What do you rate negatively about the system, what would you make better?
4. POST_Q4: Did you feel uncomfortable being recorded?
   (1 — *Yes, definitely*, 5 — *Not a bit*)
5. POST_Q5: How do you rate the understandability of given user guide?
   (1 — *the best*, 5 — *the worst*)
6. POST_Q6: How do you assess the understandability of assigned tasks?
   (1 — *the best*, 5 — *the worst*)

### ◼ 5.4.3 Results: Participant 1

- Age: 65 years
- Gender: woman
- participated in usability study of the low-fidelity prototype

**Pre-test**

Results of pre-test of Participant 1 can be found in Table 5.2.

| Question | Answer |
|----------|--------|
| PRE_Q1 | 4 — rather worse |
| PRE_Q2 | I turn the computer on and following the user guide I open the program which I am using during the shift. |
| PRE_Q3 | The system is used only for watching live records from surveillance cameras placed all over the area of the factory. |
| PRE_Q4 | 15 years |

**Table 5.2.** Results of pre-test of Participant 1

**Log**

The log from the testing session with Participant 1 can be found in Appendix P.

**Post-test**

Results of pre-test of Participant 1 can be found in Table 5.3.

| Question | Answer |
|----------|--------|
| POST_Q1 | To find out the number of people in the area of the Emergency Department. I was confused, and although I knew I have to find the *Statistics* section, I simply could not find it. |
| POST_Q2 | The register of visitors and statistics, it is a very useful tool to keep general awareness. |
| POST_Q3 | Nothing, the system suited me well. |
| POST_Q4 | 5 — not a bit |
| POST_Q5 | 1 — the best |
| POST_Q6 | 1 — the best |

**Table 5.3.** Results of post-test of Participant 2

**Evaluation**

Completing tasks took Participant 1 twenty-one minutes. The most problematic task was Task 7. The participant thought she would found the statistics in Detail of a terminal and when there was not the information she searched for, she started to panic and created an alert by mistake. Another problem was the size of the text in the program — P1 mentioned she needs a new reading glasses and it was evident she had problems to read the labels correctly.

P1 seemed under stress during the test session. She was worried she would do something wrong, so she asked many questions and was a little confused. However, in the end, she was happy she did it. She found the program useful and even though she reported that it might take some time to become accustomed to all the functions, she would like to use it.

### ■ 5.4.4   Results: Participant 2

- Age: 72 years
- Gender: man

**Pre-test** Results of pre-test of Participant 2 can be found in Table 5.4.

| Question | Answer |
|---|---|
| PRE_Q1 | 3 — average |
| PRE_Q2 | I use it for searching information on the Internet and for checking the system called "Doorkeeper" where I oversee the people present in the building. |
| PRE_Q3 | To watch a live stream from the surveillance cameras in the building. |
| PRE_Q4 | 45 years |

**Table 5.4.** Results of pre-test of Participant 2

**Log**

The log from the testing session with Participant 2 can be found in Appendix Q.

**Post-test**

Results of pre-test of Participant 2 can be found in Table 5.5.

| Question | Answer |
|---|---|
| POST_Q1 | The most difficult for me was to impersonate myself to the role of a surveillance center's operator. |
| POST_Q2 | I liked the way of processing alerts. I did not have to think so much where should I look for the information or what should I do — the system offered me proper tools for every situation. |
| POST_Q3 | I did not get the purpose why to keep a record of the number of visitors in the area. |
| POST_Q4 | 5 — not a bit |
| POST_Q5 | 2 — good |
| POST_Q6 | 2 — good |

**Table 5.5.** Results of post-test of Participant 2

**Evaluation**

Completing tasks took Participant 2 twenty-eight minutes. P2 had the most problems in Task 2. He thought that is necessary add visitor to the register manually, so he opened Detail and looked for an appropriate function there. After he had completed the task, he reported that he forgot that the system allows employees of the hospital to add a patient to the register, too. Another problematic task was Task 7. Again, P2 focused himself on Detail of a terminal too much. Nevertheless, the participant did not think the supporting tools should be placed in Detail. In his opinion, he only needed more time to notice there is a top bar that he can use, too. The participant made great strides in tasks no. 3, 4, 5 and 6 (alert solving). He finished them very quickly with no serious problems or hesitations. What is more, in the post-test, he stated that he liked the way how alert-solving is designed. The only deficiency found in this activity was poor readability of offered tags.

The participant stated that he found useless to keep a record of visitors in an area. After an explanation that the system should help in case of a global threat and possible evacuation, he changed his mind. In conclusion, he would like to use the program in his job.

### 5.4.5   Results: Participant 3

- Age: 27 years
- Gender: man
- participated in usability study of the low-fidelity prototype

**Pre-test** Results of pre-test of Participant 3 can be found in Table 5.6.

| Question | Answer |
|---|---|
| PRE_Q1 | 3 — average |
| PRE_Q2 | I use program for processing records from surveillance cameras. |
| PRE_Q3 | In our job, we have the use of a program for watching live camera records. The program is configurable and offers tools for basic processing of the file — it is possible to maximize a record on a fullscreen, look into the past, find a record from a particular time and day, etc. |
| PRE_Q4 | 5 years |

**Table 5.6.** Results of pre-test of Participant 3

**Log**
The log from the testing session with Participant 3 can be found in Appendix R.

**Post-test**
Results of pre-test of Participant 3 can be found in Table 5.7.

| Question | Answer |
|---|---|
| POST_Q1 | Probably Task 3. I did not come to that I have to click *Speak via terminal* button. |
| POST_Q2 | I liked the system overall. |
| POST_Q3 | Nothing. |
| POST_Q4 | 5 — not a bit |
| POST_Q5 | 1 — the best |
| POST_Q6 | 1 — the best |

**Table 5.7.** Results of post-test of Participant 3

**Evaluation**
It took Participant 3 nine minutes to complete all the tasks. P3 did not have any serious problem with any task; he faced only a few minor difficulties. For example in Task 4, the participant thought that selected employees are notified automatically after selection of tags.

P3 was very impressed by the program — he did not report any negative side, and he said he definitely would enjoy using the program in his job.

## ■ 5.4.6　Results: Participant 4

- Age: 35 years
- Gender: man
- participated in usability study of the low-fidelity prototype

**Pre-test** Results of pre-test of Participant 4 can be found in Table 5.8.

| Question | Answer |
|---|---|
| PRE_Q1 | 3 — average |
| PRE_Q2 | On a daily basis — searching the Internet, using programs. |
| PRE_Q3 | Monitoring whole object, zoom in and out to an object, set motion detection to a particular area, searching in records and playing records. |
| PRE_Q4 | 6 years |

**Table 5.8.** Results of pre-test of Participant 4

**Log**

The log from the testing session with Participant 4 can be found in Appendix S.

**Post-test**

Results of pre-test of Participant 4 can be found in Table 5.9.

| Question | Answer |
|---|---|
| POST_Q1 | The difficulty of all the tasks was the same. |
| POST_Q2 | I appreciate that the system automatically selects the people who could help in the current situation. Choosing people whom to call by myself would take much more time. |
| POST_Q3 | I do not see any negative sides. |
| POST_Q4 | 3 — I don't know |
| POST_Q5 | 2 — good |
| POST_Q6 | 2 — good |

**Table 5.9.** Results of post-test of Participant 4

**Evaluation** Participant 4 spent eight minutes by completing assigned tasks. Unlike other participants, he did not have a problem to find *Statistics* section in Task 7. Nevertheless, he had an issue in Task 7, too. When he had displayed the *Statistics* subwindow, P4 had overlooked that is necessary to select a different area, and he thought he already sees the number of people in the area of the Emergency Department. However, in conclusion, this was the only issue he was resolving, and besides that, he proceeded the task list without any hesitations. In the post-test, he did not report any weaknesses of the program, he only spoke well of the automatic selection of people who could help in emergency situations.

| Question | Answer |
|---|---|
| PRE_Q1 | 3 — average |
| PRE_Q2 | I operate the system for reporting, sending e-mails, using helpdesk for issue-reporting. |
| PRE_Q3 | The system allows us to view, save and search records from security cameras. |
| PRE_Q4 | 15 years |

**Table 5.10.** Results of pre-test of Participant 5

### 5.4.7 Results: Participant 5

- Age: 42 years
- Gender: man

**Pre-test**

Results of pre-test of Participant 5 can be found in Table 5.10.

**Log**

The log from the testing session with Participant 5 can be found in Appendix T.

**Post-test**

Results of pre-test of Participant 5 can be found in Table 5.11.

| Question | Answer |
|---|---|
| POST_Q1 | I think that my biggest problem was to get myself to the role of the operator. |
| POST_Q2 | I consider the process of solving problems to be smart. Offered tags are very useful and easy to understand even for people who are scared of computers. |
| POST_Q3 | The statistics should be in *Detail*. |
| POST_Q4 | 5 — not a bit |
| POST_Q5 | 2 — good |
| POST_Q6 | 2 — good |

**Table 5.11.** Results of post-test of Participant 5

**Evaluation**

It took thirty-six minutes to Participant 5 to finish all the tasks. The most difficult assignment for P5 was to finish Task 7. He expected the demanded information to be in *Detail* of the terminal in requested area. He had an issue in Task 4, too. He thought that he would call the people by clicking them on the list and he did not notice *Notify stated people* first.

P5 was very stressed during the test session. After the test, P5 reported that he had a problem to concentrate on given tasks because he was scared of failure, even he was repeatedly encouraged to calm down and relax because the object of the test is the system.

P5 stated that he did not expect the system will be so smart because, in his job, he uses the camera system only for work with camera records. So, in some tasks, he was thinking allegedly, he should search the Internet or use a mobile phone, instead of looking for the proper function of the tested program.

## ■ 5.4.8 Results: Participant 6

- Age: 76 years
- Gender: man

**Pre-test**

Results of pre-test of Participant 6 can be found in Table 5.12.

| Question | Answer |
|----------|--------|
| PRE_Q1 | 2 — slightly advanced |
| PRE_Q2 | Using Excel as an efficient replacement for paperwork, sometimes Word, too. I am keeping a record of people present in the building in a system called the *Doorkeeper* and searching the Internet. From time to time, I use a photo editor to create, for example, some map. |
| PRE_Q3 | The camera system is used only for watching live video records from cameras placed throughout the compound. |
| PRE_Q4 | 5 years |

**Table 5.12.** Results of pre-test of Participant 6

**Log**

The log from the testing session with Participant 6 can be found in Appendix U.

**Post-test**

Results of pre-test of Participant 6 can be found in Table 5.13.

| Question | Answer |
|----------|--------|
| POST_Q1 | To find out the information about people present in the area of Emergency Department. I expected this information to be in *Detail* of a terminal placed in this department. |
| POST_Q2 | I appreciate that the system detects threats automatically and provides useful information about the ongoing situation. I also liked the description via tags — it saves time, and it is very easy to understand. |
| POST_Q3 | I do not have any idea. There is nothing I found to be negative. |
| POST_Q4 | 5 — not a bit |
| POST_Q5 | 2 — good |
| POST_Q6 | 2 — good |

**Table 5.13.** Results of post-test of Participant 6

**Evaluation**

P6 spent sixteen minutes by completing the tasks. Despite the fact that P6 was the oldest participant and he did not have tested the low-fidelity prototype before, he had almost no serious problem to finish all the tasks.

The only one problematic task was the task 7. Participant 6 expected the information about the number of people present in the hospital to be in *Detail* of the terminal and without a hint given he did not realize he should look for *Statistics* section. As all other older participants, he had a problem to read offered tags.

P6 enjoyed the testing session and was very pleased with the system. He stated that he had visited Alzheimercentrum in Průhonice in Prague and he can imagine the system easily could help a lot in centers alike.

### 5.4.9 Findings

In this subsection, we describe all the defects of the high-fidelity prototype that user study revealed. Each finding has defined its ID, severity, description and improvement proposal.

**Severities of findings.** For greater clarity, we define three severities of findings: *low*, *moderate* and *high*. Their explanation can be found in Table 5.14.

| Severity | Explanation |
|---|---|
| low | Removal of this issue would enhance the user experience. |
| moderate | Elimination of this defect would improve the usability of the program. |
| high | The defect makes the program unusable. |

**Table 5.14.** Severities of findings

#### Finding N1: Poor readibility of offered tags

- Severity: *moderate*; Participants experiencing the problem: *P1, P2, P6*; Occurrence in tasks: *Task 4, Task 6*.

**Description.** Offered tags used for a description of an ongoing situation have low contrast between the background and the text. That makes it difficult to read their content and slows down the process of alert solving (Figure 5.3).
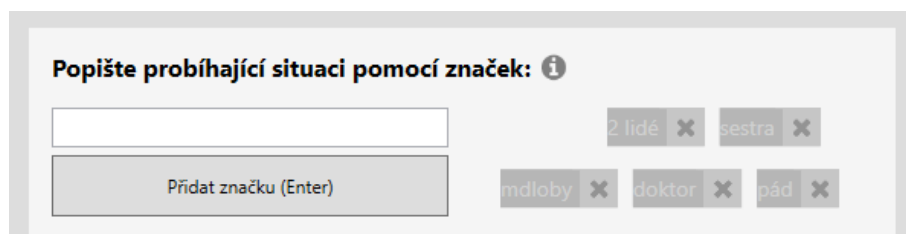


**Figure 5.3.** Non-selected offered tags (on the right).

**Possible correction.** Raise the contrast between the background of the tag and its inside content. That is, in implementation, instead of changing the opacity of non-selected tags, change their background color, so the contrast between the text and background would stay acceptable.

■ **Finding N2: Non-intuitive placement of data about the numbers of people present in selected area**

- Severity: *moderate*; Participants experiencing the problem: *P1, P2, P3, P5, P6*; Occurrence in tasks: *Task 7*.

**Description.** Nearly all of the participants did not expect the information about the people present in the hospital compound to be in the *Statistics* section. In Task 7, the participants searched for demanded information in *Detail* screen. The expected scenario is presented in figures below.
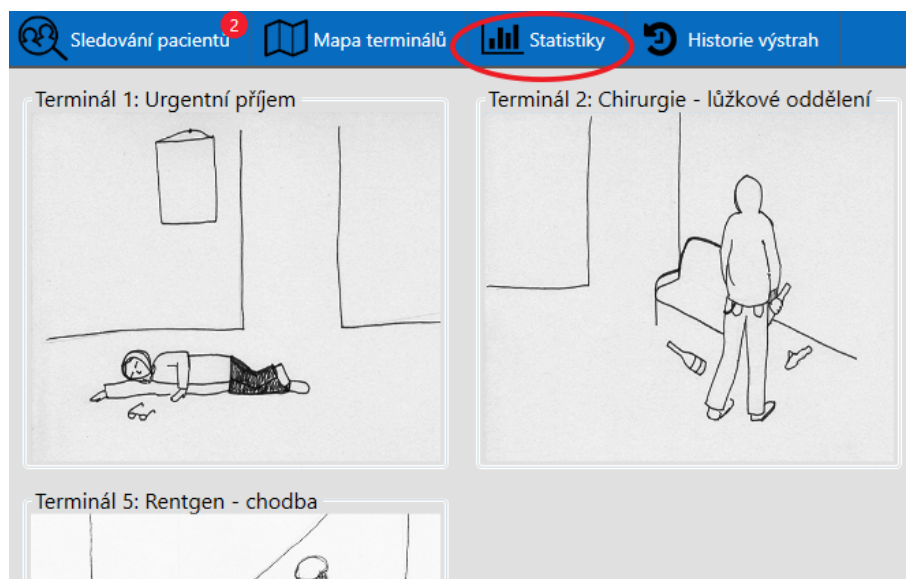


**Figure 5.4.** Expected scenario, step 1: clicking *Statistics* menu button.
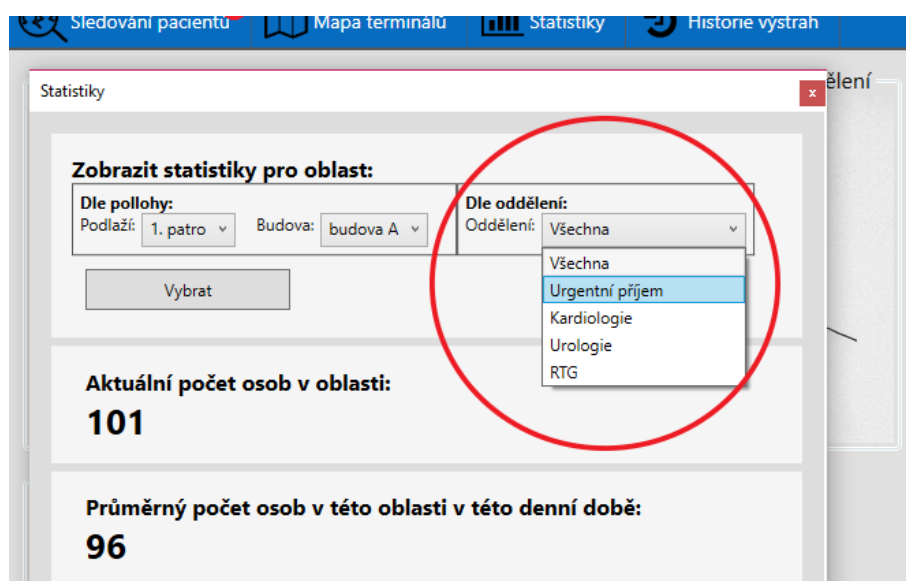


**Figure 5.5.** Expected scenario, step 2: selecting desired area.
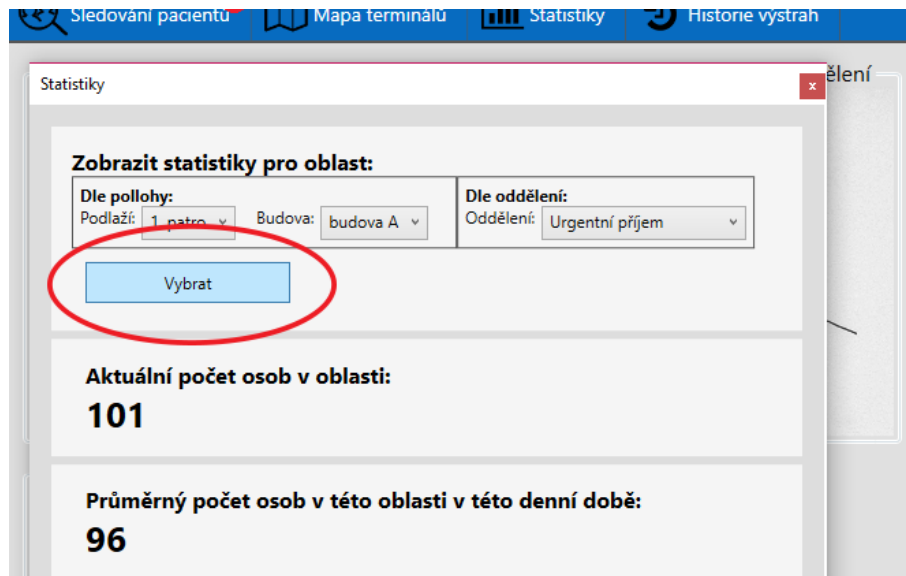
**Figure 5.6.** Expected scenario, step 3: clicking *Choose*.

**Possible correction.** To *Detail* screen, add a button *Statistics from the area* and by clicking it, show *Statistics* subwindow with results filtered for given area.

- **Finding N3: Incorrect interpretation of the input for adding own tag of a user**
  - Severity: *moderate*; Participants experiencing the problem: *P1, P6*; Occurrence in tasks: *Task 4, Task 6*.

**Description.** Some of the users did not know how to use the input for adding an own tag. They tried to drag and drop one of the offered tags to the input or clicking *Add tag* button without having anything written into the text input. The expected scenario is presented in figures below.



**Figure 5.7.** Expected scenario, step 1: clicking the input and typing a tag.



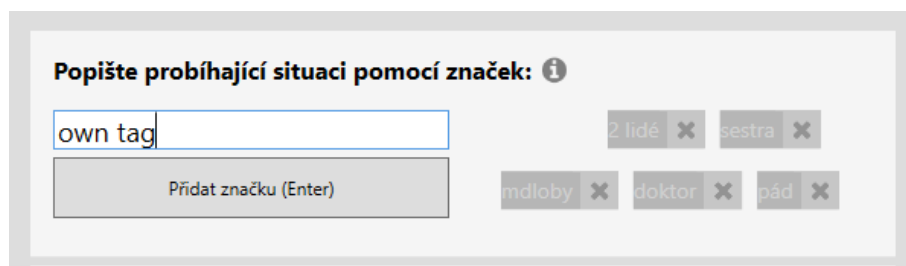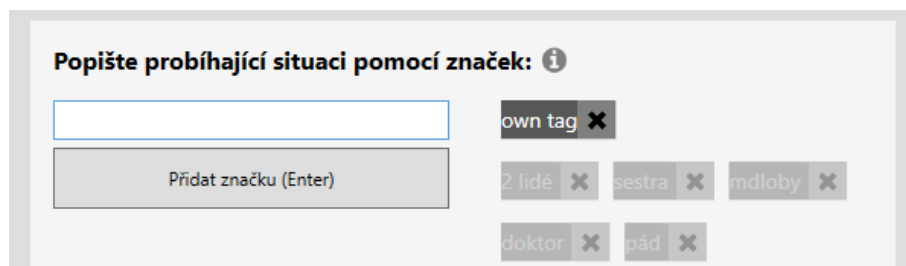**Figure 5.8.** Expected scenario, step 2: adding tag by clicking *Add tag* button or pressing *Enter*.

**Possible correction.** Add a placeholder to the text input, e.g. *Type your tag here.*

■ **Finding N4: Insufficient highlighting of *Speak via terminal* button**

- Severity *moderate*; Participants experiencing the problem: *P2, P3, P4, P5*; Occurrence in tasks: *Task 3.*

**Description.** Almost all of the participants did not notice they have to click the *Speak via terminal* button when they wanted to talk to the visitor who was demanding the information in Task 3.
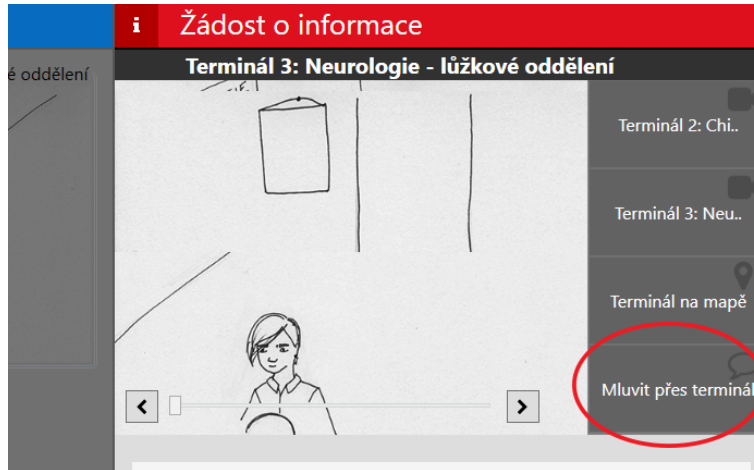


**Figure 5.9.** Expected scenario: clicking *Speak via terminal.*

**Possible correction.** Speaking via terminal could be turned on by default, or there can be some animated element on the *Speak via terminal* button in info alerts.

■ **Finding N5: Wrong positioning of modal window after confirmation of a request**

- Severity *low*; Participants experiencing the problem: *P1*; Occurrence in tasks: *Task 2.*

**Description.** After confirming a request for tracking, the confirmation window appears. The problem is, the confirmation window has lower z-value than the *Requests for tracking* window, so the confirmation stays partly hidden (Figure 5.10). For this reason, the participants did not notice they received the confirmation, and they did not click *OK* in the window.
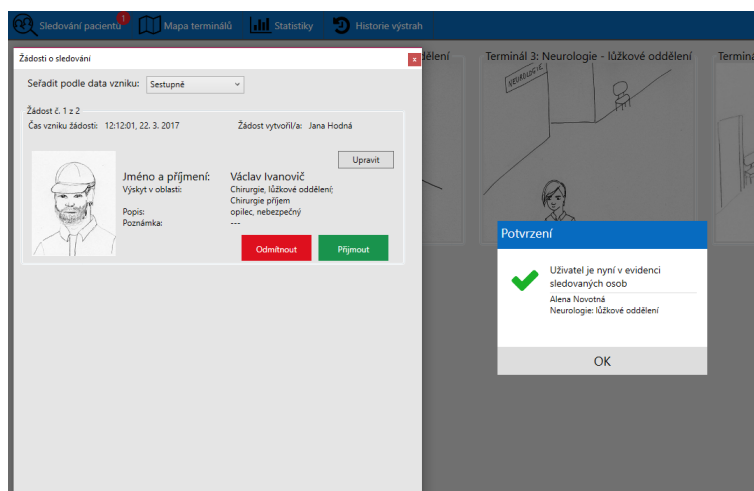


**Figure 5.10.** Confirmation window under the *Requests for tracking* window.

**Possible correction.** Remove the modal confirmation window and show a quick message in the *Requests for tracking* window instead.

### ◾ 5.4.10 Conclusion of the high-fidelity prototype evaluation

The usability study performed in laboratory settings with six representatives of primary target user group did not reveal any serious usability problem; there are only a few moderate usability issues in the user interface.

Five out of six participants had a problem to finish Task 7 — they could not find the Statistics section because they expected the information about the number of people present in particular area to be in *Detail* screen. Nevertheless, only one of the participants would relocate this section.

Probably more significant problem was poor readability of non-selected offered tasks. This issue slowed down the process of alert-resolving, which is the primary activity of the program. To read the tags was difficult for all older participants (P1, P2, P6).

Other problem shared among users appeared in Task 3. Four participants did not notice it is necessary to click *Speak via terminal* button to contact the visitor who demanded information. This issue may have been caused by settings of the test — it was difficult for the participants to identify that the caller did not hear them because the moderator in the role of the visitor sat next to them.

Two participants had a problem to use the input for adding an own tag to describe an ongoing situation better; they did not recognize that it is a text input and did not know its purpose. However, this issue could be resolved quickly by adding a placeholder to the text input.

The last problem experienced by four users is rather low. Wrong positioning of confirmation window appearing after resolving of a request for tracking caused that the participants did not notice its presence. On the other hand, the animation indicating the resolution of the request proved to be a sufficient feedback for the users, so it remains for further consideration whether it is beneficial to force the users to confirm their decision.

Overall, the participants were satisfied by the system. They enjoyed using it, and they were pleased with its design. The most appreciated functionalities by the users were:

- the process of alert-resolving,
- usage of the tags for description,
- and automatic selection of people who are nearby and might help to solve the emergency situation.

Even thought the half of participants consisted of seniors, the problems shared among all group did not differ too much, and thus, the design is considered to be satisfactory for elderly, too.

In conclusion, the system proved to be well-designed, although there remain flaws that need further improvements.

# Chapter **6**
## Conclusion

The goal of this thesis was to design and implement Surveillance Center as another part of existing in-hospital navigation system, in which is the navigation realized using face-recognition.

The development of Surveillance center consisted of several steps that correspond with the goals defined in Section 1.3. The list of these goals together with the description of their realization follows.

- **G1: Analyse the current status of existing navigation system.**

  The navigation system being developed at CTU was analyzed in Section 2.1 — both the process of the navigation, and the implementation of the system was inspected.

- **G2: Analyse related solutions of surveillance systems and the legislation behind their operation.**

  In Section 2.2, we presented three surveillance systems comparable to the system we design. The most similar were systems SARA (Situational Awareness and Response Assistant) and DOTS (The Dynamic Object Tracking System) which were used as an inspiration for the solution of our system. However, none of the systems was fully suitable for us, because they would not provide required support for the navigation system. In Section 2.3, we focused on legislative related to surveillance systems in the Czech Republic. We introduced the law that regulates such systems and listed legal attributes that the system should have defined.

- **G3: Employing user research, analyze needs and requirements of potential users of the system.**

  Assuming that the navigation system is mainly designed for healthcare facilities, we conducted semi-structured interviews with six healthcare employees at Masaryk Hospital in Rakovník. The research revealed that the participants have to deal with security problems and they are overloaded with their work. So, we decided they should be supported by a person who will focus on issues that they face and help them to focus on their job more. For this reason, we decided that the operator of Surveillance Center could be an employee of the security sector. Therefore, we conducted semi-structured interviews with seven representatives of security employees to define better their needs and experiences of using surveillance systems.

  The details and the results of realized user research are presented in Section 2.4.

- **G4: Regarding the results of the user research, define the user groups of the system.**

  Based on results of conducted semi-structured interviews with both healthcare and security employees, we defined two user groups of the Surveillance Center (see Section 2.5). The primary user group consists of operators of the system, that is the employees of security that should look after the hospital's compound and solve the problems that tax the healthcare employees. Based on the analysis of the group of safety employees, we created persona Josef as its representative. The secondary user

group consists of healthcare employees who can use the system as a support tool. Based on research of the group of healthcare employees, a profile of the group was created.

**G5: Define functional requirements.**
Reflecting the results of conducted user research, we defined elementary functional requirements that should be supported by the designed system, see Section 2.7.

**G6: Define functionalities offered by the system and describe particular tasks.**
Having defined the functional requirements, in Chapter 3 we focused on formal description and model of the user interface of Surveillance Center. Firstly, the functionalities of the system were described by scenarios, then they were generalized in use-cases and illustrated using storyboards. To provide a formal model of the interface, Hierarchical Task Analysis of the system was performed, and defined use-cases were described by plans.

**G7: Create prototypes of the UI of the Surveillance Center that meets defined requirements.**
As an implementation of the functionalities defined in Section 3.1, we created overall three prototypes. Firstly, the Surveillance Center prototype was created in the form of the paper mockup that is described in Section 3.3. We designed several screens that reflect the functional requirements and formal description of the UI. Probably the most important is a concept of Alerts — messages, which the operator of Surveillance Center creates or receives in case there is a problem or an intervention of the operator is required.

The paper mockup was evaluated using expert analysis and, because there were not many issues revealed, the second low-fidelity prototype created in tool Balsamiq Mockups strongly followed its design. Iteratively, the low-fidelity prototype was evaluated, and on the results of the evaluation, the high-fidelity described in the Section 3.5 prototype was implemented.

**G8: Describe the implementation of particular prototypes.** The implementation of the prototypes is described in Chapter 4. First, the development tools used for creating the prototypes are mentioned. Next, we focused mainly on the implementation of the high-fidelity prototype that is realized using the same platform as the navigation system uses — UIP platform.

**G9: Evaluate the developed solution with the target user audience.** In each iteration of implementation of the prototype of the UI, the prototype was evaluated (see Chapter 5). The paper mockup was assessed using expert analysis; the other two prototypes were evaluated with the target audience of the Surveillance system, that is with employees of the security sector. The issues that occurred during the testing were listed, described and the possible correction was proposed.

The process of design of Surveillance Center followed the UCD methodology and thus, the user requirements were reflected in the design in each phase of the development. According to realized evaluation of the prototypes, the design proved to be usable, useful and intuitive even for users older than 60 years, who are represented in the target audience more than in other sectors.

## 6.1 Future work

In the future, the recommendations to the design listed in Section 5.4.9 should be taken into account. The implementation of the system should be improved, too — the system should support scaling up of the Alers that is not implemented yet in the actual version. The next step is to integrate the Surveillance Center to the In-hospital navigation system and perform evaluation of the integrated version of the system.

# Appendix A
## Glossary

CTU FEE   ■   Czech Technical University in Prague, Faculty of Electrical Engineering
CUI   ■   concrete user interface
SD   ■   standard deviation
UI   ■   user interface

# Appendix B
# Use-cases — detailed descriptions

In this Appendix, detailed descriptions of use-cases defined in Section 3.1.2 are described.

## B.1 UC1: Identification of navigated user

- Preconditions

  The navigation system warns the operator about the insufficient confidence of face-recognition of a user.

- Basic flow

  1. The system informs navigated user that the recognition is under way.
  2. The system shows photography of the visitor taken by Simple terminal and displays currently navigated users who may be the visitor.
  3. The operator chooses the right user from the displayed selection.
  4. Simple Terminal provides appropriate navigation instructions to the user.
  5. The operator marks the case as solved.

- Alternate flow

  3a. The operator assesses that none of the displayed users is the visitor on the image from Simple Terminal.
  3b. Simple terminal does not show any navigation instructions.
  3c. The operator marks the case as solved.

- Exception flow

  There is no user on the image from Simple Terminal, so the operator marks the case as a false alarm.

- Postconditions

  The correctness of provided navigation instructions is fully ensured.

## B.2 UC2: Providing information to visitors

- Preconditions

  The visitor pushes *Info* button of the Smart Kiosk.

- Basic flow

  1. The system informs the visitor that he or she is connecting to the surveillance center.

2. The operator reacts to the request of the visitor, and they start to talk.
3. The operator searches for information demanded by the visitor.
*[optionally]*
4. The operator adds the visitor to the navigation system and navigates him to chosen destination.

- Alternate flow

  —

- Exception flow

  The button was pushed by mistake, so the operator marks the case as a false alarm.

- Postconditions

  The visitor received demanded information.

# B.3  UC3: Processing of request for help

- Preconditions

  A visitor pushed the *Emergency button* of the Simple Terminal
  *[or]*
  An employee of the hospital calls for help.

- Basic flow

  1. The operator analyzes the situation and decides what crisis situation is going on.

    - the health is threatened — start of UC4: Resolving of a situation when the health is threatened
    - the security is threatened — starts of UC7: Resolving of situation when the security is threatened

- Alternate flow

  —

- Exception flow

  The button was pushed by mistake, so the operator marks the case as a false alarm.

- Postconditions

  The request of help was processed.

# B.4 UC4: Resolving of a situation when the health is threatened

- Preconditions

  The system recognizes a visitor showing symptoms of indisposition.
  The operator recognizes a visitor showing symptoms of indisposition in one of the video stream from Simple terminals.

- Basic flow

  1. The operator classifies the severity of the problem.
  2. The operator contacts healthcare employees found near the visitor that needs help.
  3. The system views responses of called out employees to the operator.
  4. In case there is not any positive reaction, the 1. step follows, otherwise step 5.
  5. The operator informs via terminal the visitor that the help is on the way and provides him a mental relief.
  6. The operator observes the progress of the situation.
  7. The operator marks the case as solved.

- Alternate flow


- Exception flow

  Althought the system recognized problem, there is not any in the video stream from the place of the incident, so the operator marks the case as a false alarm.

- Postconditions

  The system ensured help to the visitor in trouble.


# B.5 UC5: Tracking of a problematic inpatient

- Preconditions

  An employee of the hospital informs Surveillance Center about the admittance of problematic patient.
  *[or]*
  The operator of Surveillance Center identifies a problematic patient.

- Basic flow

  1. The employee takes a picture of a picture of the patient.
  2. The employee describes reasons of the patient's problematic nature.
  3. The employee specifies the area in which the patient will be present.
  4. The employee sends a request to the Surveillance Center.
  5. The operator of Surveillance Center confirms the request.
  6. The employee receives a message that the patient has been added to the register.

- Alternate flow

1a. The operator takes a picture of problematic inpatient via Simple Kiosk or Smart Terminal.
1b. The operator describes reasons of the patient's problematic nature.
1c. The operator specifies the area in which the patient will be present.
1d. The operator saves the inpatient to the register.

- Exception flow

    5a. The operator rejects the request and describes a reason of denial. 5b. The employee corrects the request 5c. Step 4. of the Basic flow.

- Postconditions

    The problematic inpatient is tracked.

## B.6  UC6: Stopping the tracked inpatient from escape

- Preconditions

    Use-case UC5: Tracking of problematic inpatient

- Basic flow

    1. The system notifies the operator about a motion of tracked patient in outside the specified area.
    2. The operator notifies applicable employees about the movement of the patient.
    3. The terminals that are on inpatient's way informs the patient that he or she should go back.
    4. The system displays the responses of called out employees.
    5. In a case of a positive reaction step 5., otherwise, step 2.
    6. The operator observes the progress of the situation.
    7. The operator marks the case as solved.

- Alternate flow

    1. The operator call for help of a third party (security, police). 1. The third party detains the patient. 1. The operator marks the case as solved.

- Exception flow

    The operator figures out that the system notified him about the movement by mistake, so he marks the case as a false alarm.

- Postconditions

    The problematic inpatient is tracked.

## B.7  UC7: Resolving of a situation when the security is threatened

- Preconditions

    The operator notices a suspicious behavior of visitor or inpatient on a record from a camera.
    *[or]*
    An employee of the hospital informs the operator about the security problem.

- Basic flow

    1. The operator classifies the type of the threat.
    2. The operator chooses the people who could help and sends them a notification.
    3. The operator waits for a response of called out people. In case he did not receive any positive reaction, the process is repeated from step 2.
    4. The operator observes the progress of the situation.
    5. The security threat is resolved by called out people.
    6. The operator marks the case as solved.

- Alternate flow

    —

- Exception flow

    The operator figures out that he was notified by mistake, so he marks the case as a false alarm.

- Postconditions

    The security threat was prevented.

## B.8  UC8: Viewing statistics about the number of people present in concrete area

- Preconditions

    —

- Basic flow

    1. The operator displays statistics about the people present in the whole area of the hospital.
    2. The operator selects a location that he wants to display.
    3. The system shows statistics for selected location.

- Alternate flow

    —

- Exception flow

    —

- Postconditions

    The operator is aware of the number of people present in selected location.

## B.9 UC9: Evacuation of a hospital

- Preconditions

  A serious security threat was detected.

- Basic flow

  1. The operator analyzes the ongoing situation using the surveillance system - use-cases UC7, UC8.
  2. The operator confers with responsible person of hospital's management.
  3. The management gives the operator the permission to start the evacuation.
  4. The operator starts the evacuation plan.

- Alternate flow

  —

- Exception flow

  1. The management does not give the permission to start the evacuation.
  2. Use-case UC7

- Postconditions

  Simple terminals show the way to the nearest emergency exits.
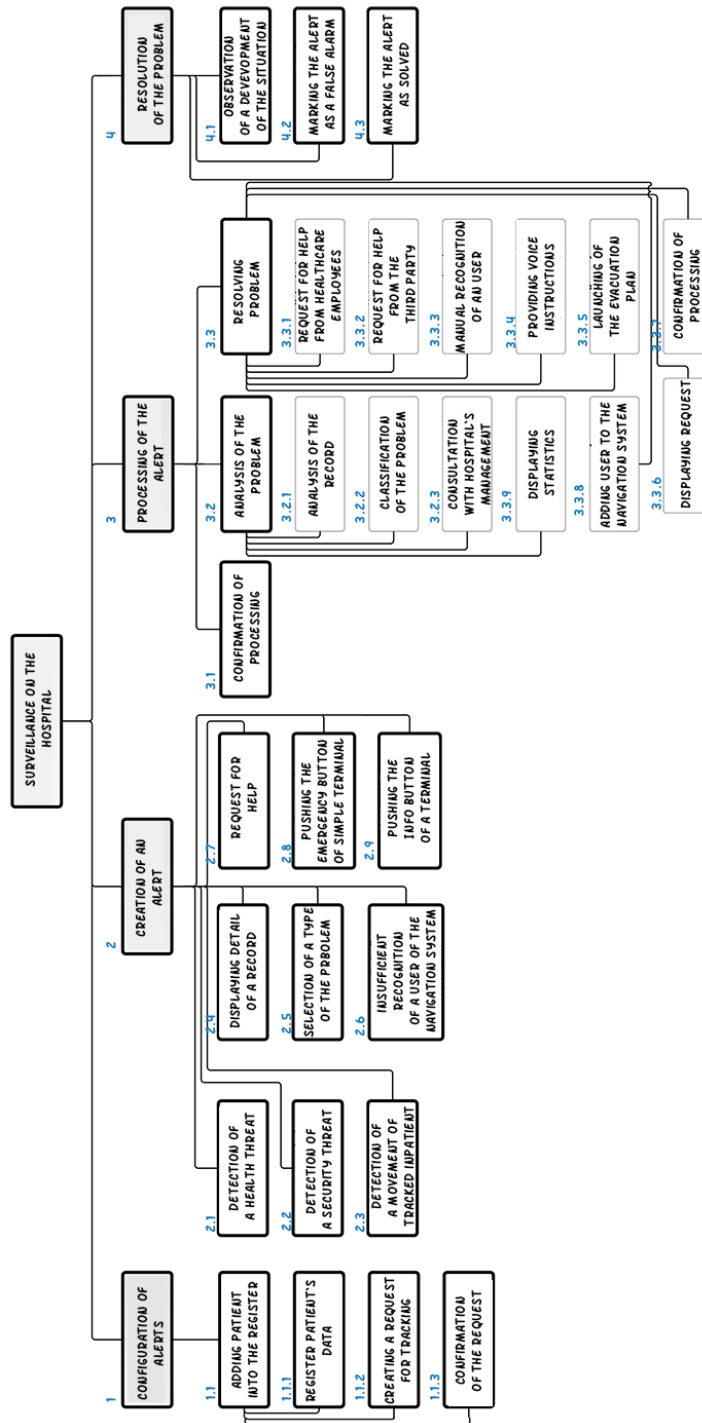
# Appendix C
# Hierarchical Task Analysis



**Figure C.1.** Hierarchical Task Analysis.

# Appendix D
## Plans

- **Plan 1 (Scenario S1N1)**

  - *Plan 1.1 (The system).* 2 (Creation of an alert) — 2.6 (Insufficient recognition of a user of the navigation system)
  - *Plan 1.2 (The operator).* 3 (Processing of the alert) — 3.1 (Confirmation of processing) — 3.3 (Resolving the problem) — 3.3.3 (Manual recognition of a user) — 4 (Resolution of the problem) — 4.3 (Marking the alert as solved)

- **Plan 2 (Scenario S3E1)**

  - *Plan 2.1 (A visitor of the hospital).* 2 (Creation of an alert) — 2.8 (Pushing the emergency button of the Simple Terminal)
  - *Plan 2.2 (The operator).* 3 (Processing of the alert) — 3.1 (Confrmation of processing) — 3.2 (Analysis of the problem) — 3.2.1 (Analysis of the record) — 4 (Resolution of the problem) — 4.2 (Marking the alert as a false alarm)

- **Plan 3 (Scenario S4E2)**

  - *Plan 3.1 (The operator).* 2 (Creation of an alert) — 2.4 (Displaying a detail of a record) — 2.1 (Detection of a health threat) — 2.5 (Selection of a type of the problem) — 3 (Pocessing of the alert) — 3.2 (Analysis of the problem) — 3.2.2 (Classification of the problem) — 3.3 (Resolving the problem) — 3.3.1 (Request for help from healthcare employees)
  - *Plan 3.2 (A healthcare employee).* 3 (Analysis of the problem) — 3.3 (Resolving the problem) — 3.3.6 (Displaying the request) — 3.3.7 (Confirmation of processing)
  - *Plan 3.3 (The operator).* 4 (Resolution of the problem) — 4.1 (Observation of a development of the situation) — 4.3 (Marking the alert as solved)

- **Plan 4 (Scenario S5S1)**

  - *Plan 4.1 (A healthcare employee).* 1 (Configuration of alerts) — 1.1 (Adding a patient into the register) — 1.1.1 (Registration of patient's data) — 1.1.2 (Creating a request for tracking)
  - *Plan 4.2 (The operator).* 1 (Configuration of alerts) — 1.1 (Adding a patient into the register) — 1.1.3 (Confirmation of the request)
  - *Plan 4.3 (The visitor of the hospital).* 2 (Creation of an alert)- 2.3 (Detection of a movement of a tracked patient)
  - *Plan 4.4 (The operator).* 3 (Processing of the alert) — 3.1 (Confirmation of processing) — 3.2 (Analysis of the problem) — 3.2.1 (Analysis of the record) — 3.3 (Resolving problem) — 3.3.2 (Request for help from the third party)
  - *Plan 4.5 (A security authority).* 3 (Processing of an alert) — 3.3 (Resolving problem) — 3.3.6 (Displaying a request) — 3.3.7 (Confirmation of processing)
  - *Plan 4.6 (The operator).* 4 (Resolution of the problem) — 4.1 (Observation of a development of the situation) — 4.3 (Marking the alert as solved)

- **Plan 5 (Scenario S6S2)**

  - *Plan 5.1 (A healthcare employee).* 2 (Creation of an alert) — 2.7 (Request for help)
  - *Plan 5.2 (The operator).* 3 (Processing of the alert) — 3.1 (Confirmation of processing) — 3.3 (Resolving the problem) — 3.3.2 (Request for help from the third party)
  - *Plan 5.3 (A security authority).* 3 (Pocessing of the alert) — 3.3 (Resolving the problem) — 3.3.6 (Displaying the request) — 3.3.7 (Confirmation of processing)
  - *Plan 5.4 (The operator).* 4 (Resolution of the problem) — 4.1 (Observation of a development of the situation) — 4.3 (Marking the alert as solved)

- **Plan 6 (Scenario S7S3)**

  - *Plan 6.1 (The operator).* 2 (Creation of an alert) — 2.2 (Detection of a security threat) — 2.4 (Displaying a detail of a record) — 2.5 (Selection of a type of the problem) — 3 (Processing of the alert) — 3.2 (Analysis of the problem) — 3.2.2 (Classification of the problem) — 3.2.3 (Consultation with hospital's management) — 3.3 (Resolving the problem) — 3.3.5 (Launching of the evacuation plan) — 4 (Resolution of the problem) — 4.1 (Observation of a development of the situation)

# Appendix E
## Storyboards

### E.1 Storyboard 1: Info request
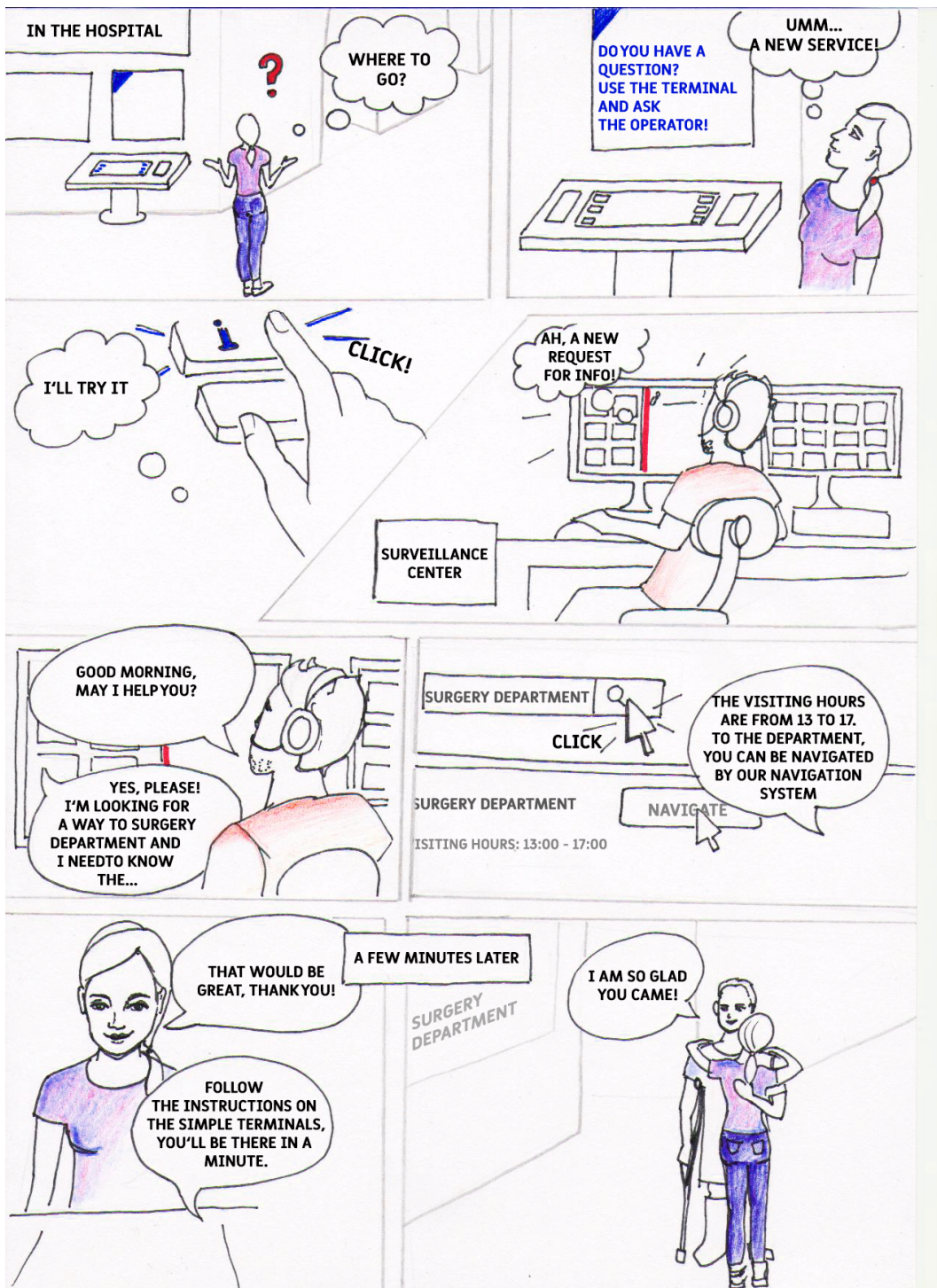
## E.2  Storyboard 2: A health threat
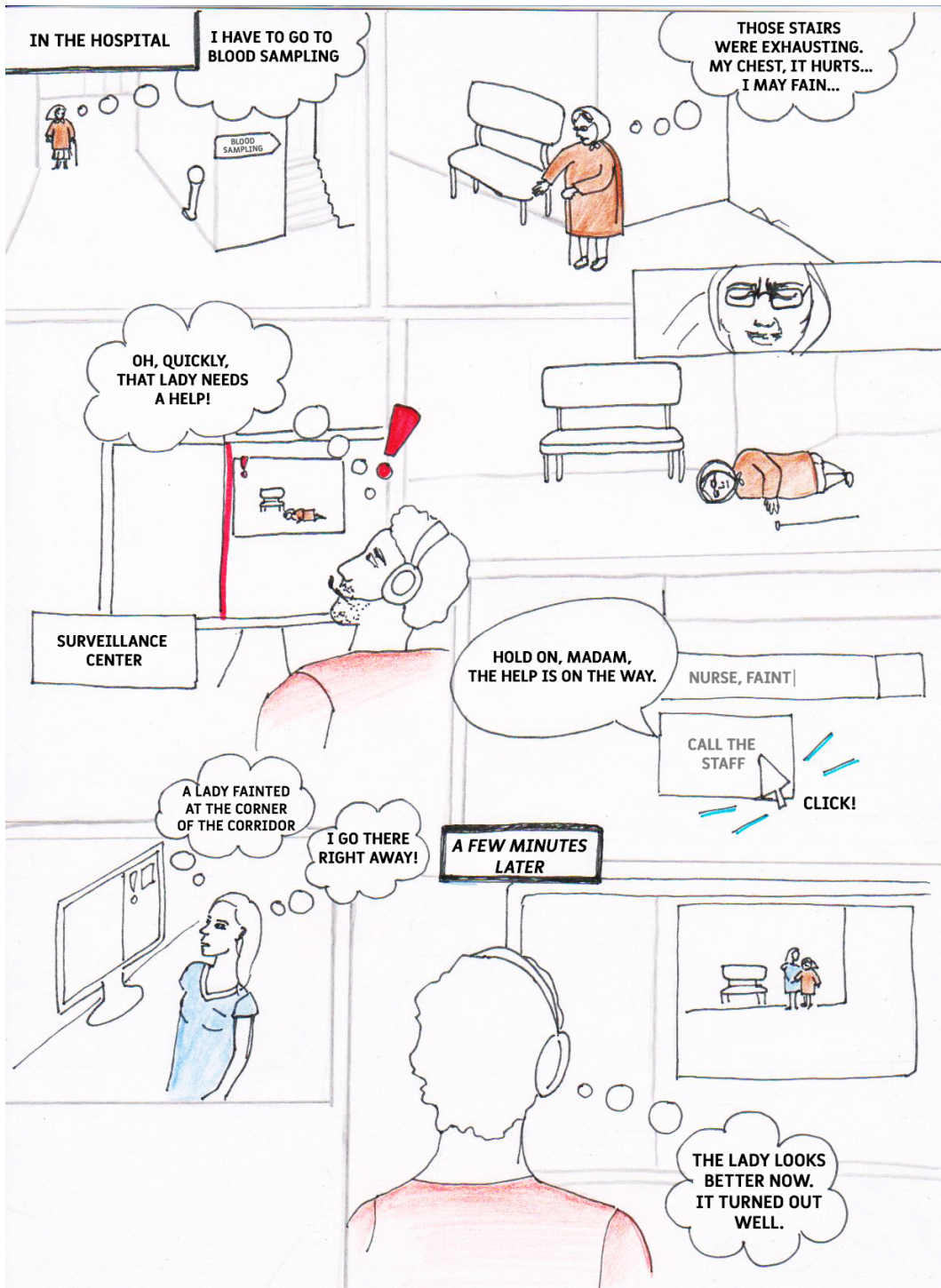
# Appendix F
# Tools for resolving of the paper mockup

In this Appendix, the Tools for resolving described in Subsection 3.3.3 are presented.

## F.1   Health alert



**Figure F.2.**  Tools for resolving of the Health threat alert

## F.2   Security alert



**Figure F.3.**  Tools for resolving of the Security threat alert

## F.3 Face recognition issue



**Figure F.4.** Tools for resolving of the Face recognition issue alert

## F.4 Move of tracked inpatient detected



**Figure F.5.** Tools for resolving of the Move of tracked inpatient detected alert

## ▍F.5    Info request



**Figure F.6.** Tools for resolving of the Info request alert

## ▍F.6    Emergency button pushed



**Figure F.7.** Tools for resolving of the Emergency button pushed alert

# Appendix G
# Supporting tools

In this Appendix, examples of the Supporting tools described in Section 3.3.4 are presented.

## G.1    Tracking of inpatients: Requests for tracking
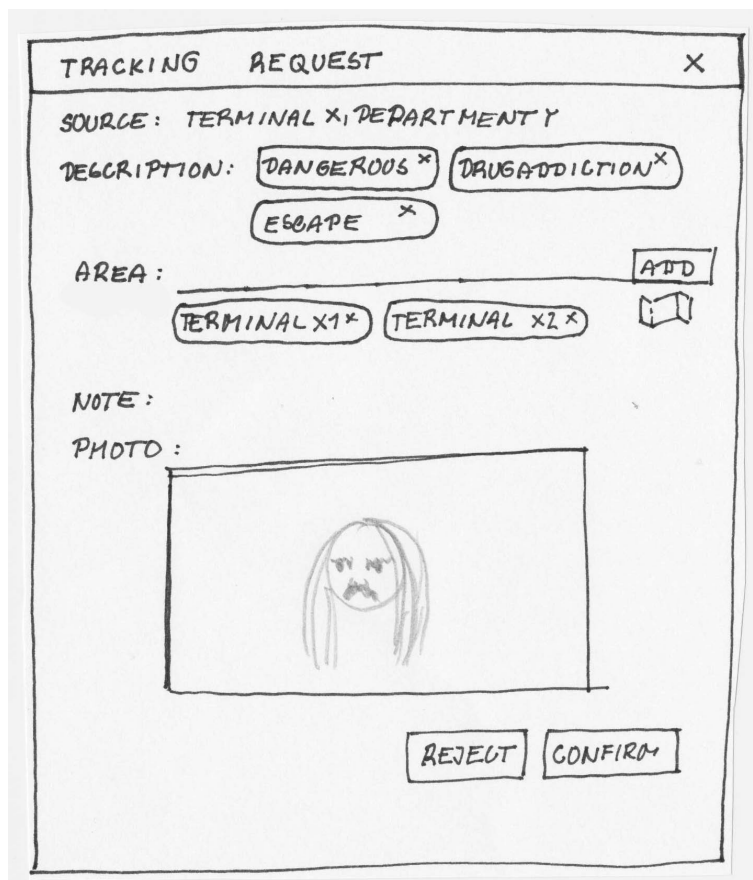


**Figure G.8.** The window showing *Requests for tracking*

## G.2 Map of terminals
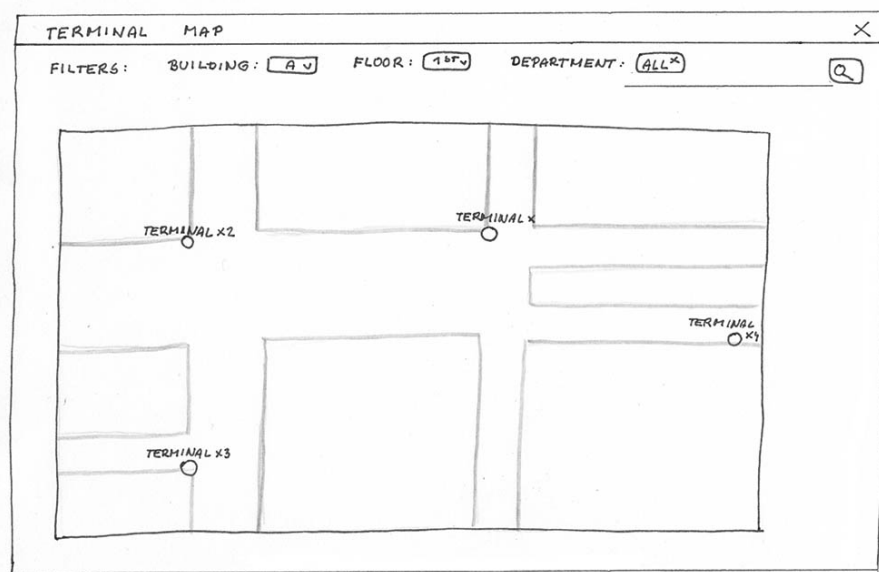


**Figure G.9.** The window representing *Map of terminals*

## G.3 Statistics
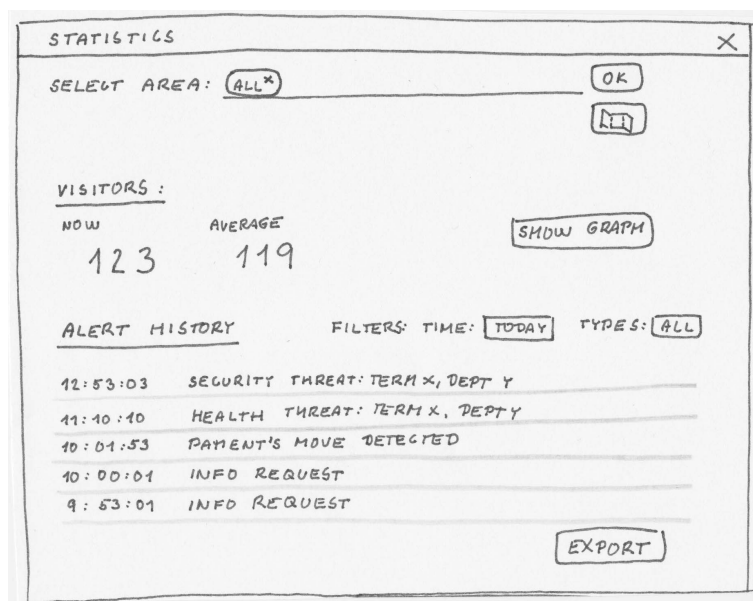


**Figure G.10.** The window representing *Statistics*

# Appendix H
# Tools for resolving of the high-fidelity protoype

In this Appendix, we present the UI of the Tools for resolving in the high-fidelity prototype (see Section 3.5).
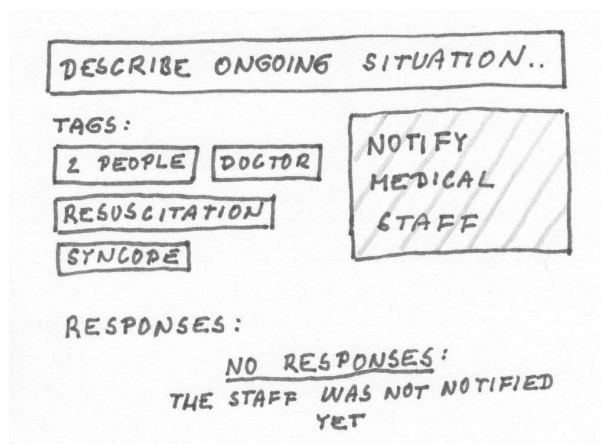
## H.1 Health alert



**Figure H.11.** Tools for resolving of the Health threat alert
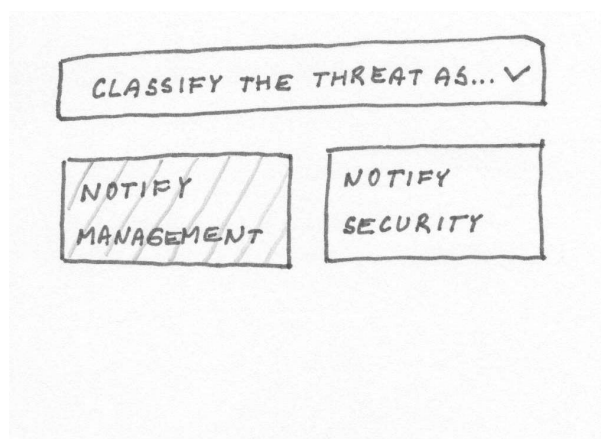
## H.2 Security alert



**Figure H.12.** Tools for resolving of the Security threat alert
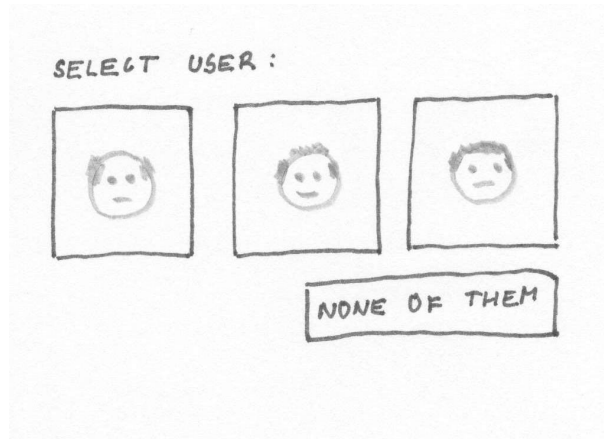
## H.3   Face recognition issue



**Figure H.13.** Tools for resolving of the Face recognition issue alert

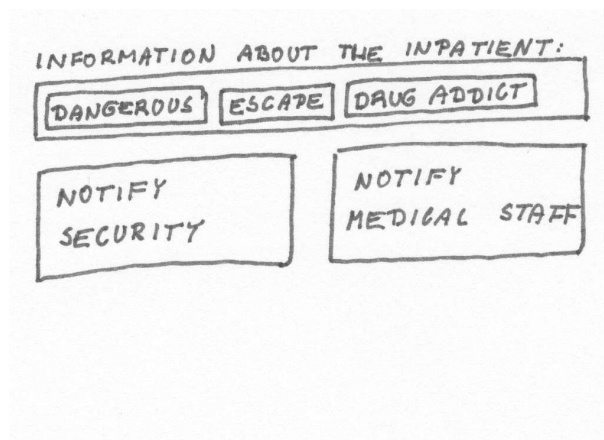## H.4   Move of tracked inpatient detected
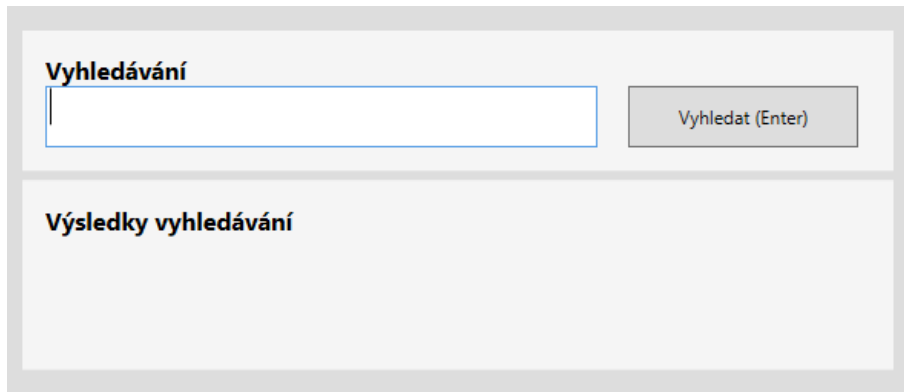


**Figure H.14.** Tools for resolving of the Move of tracked inpatient detected alert
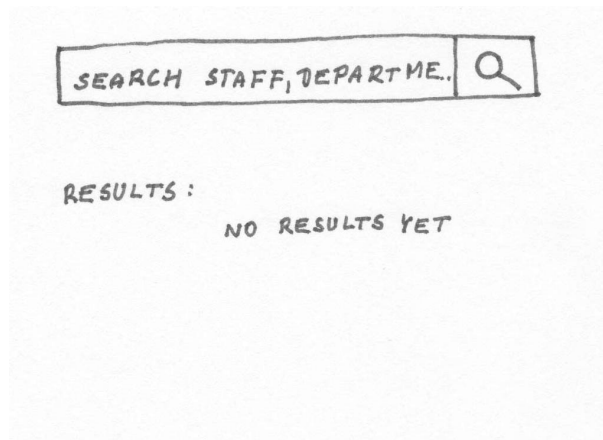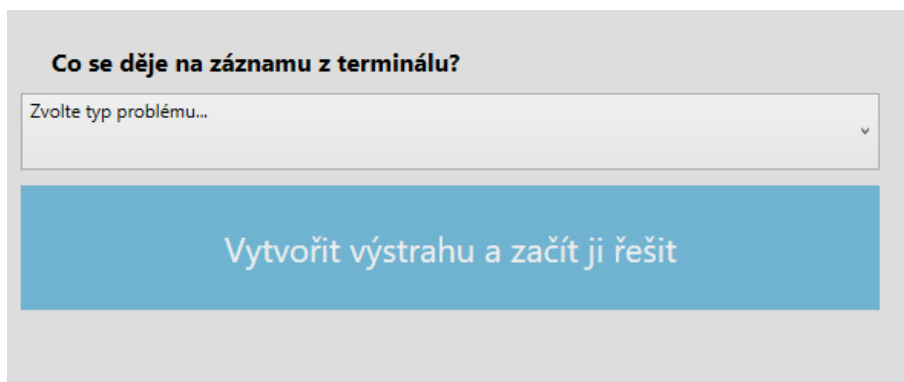
## H.5    Info request



**Figure H.15.** Tools for resolving of the Info request alert
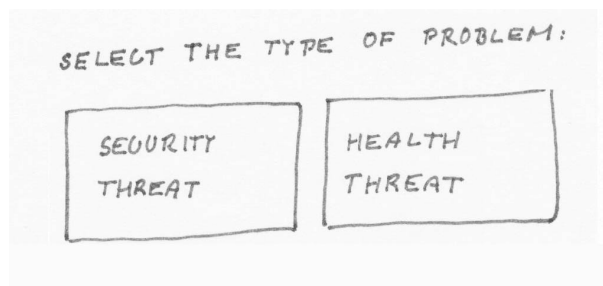
## H.6    Emergency button pushed



**Figure H.16.** Tools for resolving of the Emergency button pushed alert

# Appendix I

## Test-tasks of the usability study of the low-fidelity prototype

1. Display the map of terminals in the first floor of the hospital.
2. Find out the number of visitors present in the hospital right now.
3. Display the detail of the record from the reception of the department of radiography.

   a) Display this terminal on the map.
   b) Quit viewing the map and discover what was on the record a few seconds ago.
   c) Go back to the homepage.

4. Solve an alert with a request for manual recognition of the user of the navigation system.
   Navigation system failed to recognize the user of the navigation system with sufficient accuracy. It is up to you to recognize the user and ensure that the system will provide proper navigational instructions.
5. Call the help for a woman spotted on the record from the Terminal 5.

   a) By the time the help is on the way, tell the lady using the terminal about what is happening.

6. Process the request for tracking of a person.
7. Solve an alert which indicates that someone has pressed the emergency button on the navigational terminal.

# Appendix J
# Screener

In this Appendix, we present Screener used for the hiring of participants of the usability study of the high-fidelity prototype. Note that the Screener reflects the profile of the primary user group of the Surveillance Center described in Subsection 2.5.1.

At each answer, there is a number of participants that attended the user study.

### Gender

- Male [5]
- Female [1]

### Age

- 20 — 55 [3]
- 56 — 80 [3]

### Skills of using a surveillance system
The employee in his or her job:

- watches video streams from surveillance cameras. [3]
- operates a surveillance system — knows the features that the system offers and can use them. [3]

# Appendix K
# User guide

## Dohledový systém: **uživatelská příručka**

### Základní informace

Dohledové centrum je součástí navigačního systému určeného pro nemocnice a zdravotnická zařízení.

Navigační systém je realizován pomocí sítě **terminálů**, které jsou rozmístěny na důležitých uzlech chodeb nemocnice. Každý terminál je vybaven kamerou, malým displejem a několika tlačítky. Navigování probíhá pomocí rozpoznání obličeje navigovaného uživatele – kamera na terminálu rozpozná navigovaného a na displeji terminálu se zobrazí odpovídající navigační instrukce.

### Přehled funkcí dohledového systému

Systém je určen ke sledování dění v areálu nemocnice a zajištění řešení nouzových situací, které můžou nastat.

#### Sledování uživatelů

Systém umožňuje zavést pacienta do seznamu sledovaných osob. Pokud terminál zaznamená pohyb pacienta zavedeného v evidenci sledovaných na nějakém z terminálů, zobrazí operátorovi výstrahu, a ten může přivolat pomoc.

Návštěvníka/pacienta může do evidence sledovaných osob zavést:
a) **Personál nemocnice** (pošle žádost na sledování a ta musí být schválena operátorem dohledového centra)
b) **Operátor dohledového centra**

#### Pomocné nástroje

- Správa sledovaných osob
- Mapa terminálů
- Statistiky
- Historie výstrah

**Figure K.17.** The first page of the User guide

**Výstrahy**

Nouzové situace jsou řešeny pomocí tzv. **výstrah**. Výstrahu může vytvořit

a) Operátor centra
b) Systém
c) Zdravotnický personál nebo návštěvník nemocnice

Přehled typů výstrah a důvody jejich vzniku jsou uvedeny v tabulce:

| Typ výstrahy | Vznik |
|---|---|
| **Ohrožení zdraví** | - Systém rozpozná pád návštěvníka/pacienta<br>- Operátor zpozoruje mdloby/pád uživatele |
| **Ohrožení bezpečnosti** | - Personál volá o pomoc<br>- Operátor zpozoruje na záznamu vandalismus/opuštěný předmět/agresivní chování<br>- Hoří, unikají chemické látky,.. |
| **Problém s rozpoznáním uživatele navigačního systému** | - Systém nebyl schopen s dostatečnou přesností určit, zdali se jedná o uživatele navig. systému |
| **Žádost o informace** | - Návštěvník stiskl tlačítko na navigačním terminálu a žádá o informace |
| **Pohyb sledovaného pacienta** | - Terminál zachytil pohyb pacienta, který je na seznamu sledovaných |

**Popis situace a přivolání vhodných osob**

Systém podporuje **popis situace pomocí značek**. Na základě volby značek:

- **Systém vybere vhodné osoby k zavolání**
- **Přivolané osoby mají přehled o tom, co se děje**

**Příklad:** Je nutné přivolat dvě osoby k pánovi, který omdlel na chodbě.
**Zvolené značky: 2 osoby, mdloby, muž**

Značky lze **vybrat z nabízených** anebo **napsat vlastní**. Jednotlivé značky se oddělují čárkou.

**Ukončení řešení výstrahy**

Řešení výstrahy lze ukončit následujícími způsoby:

- **Označit ji za falešný poplach** (pokud výstraha vznikla nedopatřením)
- **Označit ji za vyřešenou** (pokud nouzová situace skončila)
- **Spustit evakuaci** (pokud se jedná o velké ohrožení a bylo obeznámeno vedení nemocnice)

**Figure K.18.** The second page of the User guide

# Appendix L
# Test-tasks of the usability study of the high-fidelity prototype

## L.1   Introductory task

View *Detail* of a record, take a look at supporting tools and close *Detail*.

## L.2   Test-tasks

1. View the Terminal 2 on the map.
2. Confirm the requests for tracking.
3. Give a response to a request for information.
4. Solve a health-threat emergency situation.

   - The system detected a fall of a person on the record from Terminal 1. Call for help for the person in trouble.

5. Solve an alert with a request for recognition of a user of the navigation system.

   - The system was not able to recognize the user of the navigation system on sufficient confidence level. Solve the generated alert.

6. Solve a case of security threat.

   - You have spotted a vandal on the record from Terminal 2. Call a security guard to resolve the situation.

7. Discover, how many people there are in the area of the Emergency Department.

# Appendix M
# Evaluation of low-fidelity prototype: Results of Participant 1

## M.1  Log

■

- **Task 1**: no problem
- **Task 2**: The participant hesitated which icon is the right one, then she chose button displaying a person, clicked it and displayed *Visitor's tracking* menu. After the advice from the moderator, the task was completed without problems.
- **Task 3**: While completing part a), the participant considered whether she has to display the map of the terminals from the top menu again. After she has noticed button *Display terminal on the map*, she completed the task without problems.
- **Task 4**: no problem
- **Task 5**: The participant spent some time searching for an appropriate action, then she tried to display terminal on the map. After she had opened *Detail*, she noticed possibility to report a problem. She created a health-threat alert, but she did not understand the system of tags. Given a small advice, she completed the task without further problems.
- **Task 6**: After she had displayed the request, she hesitated whether is necessary to fill in any information. After consultation with moderator completed without problems.
- **Task 7**: Because the participant did not notice button *Mark as false alarm* on the bottom, she wanted to classify the alert as a security threat, although she thought the alert was created by mistake.

## M.2  Post-test

**Questions of the post-test.**

- Q1: How do you assess intelligibility of given tasks?
- Q2: Which task was the most difficult to complete and why?
- Q3: Which function of the system do you like the most?
- Q4: Have you any idea which could improve the system? Which?
- Q5: Rate the test with a mark as at school (1 — the best, 5 — the worst).

| Question | Answer |
|----------|--------|
| Q1 | Pretty good. |
| Q2 | Probably to mark the alert as a false alarm. |
| Q3 | The map with terminals marked in. |
| Q4 | I have no idea of an improvement. |
| Q4 | 1- |

**Table M.1.** Results of post-test of Participant 1.

# Appendix N

# Evaluation of low-fidelity prototype: Results of Participant 2

## N.1  Log

■

- **Task 1**: no problem
- **Task 2**: The participant hesitated which icon is the right one, then she chose button displaying a person, clicked it and displayed *Visitor's tracking* menu. After the advice from the moderator, the task was completed without problems.
- **Task 3**: no problem
- **Task 4**: The participant did not realize it is necessary to click *Mark as solved* button.
- **Task 5**: no problem
- **Task 6**: no problem
- **Task 7**: Because the participant did not notice button *Mark as false alarm* on the bottom, he wanted to classify the alert as a security threat.

## N.2  Post-test

**Questions of the post-test.**

- Q1: How do you assess intelligibility of given tasks?
- Q2: Which task was the most difficult to complete and why?
- Q3: Which function of the system do you like the most?
- Q4: Have you any idea which could improve the system? Which?
- Q5: Rate the test with a mark as at school (1 — the best, 5 — the worst).

| Question | Answer |
|----------|--------|
| Q1 | 1 |
| Q2 | The most difficult for me was to find out the number of visitors. I think the icon representing *Statistics* section could be better. |
| Q3 | I like the system overall, it was wery easy to use it. |
| Q4 | It might be good to add some sound notifications when an alert appears on the screen. |
| Q4 | 1 |

**Table N.2.** Results of post-test of Participant 2.

# Appendix O
# Evaluation of low-fidelity prototype: Results of Participant 3

## O.1  Log

■

- **Task 1**: no problem
- **Task 2**: The participant clicked icon displaying a person. After a hint from the moderator, the task was finished without problems.
- **Task 3**: no problem
- **Task 4**: no problem
- **Task 5**: no problem
- **Task 6**: no problem
- **Task 7**: Although he thought the emergency button was pushed by mistake, he wanted to classify the problem as a security threat, because he did not notice *Mark as false alarm* button.

## O.2  Post-test

**Questions of the post-test.**

- Q1: How do you assess intelligibility of given tasks?
- Q2: Which task was the most difficult to complete and why?
- Q3: Which function of the system do you like the most?
- Q4: Have you any idea which could improve the system? Which?
- Q5: Rate the test with a mark as at school (1 — the best, 5 — the worst).

| Question | Answer |
|----------|--------|
| Q1 | 2 |
| Q2 | Probably Task 2, because the icons were not illustrative enough. |
| Q3 | Tracking of visitors is great, it can be really helpful. |
| Q4 | I would change the icons, but in general, it was neat. |
| Q4 | 2 |

**Table O.3.** Results of post-test of Participant 3.

# Appendix P
# Log of Participant 1 (Evaluation of high-fidelity prototype)

■ Introductory task

1. The participant looked at the top bar and noticed buttons *Visitor's tracking*, *Statistics*, *Alert history* and *Map of terminals*.
2. The participant opened *Detail* of the Terminal 1 and closed it.

- Time: 1:50

■ Task 1

1. The participant opened *Detail* of the Terminal 2 and thought the task is completed.
2. The moderator pointed out that the goal of the task is to display the terminal on the map.
3. The participant clicked the *Terminal on the map* button and finished the task.

- Time: 0:30

■ Task 2

1. The participant clicked *Visitor's tracking* and then *Requests for tracking*.
2. The participant clicked *Confirm* on the first request and read the confirmation window.
3. The moderator asked the participant to confirm the second request, too.
4. The participant clicked *Confirm* on the second request.

- Time: 0:50

■ Task 3

1. The participant clicked *Start to process the alert*.
2. The moderator simulated the visitor who asks for information and asked the operator to find out visiting hours on a bed department of Surgery.
3. The participant typed *Surgery* into the search input and clicked *Search*.
4. The participant listed the search results, clicked button *Display more* belonging to headline *Bed department of Surgery department* and found out the visiting hours.
5. The participant asked herself how to tell the visitor found information. Then she found the *Speak via terminal* button, clicked it and told the visitor the information.
6. The participant clicked *Mark as solved* and was confused by the confirmation dialog - at the first moment she thought she did something wrong so she closed the dialog.
7. The participant clicked *Mark as solved* button again, read the dialog and clicked *Yes, mark as solved*.

- Time: 3:40

- Task 4

  1. The participant clicked *Start to process the alert*
  2. The participant asked, how and to who pass the message and if it is possible to use tags.
  3. The moderator replied she is able toto use the tags.
  4. The participant selected tag *syncope.*
  5. The participant misspelled on the button and read *Modify stated people* instead of *Notify stated people.*
  6. The participant clicked *Notify stated people* button, but she thought she did something wrong.
  7. When P1 got responses from people she had notified, she realized her choice was right.
  8. The participant marked the alert as solved.

  - Time: 2:30

- Task 5

  1. The participant did not click *Start to process the alert* and clicked *Navigate.*
  2. The participant selected one of the listed users and clicked his photo, but nothing happened.
  3. The participant clicked *Navigate* again.
  4. The participant realized she did not started to process the alert, so she clicked *Start to process the alert.*
  5. The participant selected one of the users and clicked *Navigate.*
  6. The participant marked the alert as solved.

  - Time: 1:50

- Task 6

  1. The participant opened Detail of the Terminal 2.
  2. The participant selected *Security threat* and *Create alert and process it.*
  3. The participant selected tag *aggressive behavior* and *vandalism.*
  4. The participant clicked *Notify stated people.*
  5. The participant waited until he got the responses from notified people and then wanted to close the alert. Suddenly, she has forgotten how to mark the alert as solved and did not know where to find the *Mark as solved* button.
  6. The participant marked the alert as solved.

  - Time: 5:00

- Task 7

  1. The participant opened *Detail* of the terminal placed in area of Emergency department.
  2. The participant selected *Health threat* and clicked *Create and process an alert.*
  3. The participant realized she did wrong step, so she wanted to mark created alert as solved. The moderator mentioned that the alert was not processed, so to mark it as solved is not the proper way how to finish its resolution.
  4. The participant could not discover the way how to close the alert properly so the moderator encouraged her to take look to the user guide.

5. The participant clicked *Mark as false alarm* button.
6. The participant displayed *Detail* of the same terminal again.
7. The participant could not find the information about the number of the visitors in opened *Detail*, so the moderator pointed out she might focus herself on other functions.
8. The participant did not find the correct section again, so the moderator mentioned an existence of *Supporting tools* listed in the user guide.
9. The participant found button *Statistics* and clicked it.
10. The participant selected *Emergency department* and clicked *Select*.

- Time: 4:50

# Appendix Q
## Log of Participant 2 (Evaluation of high-fidelity prototype)

■ Introductory task

1. The participant opened a detail of the Terminal 1 and realized there is a woman is laying on the floor, so he thought it is necessary to call for help.
2. The moderator reminded him that this is not the goal of given task.
3. The participant started to look at the buttons right of the record.
4. The participant clicked the button *Map of terminals* and displayed the map.
5. The participant looked at other buttons and did not know what to do.
6. The moderator pointed out the goal is to discover the possibilities that the program offers.
7. The participant said he understood and looked at the buttons.
8. After a while, moderator ended introductory task and asked the participant to close opened *Detail* of a record and the *Map of terminals*, too.
9. The participant closed both.

- Time: 4:10

■ Task 1

1. The participant did not read the task carefully and thought the goal is only to open the detail of the terminal placed in Emergency department.
2. The moderator pointed out that the goal is to display the terminal on the map.
3. The participant looked at the buttons right of the record and clicked the button *Terminal on the map*.

- Time: 0:55

■ Task 2

1. The participant viewed *Detail* of the Terminal 5 where he saw a man with a beard. He thought that is necessary to see the record of the camera and add the person from the record to the register of tracked visitors.
2. The moderator specified that the operator had received requests from employees that during their shift met guests they think surveillance center should follow.
3. The participant still hesitated what to do and focused himself on *Detail* of the terminal.
4. The moderator suggested that there are other functionalities than *Detail* of the record.
5. The participant looked to the user guide and discovered that he should look for the *Register of tracked users* but still focused himself on *Detail* of the terminal. After a while, the moderator asked the participant to close *Detail* and to take a look on entire screen.

6. The participant noticed button *Visitor's tracking* and clicked it.
7. The participant hesitated if he should click button *Add visitor to the register* or *Requests for tracking.*
8. The moderator reminded that the goal of the task is to confirm received requests for tracking.
9. The participant clicked button *Requests for tracking* and looked at the requests.
10. The participant confirmed the first requests, but he did not notice he has to confirm the confirmation window.
11. The participant wanted to reject the second request because he finds the photo of the visitor strange.
12. The moderator reminded that the goal is to confirm both requests.
13. The participant confirmed the second request.

- Time: 7:35

▪ Task 3

1. The participant read the modal window and then looked at the user guide.
2. The participant clicked button *Start to process the alert.*
3. The moderator simulated the visitor who asks for information and asked the operator to find out visiting hours on a bed department of Chirurgy.
4. The participant skipped writing to search input of the alert and clicked *Search.*
5. The participant listed the search results, clicked button *Display more* belonging to headline *Bed department of Chirurgy* and found out the visiting hours.
6. The participant mentioned he would answer the question.
7. The moderator encouraged the participant to do so.
8. The participant hesitated how to speak to the visitor who demanded the information.
9. The participant discovered the button *Speak via terminal.*
10. The participant told the visitor the information.
11. The moderator had to restart the program because there appeared a bar of an operating system on the bottom of the screen, so the participant could not see buttons *Mark as solved* etc.
12. The participant clicked button *Mark as solved.*
13. The participant clicked button *Yes, mark.*

- Time: 4:40 (+ 10 seconds of restarting)

▪ Task 4

1. The participant clicked *Start to process the alert.*
2. The participant clicked *Add tag* button.
3. The participant had an issue with reading offered tags.
4. The participant selected tag *Fall.*
5. The participant clicked button *Notify stated people.*
6. After receiving the answers, the participant clicked button *Mark as solved* and confirmed his choice.

- Time: 1:50

▪ Task 5

1. The participant clicked *Start to process the alert.*

2. The participant selected one of the listed users.
3. The participant clicked *Navigate selected user*.
4. The participant clicked *Mark as solved.*

- Time: 1:00

■ Task 6

1. The participant opened *Detail* of the Terminal 2.
2. The participant selected *Security threat* and clicked *Create alert and process it.*
3. The participant had a problem to read offered tags, so he tilted the monitor a bit.
4. The participant selected offred tag *vandalism* and clicked *Notify stated people.*
5. The participant waited until he received the responses from notified people and then he marked the alert as solved.

- Time: 2:00

■ Task 7

1. The participant opened *Detail* of terminal in the area of an Emergency department.
2. The participant wanted to report problem marked as *Health threat*, but moderator stopped him and reminded him of the goal of the actual task.
3. The participant reported that he is not sure if it is correct to count people he sees on the record from the camera of the terminal or there is a different way to get the result.
4. The moderator gave the participant hint and said that in the program, there is special section for it.
5. The participant looked back to the user guide and decided he should look for "Statistics" section.
6. The participant clicked *Statistics* button, selected *Emergency department* and clicked *Choose.*
7. The participant found out the number of visitors in the Emergency department.

- Time: 5:30

# Appendix R
## Log of Participant 3 (Evaluation of high-fidelity prototype)

■ Introductory task

1. The participant opened *Detail* of a terminal. He asked what functionality offer the *Left*, *Right* button and a *slider*.
2. The moderator answered his question.
3. The participant closed *Detail*.

 • Time: 1:15

■ Task 1

1. The participant opened *Detail* of the Terminal 2 and then closed it.
2. The participant clicked *The map of terminals*.
3. The participant clicked on *Terminal on the map*.

 • Time: 0:15

■ Task 2

1. The participant clicked *Visitor's tracking* and selected menu item *Requests for tracking*.
2. The participant clicked *Confirm* on both requests and confirmed an info modal window.

 • Time: 0:30

■ Task 3

1. The participant clicked button *Start to process the alert*.
2. The moderator simulated the visitor who asks for information and asked the operator to find out visiting hours on a bed department of Surgery.
3. The participant started to speak to the visitor but did not realize he had not clicked on *Speak via terminal* yet.
4. The moderator pointed out that the visitor does not hear him.
5. The participant has been thinking for a while. Then he found *Speak via terminal* button, clicked it and told the visitor he would find requested information.
6. The participant typed *Surgery* into search input and clicked *Search*.
7. The participant listed the search results, clicked button *Display more* belonging to headline *Bed department of Chirurgy* and found out the visiting hours.
8. The participant told the visiting hours to the visitor and reported that Task 3 is finished.
9. The moderator pointed out that he has not finished the task yet.

10. The participant realized that is necessary to close the alert and marked the alert as solved.

   - Time: 3:00

- Task 4

   1. The participant clicked *Start to process the alert.*
   2. The participant selected tag *fall*, *syncope* and *doctor* and wanted to mark the alert as solved.
   3. The moderator put the participant wise to call people selected by the system.
   4. The participant clicked *Notify stated people.*
   5. The participant waited until he got the responses from notified people and then marked the alert as solved.

   - Time: 1:20

- Task 5

   1. The participant clicked *Start to process the alert.*
   2. The participant selected one of the listed users.
   3. The participant clicked *Navigate selected user.*
   4. The participant asked the moderator if it is necessary to tell the user that the system navigates him again now.
   5. The moderator specified that the system provides the user this information automatically.
   6. The participant clicked *Mark as solved.*

   - Time: 1:20

- Task 6

   1. The participant opened *Detail* of the Terminal 2.
   2. The participant clicked *Create alert and process it*, but then realized that is necessary to select the type of the problem.
   3. The participant selected *Security threat* and clicked *Create alert and process it.*
   4. The participant selected tag *vandalism* and clicked *Notify stated people.* When the participant got the responses from the employees he had notified before, he marked the alert as solved.

   - Time: 0:50

- Task 7

   1. The participant clicked *Statistics* button.
   2. The participant selected the Emergency department and clicked *Select.*

   - Time: 0:45

# Appendix S
# Log of Participant 4 (Evaluation of high-fidelity prototype)

- Introductory task

  1. The participant opened *Detail* of the Terminal 2 and tried switching between different terminals. He displayed the terminal on the map a noticed the possibility to speak via terminal.
  2. The participant closed *Detail*.

  - Time: 2:00

- Task 1

  1. The participant opened *Detail* of the Terminal 2 and then clicked the *Terminal on the map* button.

  - Time: 0:45

- Task 2

  1. The participant noticed he has two requests for tracking.
  2. The participant clicked *Visitor's tracking* and selected item *Requests for tracking.*
  3. The participant clicked *Confirm* on both requests and confirmed an info modal window.

  - Time: 0:20

- Task 3

  1. The participant clicked button *Start to process the alert.*
  2. The moderator simulated the visitor who asks for information and asked the operator to find out visiting hours on a bed department of Surgery.
  3. The participant started to speak to the visitor but did not realize he had not clicked on *Speak via terminal* yet.
  4. The moderator pointed out that the visitor does not hear him.
  5. The participant clicked *Speak via terminal* button and told the visitor he would find requested information.
  6. The participant clicked *Search.*
  7. The participant listed the search results, clicked button *Display more* belonging to headline *Bed department of Chirurgy* and found out the visiting hours.
  8. The participant told the visiting hours and marked the alert as solved.

  - Time: 1:40

- Task 4

1. The participant clicked *Start to process the alert.*
2. The participant selected tag *fall.*
3. The participant clicked *Notify stated people.*
4. The participant waited until he got the responses from notified people and then marked the alert as solved.

- Time: 1:20

- Task 5

1. The participant clicked *Start to process the alert.*
2. The participant selected one of the listed users.
3. The participant clicked *Navigate selected user.*
4. The participant clicked *Mark as solved.*

- Time: 0:25

- Task 6

1. The participant opened *Detail* of the Terminal 2.
2. The participant selected *Security threat* and *Create alert and process it.*
3. The participant selected tag *vandalism* and clicked *Notify stated people.*
4. When the participant got the responses from personnel he had notified, he marked the alert as solved.

- Time: 0:50

- Task 7

1. The participant opened *Detail* of a terminal placed in Emergency department.
2. The participant clicked *Statistics* and thought that now he sees actual number of people in the Emergency department, so he reported number *101.*
3. The moderator encouraged the participant to look carefully at the *Statistics* window.
4. The participant noticed it is necessary to select the *Emergency department* and clicked *Select.*

- Time: 0:50

# Appendix T
# Log of Participant 5 (Evaluation of high-fidelity prototype)

**Log**

- Introductory task

  1. The participant opened *Detail* of Terminal 2 and examined the screen carefully.
  2. The participant asked if he should report a problem.
  3. The moderator responded that it would be better to leave this for one of the test tasks.
  4. The participant clicked *Terminal on the map*
  5. The participant switched between near cameras.
  6. The participant closed *Detail* and took a look on the top bar.

  - Time: 3:20

- Task 1

  1. The participant opened *Detail* of Terminal 2.
  2. The participant wanted to report a problem.
  3. The participant pointed out that we follow the test-task list, because the participant seemed disappointed.
  4. The participant closed *Detail*.
  5. The participant clicked *Map of terminals*.
  6. The participant clicked *Terminal 2*.

  - Time: 3:10

- Task 2

  1. The participant did not do any action for some time.
  2. The moderator asked him to think aloud.
  3. The participant said he is not sure what to do.
  4. The moderator answered that now is the goal to display requests for tracking and confirm them.
  5. The participant read the task again.
  6. The participant clicked *Visitor's tracking* and then *Requests for tracking*.
  7. The participant read descriptions of the requests and confirmed them.
  8. The participant confirmed modal window.

  - Time: 4:50

- Task 3

  1. The participant clicked button *Start to process the alert*.

2. The moderator simulated the visitor who asks for information and asked the operator to find out visiting hours on a bed department of Surgery.
3. The participant asked if he can speak to the visitor.
4. The moderator agreed.
5. The participant did not do any action for some time. Then he clicked *Speak via terminal* and said to the visitor he is going to process the request.
6. The participant typed *Surgery* into the *search input* and clicked *Search*.
7. The participant listed the search results, clicked button *Display more* belonging to headline *Bed department of Chirurgy* and found out the visiting hours.
8. The participant told the visiting hours and marked the alert as solved.

- Time: 4:20

- Task 4

1. The participant read the task and asked, if he is the operator now and it is his assignment to call for help from other people, or he has to help the person himself.
2. The moderator answered that the operator of the system should not leave the system without surveillance.
3. The participant clicked *Start to process the alert.*
4. The participant selected tag *fall.*
5. The participant clicked the people from the list.
6. The participant stated that he does not know how to call them - if he has to find their mobile numbers or what to do.
7. The moderator responded that he can call them by the system.
8. The participant clicked *Notify stated people.*
9. The participant waited until he got the responses from notified people and then marked the alert as solved.

- Time: 3:90

- Task 5

1. The participant clicked *Start to process the alert.*
2. The participant selected one of the listed users.
3. The participant clicked *Navigate selected user.*
4. The participant clicked *Mark as solved.*

- Time: 1:20

- Task 6

1. The participant opened *Detail* of Terminal 2.
2. The participant selected *Security threat* and *Create alert and process it.*
3. The participant selected tag *aggressive behaviour*, *vandalism* and clicked *Notify stated people.*
4. When the participant got the responses from the personnel he had notified, he marked the alert as solved.

- Time: 3:10

- Task 7

1. The participant asked if he has to call to someone.

2. The moderator answered that he has not to call anyone.
3. The participant opened *Detail* of Terminal 1 (Emergency department) and clicked *Terminal on the map.*
4. The participant clicked *Terminal 1* on the map.
5. The participant closed *Map of terminals* and examined opened *Detail* screen.
6. The participant stated that he has no idea what to do now.
7. The moderator asked the participant to take a look at the user guide because there is a section where he can found desired information.
8. The participant decided he should look for *Statistics* section.
9. The participant clicked *Statistics* and then chose *Emergency department* and clicked *Choose.*

- Time: 7:30

# Appendix U
## Log of Participant 6 (Evaluation of high-fidelity prototype)

- Introductory task

  1. The participant opened *Detail* of the Terminal 1 and tried to create an alert. He created *Health threat* alert and discovered the main components of the alert window.
  2. The participant read *offred tags* and reported it is difficult for him to read the *tags*.
  3. The participant wanted to make him sure if he got the idea what means to *Notify stated people*.
  4. The moderator specified that by clicking this button, the system will send messages to selected personnel.
  5. The moderator stopped introductory task, because solving of an alert is one of the test tasks. The participant was asked to close the alert.
  6. The participant clicked *Mark as false alarm*.
  7. The participant took a look on buttons right of the video (*Map of terminals*,*Speak via terminal*, etc.)
  8. The participant closed *Detail*.

  - Time: 2:30

- Task 1

  1. The participant clicked *Map of terminals*.
  2. The participant clicked *Terminal 2*

  - Time: 0:40

- Task 2

  1. The participant clicked *Visitor's tracking* and selected item *Requests for tracking*.
  2. The participant clicked *Confirm* on the first request.
  3. The participant confirmed the modal window.
  4. The participant clicked *Confirm* on the second request.
  5. The participant confirmed the modal window.

  - Time: 2:00

- Task 3

  1. The participant clicked button *Start to process the alert*.
  2. The moderator simulated the visitor who asks for information and asked the operator to find out visiting hours on a bed department of Surgery.
  3. The participant clicked *Speak via terminal* and informed the visitor that he is going to find out requested information.

4. The participant typed *Surgery* into the *search input* and clicked *Search*. Unfortunately, he forgot what information the visitor wanted to know, so he spoke via terminal again.
5. The participant clicked *Search* again, then he realized he already sees the results of searching.
6. The participant listed the search results, clicked button *Display more* belonging to headline *Bed department of Chirurgy* and found out the visiting hours.
7. The participant clicked *Speak via terminal* and told the visitor the visiting hours.
8. The participant marked the alert as solved.

- Time: 3:00

▪ Task 4

1. The participant clicked *Start to process the alert.*
2. The participant selected tags *fall*, *doctor*, *syncope*, *2 people*, *nurse*.
3. The participant clicked *Add a tag*, but nothing happened. He tried to drag and drop one of offered tags.
4. The moderator informed Participant that the purpose of the input is to add his own tag.
5. The participant clicked on listed employees to notify them.
6. The participant clicked *Notify stated people.*
7. The participant move the pointer on *Information* icon and read the description.
8. The participant hesitated how to add his own mark. After a while, he typed *nurse* into the input and pressed *Enter*.
9. The participant noticed he already received responses from the personnel he notified.
10. The participant marked the alert as solved.

- Time: 2:50

▪ Task 5

1. The participant clicked *Start to process the alert.*
2. The participant selected one of the listed users.
3. The participant clicked *Navigate selected user.*
4. The participant clicked *Mark as solved.*

- Time: 1:00

▪ Task 6

1. The participant opened *Detail* of the Terminal 2.
2. The participant selected *Security threat* and *Create alert and process it.*
3. The participant selected tag *vandalism*, *aggressive* and clicked *Notify stated people.*
4. When the participant got the responses from the notified staff, he marked the alert as solved.

- Time: 1:40

▪ Task 7

1. The participant opened *Detail* of a terminal placed in the Emergency department.
2. The participant clicked *Speak via terminal* and asked, how many people there is.

3. The moderator stated this is not the way how to get requested information.

4. The participant opened *Map of terminals* and clicked on *Emergency department.*

5. The moderator stated this is not the way how to get requested information.

6. The participant opened *Statistics.*

7. The participant selected *Emergency department* and clicked *Choose.*

8. The participant reported requested number.

- Time: 2:20

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