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Concept, Design and Implementation of Identification and Tracking Technologies for Cooperative Refugee Management

DISSERTATION

submitted in partial fulfillment of the requirements for the degree of

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by

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Registration Number 0725838

to the Faculty of Informatics
at the TU Wien

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Wien, 09.04.2021

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(Ort, Datum) René Lamber

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Und zum Schluss noch einen großen Dank an meine Freunde, die hinter mir standen und mich immer wieder ermutigt haben.

Abstract

In 2015 and the first months of 2016, the European Union went through one of the most intense streams of refugees since World War II. The refugees came mostly from Asia, Africa, and the Middle East and tried to pass the national borders. One of the most desirable destinations was Germany, followed by Sweden, Norway, and Great Britain. Italy, south-eastern Europe (including Greece), and Austria acted as transit countries. The situation in the refugee camps worsened. The governmental employees and NGOs (Non-governmental organizations) had to face one of the biggest challenges in the refugee crisis. Due to the unfortunate circumstances that occurred in Italian hotspots and other European countries during the crisis in 2015, the author wanted to analyze the needs of a refugee camp. Questions arose like, how to reduce the long queues in front of the refugee camps and facilitate the work for the employees or what are the ethical issues that can emerge in a refugee camp? Moreover, there is a lack of scientific contribution in the field of European refugee camps and those internal processes.

The author held several interviews with representatives from the ministries of the interior of different countries (Austria, Germany, and Italy), European Institutions such as EASO and IT experts. The following problems arose: The currently developed Hotspots are not applicable in every country, due to the resources that are needed to maintain such an elaborate refugee camp. Furthermore, it will take time to establish a working and efficient Hotspot when the refugee stream changes. Besides that, every Member State has its own refugee registration and management system.

A portable and standardized identification solution, applicable to all regions and countries, could help to respond to refugee stream changes quickly. The target is to understand and define the requirements for a European refugee camp, which could enhance the situation for refugees and employees during challenging periods. The conclusion is to achieve a Europe-wide and centralized system for identifying and collecting information about refugees' data. Furthermore, an efficient tracking technology could enhance the management and control within the national borders. One of the most important characteristics is fast applicability, simplicity, and portability. Central European software applications, connected to all essential government services (such as Eurodac, SIS), will increase the portability of the system. Moreover, ethical aspects will also be considered for the concept.

The proposed prototype includes the system architecture, the acquired requirements and services, use-case diagrams, mock-ups, and a working web application. This doctoral thesis tries to figure out how to create an autonomous registration application with a high focus on portability and fast disaster response. The already mentioned IT experts reviewed the defined requirements and the low-fidelity prototype. Afterwards, the resulting identification, registration, and accompaniment system were implemented as a high-fidelity prototype.

Keywords: Refugee Registration, European Asylum System, Hotspot, VIS, SIS, Eurodac, CEAS

Kurzfassung

Im Jahre 2015 und in den ersten Monaten des Jahres 2016 musste die Europäische Union mit einer neuen Flüchtlingskrise zurechtkommen. Die Flüchtlinge aus Asien, Afrika und dem mittleren Osten versuchten die europäischen Grenzen zu durchqueren. Eines der begehrtesten Ziele für den größten Teil der Flüchtlinge war Deutschland, gefolgt von Schweden, Norwegen und England. Italien, Griechenland und Österreich fungierten als Transitländer und ließen die Flüchtlinge Richtung Norden durchreisen. Das Problem war, dass sich die Situation in den Flüchtlingslagern rapide verschlechterte. Die Behörden und NGOs (Non- Government Organizations) mussten mit einem gewaltigen Ansturm von Menschen zurechtkommen.

Der Autor führte zahlreiche Interviews mit unterschiedlichen Behörden, wie dem Außenministerium von Italien, Deutschland und Österreich. Außerdem wurden europäische Organisationen wie EASO und eu-LISA kontaktiert. Die Interviews und eine detaillierte Recherche des europäischen Asylsystems deckten folgende Probleme auf: Es ist äußerst wichtig, eine Identifizierung anzubieten, die dabei hilft, unbegleitete Minderjährige zu identifizieren. Die Aufnahme der Flüchtlinge über standardisierte Flüchtlingslager (Hotspots) ist aktuell nicht in jedem Land schnell und effizient einsetzbar. Es fehlt an Ressourcen, um so ein komplexes Flüchtlingslagersystem umsetzen und verwalten zu können. Zudem ist es schwierig, schnell auf Veränderungen der Flüchtlingsströme reagieren zu können.

Ein mobiles und schnell einsetzbares Registrierungssystem ist notwendig, um auf die Flüchtlingsströme reagieren zu können. Das Ziel der vorliegenden Arbeit ist es, ein Identifizierungs- und Registrierungssystem zu bestimmen, das europaweit einsetzbar ist. Es soll auch wichtige Aktivitäten innerhalb des Lagers protokollieren und dabei helfen, Ressourcen effizient planen zu können. Eine zentrale Umsetzung hilft dabei, Daten grenzüberschreitend zwischen Ländern zur Verfügung stellen zu können. Die Integration von europäischen Informationssystemen (Eurodac, SIS, usw.) ist ein weiterer Bestandteil dieser Lösung.

Diese Arbeit stellt eine standardisierte Lösung für ein Identifizierungs- und Registrierungssystem dar, das in europäischen Flüchtlingslagern einsetzbar sein sollte. Das Konzept beinhaltet die Systemarchitektur, alle ermittelten funktionalen und nicht funktionalen Anforderungen, Use-Case Diagramme, Mock-Ups und eine funktionierende Web Applikation. Ausgewählte IT-Experten und Interview-Partner beurteilten die daraus folgenden Ergebnisse (Low-Fidelity Prototyp). Weiters wurden Umfragen mit anderen Institutionen und Flüchtlingen umgesetzt. Die Ergebnisse wurden genutzt, um daraus einen funktionierenden Prototyp zu implementieren (High-Fidelity Prototyp). Die finale Umsetzung in einer realen Umgebung, in einem Flüchtlingslager, und dessen Evaluierung wird zu einem späteren Zeitpunkt durchgeführt und hätte den Rahmen dieser Arbeit gesprengt.

Schlüsselwörter: Flüchtlingsregistrierung, European Asylum System, Hotspot, VIS, SIS, Eurodac

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1 Introduction

This chapter gives a brief overview of the refugee development in Europe in the last years and the resulting motivation for this doctoral thesis, including the methodological approach.

1.1 Problem Description

In 2015 and the first months of 2016, the European Union went through one of the most intense streams of refugees since World War II. The refugees came mostly from Asia, Africa, and the Middle East and tried to pass the national borders. One of the most desirable destinations was Germany, followed by Sweden, Norway, and Great Britain. Italy, south-eastern Europe (including Greece), and Austria acted as transit countries. The transit countries did not want to register any refugees. Most of the refugees only wanted to pass the current state and reach one of the northern European countries. In the period between 2015 and 2016, no standard European solution was developed to register and manage refugees in a refugee camp.
The trespassing of refugees without any registration worked for some months until the first countries' capability limits were reached. That led to the closure of the Schengen borders of each affected country in this crisis. The worst-case scenario occurred as Bavaria closed the southern border as well. The pressure on the transit countries increased, even more for the southern European countries such as Italy and Greece. The situation in the refugee camps deteriorated further. The governmental employees and NGOs (Non-governmental organizations) had to face one of the biggest challenges in the refugee crisis.

The author held several interviews with representatives from the ministries of interior of different countries (Austria, Germany, and Italy) and IT experts. The following problems arose: The migration flow in Europe and all other parts of the world is a highly complex phenomenon. This phenomenon involves human lives. Due to this fact, it is essential to be able to react to and support the needs of these people as efficiently as possible. The need for sustainable identification is especially essential to identify minors or people that illegally pretend to be a minor. A comprehensive identification process could also help government agencies to protect the EU citizens adequately. Possible threats to national or international security and public policy can be spotted more efficiently with a reliable identification and registration process.

The European countries had no standard solution for the registration of refugees in refugee camps. Each state had to deal with the registration management on their own without any experience in this complex situation. A massive number of people had to be processed and registered quickly and securely.

Not every IT infrastructure was adequate for this situation. It is challenging to organize and develop a working identification and registration process for such an extreme situation and prepare local authorities for new refugee streams.
Each European country performs the identification and registration process individually. At the beginning of the refugee crisis, Austria tried not to register refugees who only wanted to pass through the country. Since the refugee stream did not decrease and the German border closed, Austria had to register all refugees coming over the national border. This was supported electronically by the *IFA* ("Integrierte Fremdenadministration"). Italy uses a numbered bracelet for the pre-identification. This is the step where refugees are collected in the rescue boats before they arrive at an Italian refugee camp. Afterward, the refugee is assigned a unique identification code provided by the *AFIS* (Automated Fingerprint Identification System). [1]
When refugees arrive at a German border, they receive proof of arrival in paper form and are registered afterwards in the central *KDS* (Kerndatensystem)[1]. In case the refugee was permitted to stay in the country during the asylum procedure, the refugee will receive a certificate of permission to reside afterwards.

Finally, after several EU commission meetings, a solution that should decrease the refugees coming from the Balkan route was developed: the *EU-Turkey Statement*. This statement of 18th March 2016[2] identified a plan to reduce the irregular migration of arrivals coming from Turkey. Since Turkey is still holding the EU statement, the number of refugees decreased significantly in Greece and other EU countries. However, the flow of migration to Italy remained quite intense: around 93.300 people arrived in 2017. There was only a small decrease in incoming refugees, considering the huge amount of refugees in 2016 (181.436).[3] The next years between 2018 and 2020 demonstrated that the European Union had to face many political problems. Hungary and Poland stopped relocating refugees and prohibited other European countries from relocating their refugees to the countries. The refugee stream changed from Italy and Greece to Spain. Hence, the refugees' journey became much more dangerous because of the huge distance they have to bear. Additionally, Italy tried to close its southern border and to stop the illegal migration from Libya and Malta. Due to the war in Syria and Turkey's involvement in this war, the EU-Turkey Statement was going to fall apart. More refugees tried to travel to Greece again, which led to a devastating situation in the refugee camps. Greece and Turkey have a lack of money and resources to be able to cope with these problems.
Nevertheless, at the same time as the EU-Turkey Statement entered into force, the EU commission developed a plan for a standardized refugee camp for the southern EU countries such as Italy and Greece. These refugee camps are called "*Hotspots*"[4]. The idea was to apply a Hotspot in a region where many refugees are expected to cross the national border. Currently, Italy, Greece, and Spain are affected. The refugee crisis has been declining in importance in the broader agenda of the countries which are geographically not directly connected to the sea. The problem is that if the current EU-Turkey Statement does not hold anymore, all European Member States will have the same problem as before. A standardized Hotspot is not applicable in every country due to the resources needed to maintain such an elaborate refugee camp.

[1] https://www.bundestag.de/dokumente/textarchiv/2016/kw02-ak-datenaustausch/400406
[2] http://www.consilium.europa.eu/en/press/press-releases/2016/03/18-eu-turkey-statement/
[3] http://data2.unhcr.org/en/situations/mediterranean/
[4] https://ec.europa.eu/home-affairs/sites/homeaffairs/files/what-we-do/policies/european-agenda-migration/background-information/docs/2_hotspots_de.pdf

1.2 Research Questions and Results

This thesis's result includes a proposed identification and registration system prototype, which is applicable in a European refugee camp. The designed concept will consist of the system architecture and framework, the acquired requirements, services, mock-ups, and a high-fidelity prototype. Extensive literature research, including quantitative and qualitative research, gives the basis for the evaluation of the results. The primary purpose of this work is to present a concept and design of a centralized identification technology and mobile services used for fast identification and efficient tracking management. The technology should also enhance the coordination and monitoring of refugee services within a refugee shelter used by government employees and refugees. The registration application should be available for every European country that requires a fast and responsive system when facing new refugee streams. The research questions which should be answered are:

Research Question 1: How can an identification and registration system for European refugee camps be conceived and evaluated, including the integration of European information systems and considering ethical issues?

- To answer this question, quantitative and qualitative surveys with experts, European agencies, and refugees were conducted.
- Moreover, state-of-the-art research and discussions were carried out and evaluated for the architecture.

Research Question 2: How could a blueprint for a European refugee management system be designed and implemented that supports the integration of a contactless identification medium and provides features for the refugee registration process?

- To answer this, use-case diagrams and mock-ups were defined and qualitatively evaluated.
- The refugee management system was designed and implemented as a high-fidelity prototype.

1.3 Methodological Approach

This thesis is organized into three main layers, where the first layers consist of basic research of the fundamentals. The second layer includes the definition and evaluation of the requirements. Finally, the third layer provides the design and implementation of the high-fidelity prototype. The author decided to compose this work in four main chapters: *Theoretical Fundamentals (Chapter 2)*, *State of the Art (Chapter 3)*, *EU Refugee Management System (Chapter 4)*, and *Conclusions (Chapter 5).*

Chapter 2 Theoretical Fundamentals provides theoretical knowledge about the current legislation and legal situation of the European asylum system. These fundamentals help to define the requirements of an identification and registration system for a European refugee camp.

Moreover, *Chapter 2* includes an introduction about the regulation, directives, and statements made to achieve a common asylum system in Europe. Furthermore, this chapter describes the involved European agencies, information systems, and the application of the Hotspot solution. Other important topics such as the description of data protection regulations, the use of requirement engineering techniques, and the impact of ethical issues were also described.
Chapter 3 State of the Art gives an overview of actual refugee registration systems in the economic and government sectors and introduces them to a set of scientific solutions that contributed important knowledge for the results in this doctoral thesis. At the end of this chapter, a comparison of all solutions forms the basis for the refugee camp information system requirements.
The next *Chapter Results* is based on a *User-Centered Design* approach. The author decided to select this approach due to the high involvement of users and stakeholders during the analysis, evaluation, and implementation. The author used the knowledge of the chapters *2 Theoretical Fundamentals* and *3 State of the Art* to define the requirements for the proposed refugee identification and registration system. The results chapter is composed of five main stages, which include qualitative and quantitative evaluations. The results are a theoretical concept, a low-fidelity prototype (with mock-ups), and a high-fidelity prototype (working web application)
The scientific questions defined at the beginning of the work are described and summarized in the last *Chapter 5 Conclusions.* The chapter also includes a discussion and a description of future work. The next figure gives a quick illustration of the entire doctoral thesis approach.

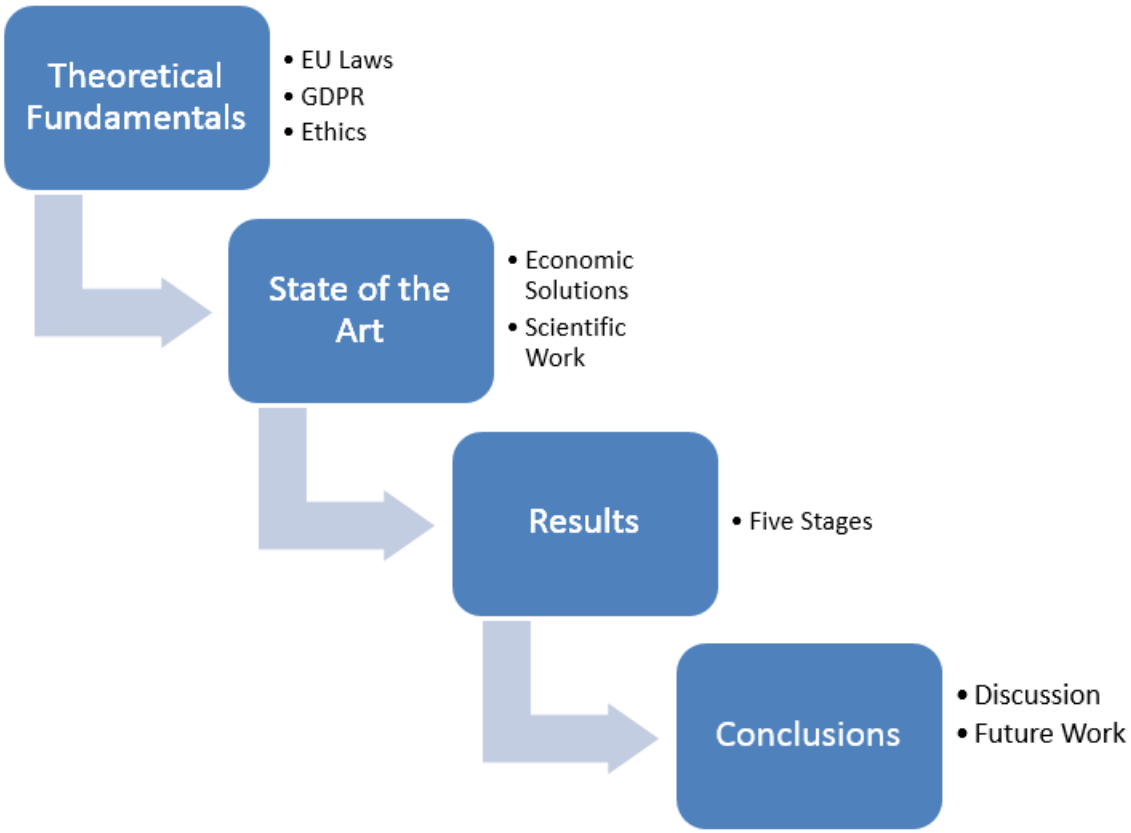


Figure 1: Methodological Approach

1.4 Publications by the Author

The author published several papers that were very important for analyzing and evaluating the requirement areas of the proposed concept, ethical aspects, and GRPR regulation. The papers are listed below and referenced in this thesis.

Requirements Engineering and Concept (2018-2019):

- R. Lamber, K. Kappel, T. Grechenig, A. Aigner and R. Baranyi, "A Hands-on Technology Mix for a European Refugee Management System serving Migrants and Institutions," in International Conference on Software Engineering and Service Science, (pp. 26-31). IEEE. Peking, China, 2018.

- R. Lamber, K. Pinter, A. Aigner, M. Reiterer, K. Kappel and T. Grechenig, "Quantitative Requirements Evaluation for a European Refugee Management System serving Migrants and Institutions," in International Conference on Information and Digital Technologies (IDT), (pp. 283-287). IEEE. Zilina, Czechoslovakia, 2019

Ethics (2019):

- R. Lamber, K. Pinter, A. Aigner, M. Reiterer, K. Kappel and T. Grechenig, "Ethical Issues arising through Identification and Registration Systems applied in a European Refugee Camp," in International Conference on Advanced Computer Information Technologies (ACIT), (pp. 320-324). IEEE. Ceske Budejovice, Czech Rebublic, 2019.

GDPR (2019-2020):

- K. Pinter, D. Schmelz, R. Lamber, S. Strobl and T. Grechenig, "Towards a multi-party, blockchain-based identity verification solution to implement clear name laws for online media platforms," in International Conference on Business Process Management (BPM), (pp. 151-165). Vienna,Austria, 2019.

- D. Schmelz, K. Pinter, J. Brottrager, P. Niemeier, R. Lamber and T. Grechenig, "Securing the Rights of Data Subjects with Blockchain Technology," in International Conference on Information and Computer Technologies, (pp. 284-288). IEEE. Zilina,Czechoslovakia, 2020.

Model Simulation:

- Evaluation of a European Refugee Camp Registration System with the Aid of a Model Based Agent Simulation (In Progress)

2 Theoretical Fundamentals

The first step is to acquire theoretical knowledge about the current state and progress of the European regulations and directives of the European border and migration system. Furthermore, it is crucial to know and understand the information systems that support border control management within Europe. The theoretical knowledge about the technical infrastructure, the general data protection regulations, ethics, and requirements engineering will contribute to a better understanding of the design progress for developing a refugee identification system.

2.1 CEAS Common EU Asylum System

This section gives a brief overview of the key facts about the *Common European Asylum System* and its role in the refugee crisis. The principal target of CEAS is to enhance the collaboration between all EU members in the domain of asylum regulation and strategy. During the ’90s, the European Union already faced the issues and challenges of illegal migration and asylum procedures. The first common program in this domain was developed by the European Council, the *Tampere* program (five-year plan). It should help enhance collaboration between the European Member States in providing justice, freedom, and security for all refugees. Instead of specifying regulations and policy documents, the Tampere program provided important deadlines and political priorities, which were to be implemented by each EU Member State. It also defined the minimum standards (those which had never been applied) for refugees or temporary protection. [2]

In 1999, the European Union created a new migration and asylum system, the *Common European Asylum System (CEAS)*. With the aid of CEAS, the EU tried to provide regulations for defining each Member State's responsibilities in the application of migration and asylum procedures. In the last years, CEAS was developed in 2 stages: the first stage, which was conducted in 2005, defined just a few standards to cover the minimum for the protection of refugees. The second stage (*CEAS II*) in 2013 provided more rules to ensure equal and fair treatment of refugees or applicants in each European Member State. The most important regulations are the legislative frameworks described in the next sections, the *Dublin System* (*Section 2.1.4*), and *European Dactyloscopy* (*Eurodac*) (*Section 2.2.3*). Two EU Agencies are significant for applying these regulations: the *European Asylum Support Office (EASO)* and the Border Agency *Frontex*. [2]

Despite the ambitious effort which has been done by the European Commission for the development of a common European asylum system in the last years, all Member States still have different standards regulating the national asylum application. One of the reasons is the past of the European Union. Beginning in 2007, numerous new Member States (10 countries) joined the European Union. [2]

Subsequently, in 2007 and 2013, Romania, Bulgaria, and Croatia were also integrated into the European Union. The diverse cultural and economic standards of the European Member States hold up the efficient application of the Common European Asylum System. [2]

The most important legislative framework topics of CEAS are the *Qualification Directive*, *Asylum Procedures Directive,* and *Reception Conditions Directive*. *Chapter 0 Definitions* describes some definitions provided by the *Council Directive 2011/95/EU*, which may give a better understanding of the directives outlined in the next sections.
The figure below shows a brief overview of the entire process of the CEAS system when a refugee or a person with subsidiary protection status arrives at a European Member State border. CEAS tries to standardize all processes between asylum reception conditions, fingerprint registration, asylum application qualification conditions, and procedure directives. The next sections describe all components involved in this asylum qualification process. [3]

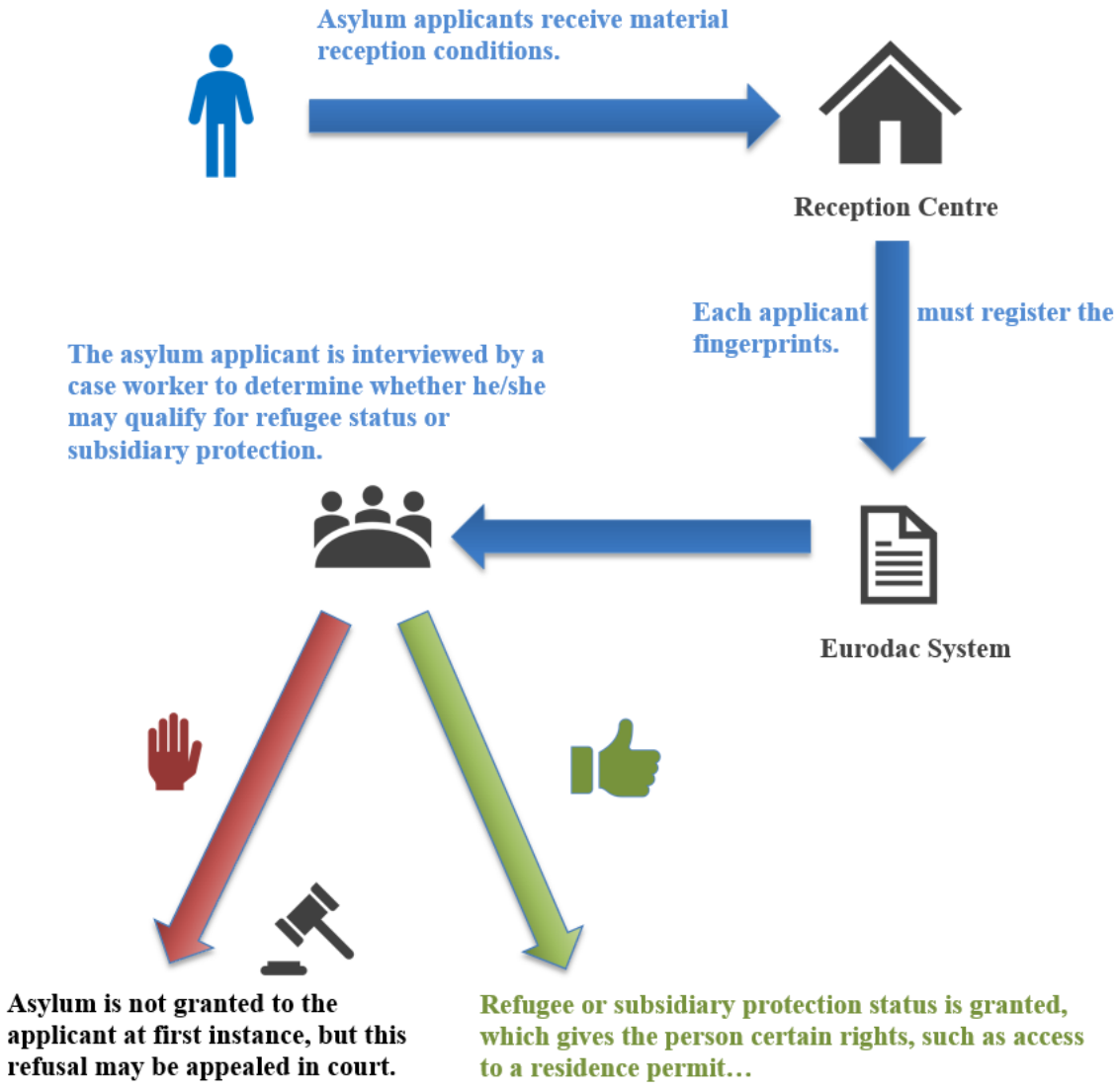


Figure 2: CEAS Overview

2.1.1 Qualification Directive

The *Qualification Directive* defines the criteria for classifying a person as a refugee or beneficiary for protection. This directive was in the first place conducted with the *Council Directive 2004/84/EC*[5]. The first version of the Qualification Directive defined the minimum standards to classify a stateless person a refugee or as a person seeking international help. [3]

> *"The main objective of this Directive is, on the one hand, to ensure that Member States apply common criteria for the identification of persons genuinely in need of international protection, and, on the other hand, to ensure that a minimum level of benefits is available for those persons in all Member States."* Article 12 [3]

The minimum standards defined by the first version of the Qualification Directive were not adequately specified for the different European Member States. The chances to be qualified as a refugee were too different between the EU Member States. The Qualification Directive had to be recast with the new *Council Directive 2011/95/EU*. It was published on the 20th December 2011 in the Official Journal of the European Union and entered into force on 21st December 2013. The new directive tries to define qualification rules which are fairer for the person seeking help. [3]

The divergences between the EU Member States should be reduced to ensure a common and standardized qualification procedure. It defines more robust criteria for determining admittance and international protection for a refugee. Furthermore, it provides more rights for refugees and all *subsidiary protection* recipients, including rights for healthcare and employment. A person will be qualified for subsidiary protection when he/she has to expect serious harm when going back to the origin country. Serious harm consists of [3]:

- Death penalty or execution.
- Punishment in the origin country or torture.
- Serious threat to the individual due to a national or internal armed conflict.

The directive also enlarges the duration for granted stay of refugees in a European Member State. Another important aspect is the asylum application of children. The directive also takes into account the needs of children and deals with gender-specific situations. [3]

> *"It is necessary, when assessing applications from minors for international protection, that Member States should have regard to child-specific forms of persecution."* Article 28 [3]

It also must be considered that Denmark, Ireland, and the United Kingdom are not included in the new directive; they still hold to the old version of 2004. [3]

[5] Council Directive 2004/83/EC of 29 April 2004 on minimum standards for the qualification and status of third country nationals and stateless persons as refugees or as persons who otherwise need international protection and the content of the protection granted, OJ 2004, L 304/12.

2.1.2 Asylum Procedures Directive

The next directive, the *Asylum Procedure Directive*, defines all rules related to the asylum application procedure of refugees and recipients for subsidiary protection. The regulations include definitions for how the refugees are to apply, what help they receive, how to react when an applicant requests multiple or repeated applications, and so on. [4]

> *"The main objective of this Directive is to further develop the standards for procedures in Member States for granting and withdrawing international protection with a view to establishing a common asylum procedure in the Union."* Article 12 [4]

The Asylum Procedure Directive 2005/5/EC[6] was introduced in 2005 and provided the first common regulations for the European Member States. The problem was that the regulations were too imprecise to maintain a common European asylum procedure in each Member State. By defining their own rules, the Member States benefited from the vague regulations. These led to new national rules, which partially were below the European asylum standards. The European Commission report of 2010, about the application of asylum procedures in the European Member States, emphasized the high divergence between the national procedures[7]. [4]

Due to the divergence and vague definitions between the regulations, the new *Asylum Procedure Directive 2013/32/EU* was introduced by the European Commission. The new directive aims to be more precise by defining the asylum procedure regulations. The main purpose is to accelerate the asylum procedure, which should not take longer than six months (in a typical case). The training for decision-makers should be improved to provide more help quickly to refugees. Not only will the refugees benefit from this improvement, but also the local government. The costs produced by the refugee while spending more time in reception offices, the local government or state sponsor, shall be reduced. Due to more precise asylum application decisions, additional costs shall be minimized. [4]

The directive defines that persons seeking help because of their disability, post-traumatic experience, health, disability, sexual orientation, or age, will receive adequate support. Moreover, the directive defines that refugees should be given sufficient time to explain their problems. National authority representatives will support children who are not in the company of adults (so-called unaccompanied minors). [4]

[6] Council Directive 2005/85/EC of 1 December 2005 on minimum standards on procedures in Member States for granting and withdrawing refugee status, OJ 2005, L 326/18

[7] European Commission, Report from the Commission to the European Parliament and the Council on the application of Directive 2005/85/EC of 1 December 2005 on minimum standards on procedures in Member States for granting and withdrawing refugee status, Brussels, 8 September 2010, COM (2010) 465 final, p. 15.

Exceptional cases such as unaccompanied minors or victims of violence will be processed by special asylum procedures, the "accelerated" and "border" procedures [4]:

> "*Member States shall ensure that where applicants have been identified as applicants in need of special procedural guarantees, they are provided with adequate support in order to allow them to benefit from the rights and comply with the obligations of this Directive throughout the duration of the asylum procedure.*" Article 24/1 [4]

The rules for unaccompanied minors were revised and explained in more detail. An unaccompanied minor is a child aged up to 18 years. A legal authority will interview each unaccompanied minor. The presence of a person who knows the individual needs of children is obligatory. In case the Member States is not sure about the age of the minor, it is possible to make specific medical examinations. If the Member States still have doubts about the real age even after the medical examination, they shall classify the individual as minor. [4]

The directive also specifies that if the decision regarding an application's admissibility is taking longer than four weeks, then the Member State must grant entry into the national territory for an asylum request. In case of a large number of arrivals incoming to the national border, which makes it impossible to process all decisions about the admission of an application for each entry, the Member State can accommodate all arrivals at another location near the border or transit zone. That means that the decision about the admissibility of applications is allowed not only in the border zone but also in other places. [4]

However, persons who are not cooperating with the national representatives and the border management will also be processed with the special asylum procedures. These persons will be returned to their origin country, in case there is no serious harm or war to expect. Not only can persons who are not cooperating be returned to the state of origin or another third-party country, but also individuals by whom the validity of international protection status has to be revised. In such a case of application withdrawal, the affected person must be informed that the competent authority is reconsidering his/her protection status. With the aid of a personal interview or written statement, the affected person can submit the reason why his/her status of international protection should not be revised. In the case that the responsible authority decided to withdraw the status of international security, the person has the right to obtain legal assistance for free. [4]

As mentioned before, the rules and regulations are much more transparent in the new directive version than before. The *European Court of Human Rights* had to deal with many cases caused by the vague EU law in the domain of asylum procedures. This led to an increase in costs and legal discrepancies for the application of fundamental rights by the European Court in Strasbourg. The Member States will also receive better IT equipment to deal with repetitive asylum applications done by a refugee after receiving a negative reply to his/her asylum request. Some refugees tried to repeat the qualification request of asylum to prolong the residence permit in the current country for an indefinite time. [4]

2.1.3 Reception Conditions Directive

The last directive of CEAS is the *Reception Conditions Directive 2013/33/EU*. It replaced the Reception *Condition Directive 2003/9/EC*[8] conducted on 27th January 2003. The directive describes the reception regulations for refugees waiting for their asylum decision. [5]

> *"Standards for the reception of applicants that will suffice to ensure them a dignified standard of living and comparable living conditions in all Member States should be laid down."* Paragraph 11 [5]

The old reception directive was replaced due to the vague regulations, especially for the areas of health care, free movement rights, needs of vulnerable persons, access to employment, and material reception conditions. A report of the European Commission about the function of the reception directive showed high divergence between the European Member in applying the mentioned fields. It was an elaborate process to define proper regulations for the new Reception Conditions Directive conducted in 2013. The old directive was applied for all Member States except Ireland and Denmark. The UK did not accept the new directive and is still holding to the old one. [6]

As mentioned before, the fields that are regulated by the reception directive are medical care, psychological support, employment, food, and housing. The new directive ensures the fundamental rights of each refugee [5]:

- The limitation of detention of each Member State to avoid arbitrary detention processes, including the restriction of detention for minors.
- The guarantee to obtain access to non-governmental organizations.
- The right to be reunited with the family.
- Access to fresh air.
- The right to be able to communicate with lawyers.

Regulations regarding vulnerable persons, such as victims of torture and unaccompanied minors, are also essential topics regulated by the updated reception directive. The directive specifies that vulnerable refugees, especially children, have the right to psychological counseling. [5]

> *"Unaccompanied minors shall be detained only in exceptional circumstances. All efforts shall be made to release the detained unaccompanied minor as soon as possible."* Article 11/3 [5]

It also specifies the qualification rules for representatives of unaccompanied children/minors. Another important rule is that an employment request of an asylum applicant must be approved within nine months. [5]

[8] Council Directive 2003/9/EC of 27 January 2003 laying down minimum standards for the reception of asylum seekers, OJ L 31 of 6.2.2003

2.1.4 Dublin Regulation

The *Dublin Regulation* was defined for the first time as part of the *Dublin Convention* on 15th June 1990. The definition of the Dublin Regulation is described as follows [7]:

"... establishing the criteria and mechanisms for determining the Member State responsible for examining an asylum application lodged in one of the Member States by a third-country national." [7]

The Dublin Convention was signed by Belgium, Denmark, Germany, France, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, and the United Kingdom. The act entered into force on 1st September 1997. Austria, Sweden, Finland, and the Czech Republic joined the regulation afterward. The primary target of the Dublin Convention is to guarantee each foreigner access to the asylum procedure in an EU member state. The primary regulation of the Dublin Convention is: the member state over which the refugees crossed the European borders is responsible for the asylum application and process. For that purpose, a thus determined European Member State will enhance the asylum procedure, due to fast accessibility to the asylum process. That means each country must be able to decide whether it is responsible for a specific asylum procedure. With the aid of this regulation, multiple asylum requests in different countries should be minimized. No further asylum requests can be made by the refugee when at least one asylum procedure was already performed. [7]

The next application of the Dublin Convention is the Dublin Regulation of 2003. It is called the *Dublin II Regulation*. Since 2006 all European Member States have adopted the Dublin II Regulation, including the non-European Member States Norway, Island, and Switzerland. The most important aspect of the Dublin II Regulation is the *Eurodac* system, which was introduced on 15th January 2003. The fingerprints of the refugee must be registered (if specific conditions are fulfilled). The system stores when a person already requested an asylum application or/and when the European border was crossed illegally. The Eurodac regulation will be explained in the next section in more detail. The conditions in which a country is responsible for a specific asylum application were adapted and enhanced with the Dublin II Regulation. New regulations were included, which will be applied with a particular hierarchical order. This should give more support to unaccompanied minors. See Article 6 of the Dublin II Regulation [7]:

"Where the applicant for asylum is an unaccompanied minor, the Member State responsible for examining the application shall be that where a member of his or her family is legally present, provided that this is in the best interest of the minor." Article 6 [7]

However, not only unaccompanied minors have more advantages through the new Dublin Regulation, but also persons with family members in the other European Member States will benefit from the adaptation [7]:

"If the asylum seeker has a family member in a Member State whose application has not yet been the subject of a first decision regarding the substance, that Member State shall be responsible for examining the application for asylum, provided that the persons concerned so desire." Article 8 [7]

Furthermore, the rest of the clauses describe how a member state must react when specific conditions occur. For instance, if the person has a valid residence document, the Member States that issued the document shall be responsible for the asylum application. Nevertheless, if a person has a forged VISA, false documents, or pretends to be someone else, the Member State in which the documents were issued is not responsible for an asylum application. In addition to the hierarchical clauses, a humanitarian clause was conceived. The focus of the new regulations lies in keeping families together [7]:

> *"Any Member State, even where it is not responsible under the criteria set out in this Regulation, may bring together family members, as well as other dependent relatives, on humanitarian grounds based in particular on family or cultural considerations."* Article 15/1 [7]

The next described update of the Dublin Convention is the *Dublin III Regulation* of 2013. The Dublin Regulation was revised again to improve the entire Dublin System. The following points describe some new enhancements of the Dublin Regulation briefly: In the last years, Italy had to face high refugee flow pressure in the southern regions. A new early pressure detention system should help understand where the European asylum system experiences the highest flow of incoming refugees. The regulations for unaccompanied minors were optimized for the children's interests. Furthermore, the possibilities of reuniting family members with their children were also enhanced.
In case a person wants to appeal a suspension for the current execution of the transfer, he/she has the right to stay in the territory during the pending court decision. Each refugee has the right to free legal assistance until the asylum request is conducted. The detention rules were enhanced for the refugee's interest in decreasing the detention duration. With the new Dublin Regulation asylum seekers, those who were identified as illegal migrants receive more protection during the return process as the return directive defined it.
Furthermore, asylum seekers have the right to request a court appeal against their transfer decision. The legal responsibilities were clarified between the European Member States. The entire Dublin procedure cannot take longer than 11 months in case the asylum request was granted. In case the asylum seeker was classified as not applicable, he/she must be transferred back to the origin country within nine months. [8]

2.1.5 Relocation Scheme

On 13th May 2015, the European Commission presented the *emergency response mechanisms* of Article 78(3) of the *Treaty on the Function of the European Union (TFEU)*. The reason was the high pressure on the national borders through the migration flow in the Southern Member States such as Italy and Greece. The first emergency response mechanism should be applied for the Member States with an asylum recognition rate above 75%. The duration of the relocation process for Italy and Greece was set to two years. [9]

40.000 migrants should be relocated from Italy (24.000) and Greece (16.000). Furthermore, the Council decision *(EU) 2015/1601*[9] was introduced. The Council decision 2015/1601 proposed to relocate 120.000 migrants from Italy, Greece, and the other European Member States in the case they are confronted with an emergency. Sweden had to host 1.396 persons. Article 4(3)(2) of the decision 2015/1601 defines that a European Member State has the right to inform the European Commission when an emergency occurs. Such an emergency would be a sudden inflow of migrants due to an inevitable migration flow change. In this case, the European Commission will tackle the problem and propose a new Council decision. [9]

One of the negative aspects of the first relocation decision is that the asylum applicant cannot choose the destination when he/she is classified for the relocation procedure. The refugee does, however, have the right to an effective remedy against the relocation decision itself.
The second relocation decision included new decisions with the primary purpose of regulating the distribution mechanism to the European Member States. That means the relocation of an asylum seeker was distributed to the other European Member States, taking the following criteria into consideration [10]:

- The national gross domestic product (GDP) (40%). The GDP indicates the current economic efficiency of a country. It would not be fair to relocate the same number of refugees to a country with a low GDP as to a country with a high GDP. It is important to keep the economics of a European Member State stable.

- The population factor (40%) is weighted the same as the GDP factor. Usually, a country with a large population reflects the capacity of integrating refugees.

- The unemployment level (10%) also reflects the integration capacity.

- Lastly, the number of already applied asylum seekers and resettled refugees (10%) is given from 2010 to 2014.

These distribution criteria were supposed to be mandatory for each European Member State. The Member States can only refuse a refugee if the State complains about security issues. Furthermore, a refugee can rank a specific destination Member State as a favorite relocation country. The ranking is composed of personal criteria such as family reunification, language skills, study experiences, previous stays, working experiences, and cultural or social issues. On the whole, there were two main relocation decisions made by the European Council. The following problem arose when facing both regulations: The first relocation decision specifies that only refugees who were successfully identified and registered in Italy or Greece are allowed to be relocated. However, this only applies if they were allowed to obtain a European asylum application by Italy or Greece (the country that would be responsible for the asylum application according to the Dublin regulation). [10]

[9] Council Decision (EU) 2015/1601 of 22 September 2015 establishing provisional measures in the area of international protection for the benefit of Italy and Greece

Furthermore, the refugee had to be successfully identified and registered with his/her fingerprints. In case any asylum application was not registered successfully, the refugee is not permitted to join the relocation program. According to the first relocation decision, only refugees who arrived in Italy or Greece after 15th August 2015 can participate in the relocation program. The same counts for the second relocation decision where refugees who came after the 24th March 2015. Due to this, it seems that the arrival date in Italy or Greece determines the possibility of relocation. It depends on the destination Member State if the asylum application is relocated successfully. This fact is crucial for granted asylum applications. The table below shows the effectiveness of each Member State in the relocation mechanism since 2015. The European Commission report[10] provides the data of 2017 and shows the top 10 relocators. The percentage efficiency depends on the resources and the voluntary engagement of a European Member State and its population. The optimal ranking will be reached by relocating as many asylum applicants as the destination state is responsible. [10]

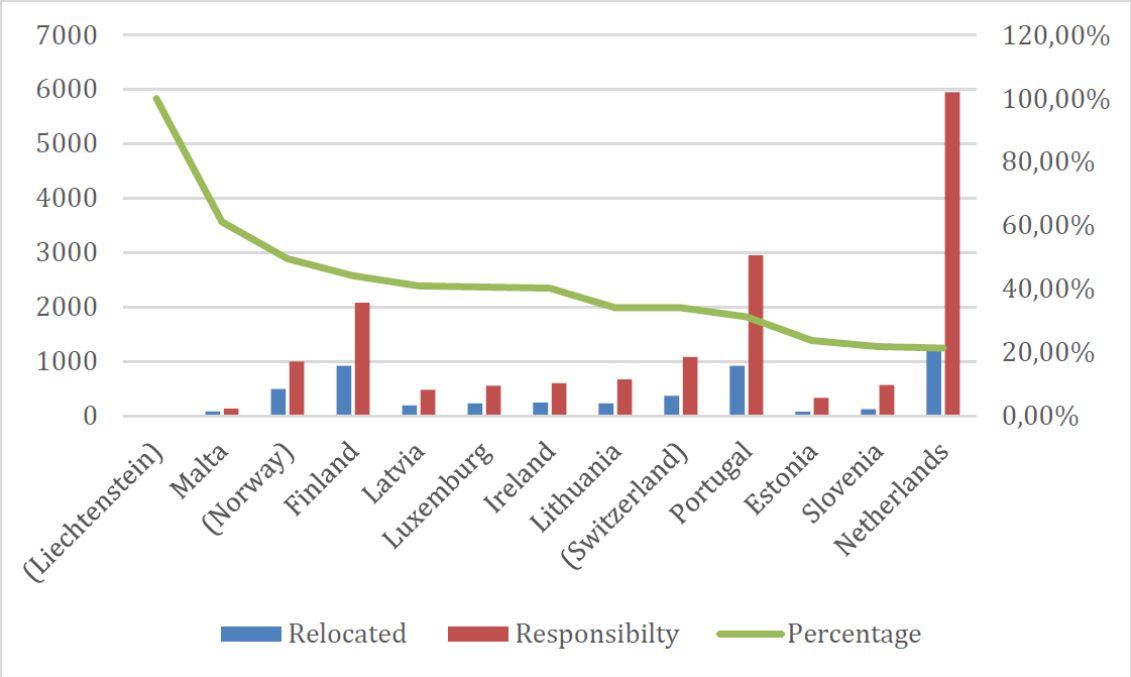


Figure 3: Top 10 relocators and their performance 2017 [10]

[10] https://ec.europa.eu/homeaffairs/sites/homeaffairs/files/what-we-do/policies/european-agenda-migration/pressmaterial/docs/state_of_play_-_relocation_en.pdf

2.1.6 EU-Turkey Statement

The EU-Turkey Statement entered into force on 18th March 2016. The statement was agreed on between Turkey and the European Council, to counter the illegal smuggling of human lives and reduce the bottleneck in Greece. The following nine keys were defined to reduce the illegal migration from Turkey to Greece [11]:

The first point defines that all new irregular migrated refugees in Greece from 20th March 2016, have to be resettled back to Turkey. The statement guarantees that all international standards and human rights aspects for a refugee are fulfilled. The act should be considered as a temporary solution for stopping human suffering and restoring public policy. Migrants who are arriving at the Greek islands will be registered in an orderly fashion. The Greek authorities will process the asylum request in collaboration with UNHCR[11]. The refugees with asylum request which were not accepted will be resettled back to Turkey. This process will be executed in cooperation with Greek authorities in Turkey and Turkish officials in Greece. The European Union will cover the cost of resettlement. The EU agency in Greece Hotspots will also support Greece and Turkish authorities with their work [12]:

> *"The Statement flipped the purpose of hotspots in Greece, turning them from a preparatory screening instrument in view of relocation to a registration and detention centre for irregular migrants pending their return to Turkey."* [2]

The next point defined in the EU-Turkey Statement emphasizes that Turkey has to control and prevent all illegal refugee routes, which would cross the European Union. Turkey has to collaborate with all neighboring states to avoid illegal migration as efficiently as possible. In case the illegal immigration from Turkey to Greece or the other European Member States decreases significantly, the voluntary relocation will be applied to fulfill the humanitarian rights of the refugees. This means the European Member States will contribute resources and help as volunteers.
The next regulation of this statement defines the timetable of VISA liberalization for Turkish citizens in the European Union. This regulation should revoke the VISA requirement for Turkish citizens entirely. However, only if Turkey fulfills the specific benchmarks required by the European Commission. But until now, no VISA liberalization was applied. The European Union will support Turkey in developing projects and refugee reception centers with 3 Billion Euro. The mentioned projects are intended to help refugees in the domain of health, education, infrastructure, food supply, and cost of living. In case Turkey fulfills the specified benchmarks until 2019, the European Union will support Turkey with additional 3 Billion Euro. [11]
Furthermore, the European Commission and Turkey will reopen the integration process's discussion and decision to the European Union. The last point of the statement determines the collaboration between EU and Turkey in improving and stabilizing the refugee Hotspots between the Turkish and Syrian border. The plan is to ensure secure living zones for citizens and refugees. The report of the European Commission in 2019 about the impact of the EU-Turkey Statement on the refugee-flow pressure in Greece describes the following: The business model of smugglers can be broken with the aid of the EU-Turkey Statement. Ten thousand refugees arrived in the Greek islands every day. [13]

[11] http://www.unhcr.org/

Since the EU-Turkey Statement entered into force, only an average of 43 refugees a day crossed Greek borders. As can be seen in the figure below, the flow pressure decreased by 97%. [13]

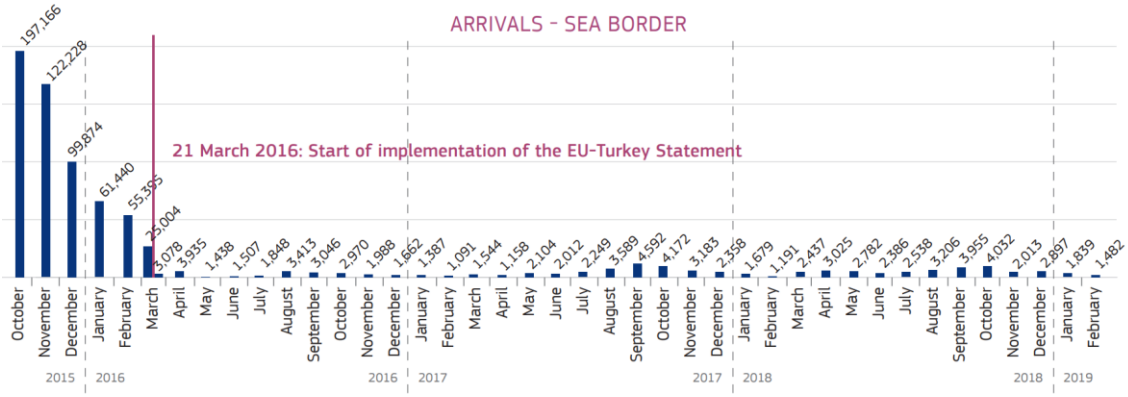


Figure 4: The course of refugee arrivals on Greece borders 2019 [13]

The number of relocations is shown in the figure above and is continuing at a steady pace. Until February 2019, 20.292 Syrians were relocated to the EU.

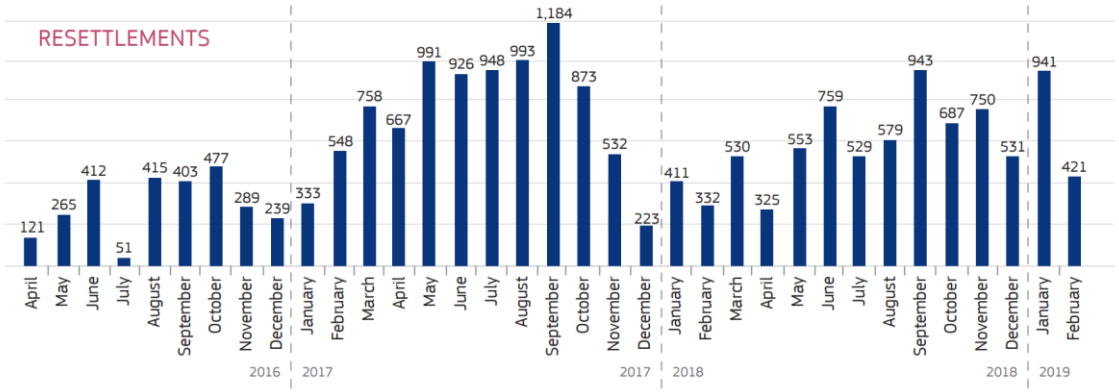


Figure 5: Relocated Syrians from Turkey to the EU [13]

In 2020, due to war and the political instability in Turkey, the arrivals to the European border increased again, and the relocations to the EU were reduced. This will impact the European refugee management coordination and the situation at Greek borders.

2.2 EU-LISA

The agency *eu-LISA*[12] *(European Agency for the operational management of large-scale IT systems in the area of freedom, security, and justice)* provides technical support for the European authorities to maintain internal security in the Schengen countries. The author held several interviews with the press office of eu-LISA, which provided more detailed information about the current situation of the coordination and administration process.

Eu-LISA supports all Member States in developing and maintaining comprehensive IT solutions within the European Union in the area of freedom, security, and justice. The three most important systems are *VIS*, *SIS II,* and *Eurodac* (as mentioned before in *Section 2.1.4*). With the aid of these systems, eu-LISA increases the security within Europe and supports the development of asylum-, migration- and border-control-politics. Eu-LISA attaches importance to big data and information exchange between the Member States. [14]

The figure below shows a quick overview of the three eu-LISA information systems. These three information systems are essential for this work because they provide essential data and services for the management of refugee registration systems in Europe.

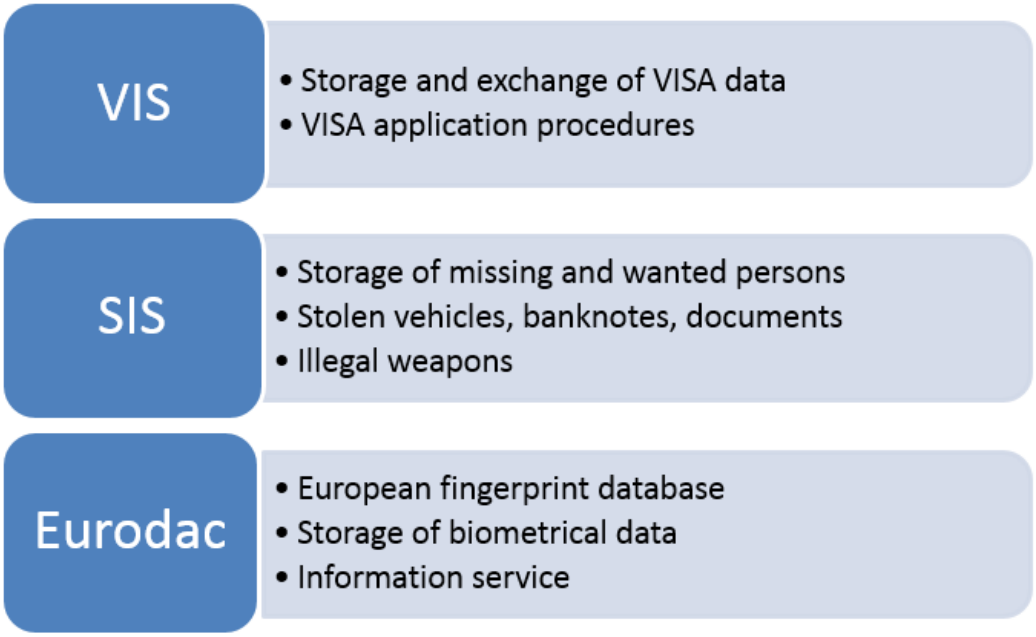


Figure 6: eu-LISA Information Systems

[12] http://www.eulisa.europa.eu/Pages/default.aspx

The organizational structure of eu-LISA is composed of an administrative council, advisory groups, and the managing director. Agents of each Member State and the European Commission represent the administrative council. Other associated countries (Switzerland, Island, Norway, and Liechtenstein), but also agencies such as *Europol*[13] and *Eurojust*[14], are also members of the executive council. The administrative committee's main task is to guarantee that eu-LISA fulfills the given targets efficiently and with low costs. The advisory group's function is to advise the executive council on technical issues regarding the three European information systems (VIS, SIS II, and Eurodac). [14]

2.2.1 VIS System

The European Parliament defined 2004 the implementation of VIS, the *VISA Information System*. This system is responsible for the exchange of VISA information between the Schengen countries. Eu-LISA is accountable for the maintenance of VIS and the communication between the countries. The VIS application supports the implementation of the European Visum politics and simplifies communication on the European border. The system enables national agencies and Europol to request the stored personal data (via biometrical registration mechanisms) for VISA applications within the Schengen area. The next figure illustrates the operational structure of the VIS.

As can be seen in the next figure, the VIS architecture is composed of two main components: the *N-VIS (National VISA Information System)* and the *C-VIS (Central VISA Information System)*. The N-VIS is nation-dependent and has to be implemented and maintained by the Member State itself. The C-VIS is controlled and maintained by eu-LISA. All N-VIS components are connected with the C-VIS unit. Eu-LISA guarantees the communication and application between those components. [15]

The N-VIS component itself is typically responsible for the VISA data exchange between the national consulates, border-crossing points (such as land borders, port, airports, and so on), police departments, and ministries. The physical location of the eu-LISA's central unit is in Brussels. Furthermore, the figure below shows the different components within a European Member State: the consulates, border-control systems, and the national *AFIS (Automated Fingerprint Information System)*. [16]

The consulates can be connected in three different communication types. One type is "real-time online transactions." In this case, all changes on a VISA entry or new VISA entries are synchronized between the N-VIS and the consulate system. The second type is the "near real-time online transactions," which processes data changes with a certain delay between the N-VIS and the consulate information system. The last type uses "Pure batch" as data synchronization. Sometimes data changes are processed in specific scheduled batch transactions due to communication infrastructure and performance issues. [17]

[13] http://www.eurojust.europa.eu/Pages/home.aspx
[14] https://www.europol.europa.eu

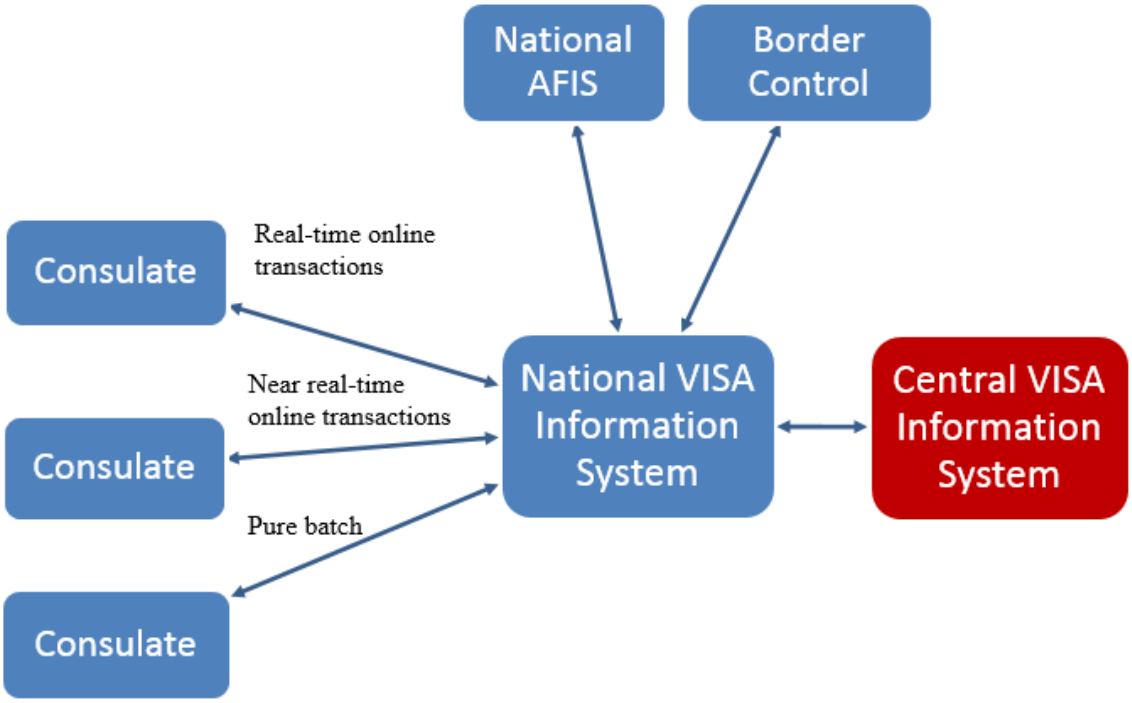


Figure 7: VIS System Architecture

The AFIS unit is responsible for the identification and collection of fingerprints. Each European Member State may have a different AFIS component. The data collected by the system is processed to the national VISA information system. The European Commission developed a *User Software Kit (USK)* with four subsets (USK 1- USK 4). All technical subsets have a specific task: USK 1 provides quality checks of the fingerprint image, USK 2 checks if a record is unique, USK 3 filters inaccurate fingerprint data, and USK 4 performs the quality check of all five fingerprint entries for one entire hand. The Member States should use the four user software kits to obtain good fingerprint quality and fulfill the *Biometric Matching System (BMS)* requirements. [18] [19]

Due to the massive amount of fingerprint data processed to the central unit, the quality of stored fingerprint data must be as high as possible. Therefore, the data that will be saved to the central unit will be checked before: it must fulfill the BMS requirements. In case the information does not satisfy the criteria, it will be marked as excluded in the internal database and not be shown when a national office wants to search for personal data. Eu-LISA regularly provides statistics to the Member States, including the rejection state of their processed fingerprint data. This helps the Member States to improve their accuracy in registration fingerprint data. [18]

The different N-VIS components are not connected and have only one physical connection to the C-VIS unit. Each change or adaptation of the C-VIS unit has to be implemented on the N-VIS component. This keeps a logical separation between the N-VIS components. All Member States can implement additional features on their N-VIS component, independent of the other Member State's components. The N-VIS unit must fulfill all requirements defined by the *Interface Control Document (ICD)* defined by eu-LISA.

The ICD defines the format and mechanism of preparing, sending, and receiving data. Thus, all data exchanged between the several national components and the central component is consistent.

Furthermore, eu-LISA is responsible for maintaining the security of the complete system and data in the central unit. The communication between the national central access point and the central unit is also controlled by eu-LISA. The Member States are responsible for all other activities beyond the national central access point. Moreover, eu-LISA has to provide 24/7 support to all Member States regarding all technical issues during the communication. Due to each country's different legal and cultural boundaries, the coordination has to be as effective as possible. Creating or changing requirements and features for the central VIS component involves a long and complicated process: the VIS Advisory Group meets regularly (four times per year) with representatives of all VIS-associated countries and the European Commission.

2.2.2 SIS System

The European Union introduced the *Schengen Information System (SIS)* on 19th June 1990. SIS implements the requirements defined by the Schengen Agreement (June 1985) between the Federal Republic of Germany, the French Republic, and the Benelux Economic Union. SIS supports the European Union technically in the application of the Schengen Convention and the abolition of borders checks within the Member States. Furthermore, SIS is available for all Member States, Europol, and Eurojust. SIS provides an automated search for wanted persons and stolen objects (such as vehicles). It uses a private database (within the European Member States) that includes data about missing or wanted persons, stolen cars, banknotes, seized documents, and illegal weapons. [20]

Eu-LISA is responsible for the organization and technical support of the system since 2012. The system has the same architectural structure as VIS: it is composed of a national system N-SIS and the central system C-SIS. The database of the central system is in Strasburg. Furthermore, each Member State has a governmental unit, called the *SIRENE Bureau* that provides access to police departments for retrieving information from the central unit. Each bureau can define which data will be shared with the other Member States. The bureau also checks the quality of data that was entered into the SIS system. How the SIRENE Bureau has to act or how they have to be coordinated is written in the European Commission regulation [21]:

> *"Supplementary information shall be exchanged in accordance with the provision of the 'SIRENE Manual' and using the communication infrastructure."* Article 8/1 [21]

The European Commission proposed an updated version of the Schengen Information System, the SIS II. Due to organizational and political delays for the SIS II implementation, another version of SIS (*SISone4all*, later *SIS 1+*) was developed in parallel. This temporary solution provided access to the SIS data for the new European Member States and other states such as the United Kingdom, Cyprus, Ireland, and Switzerland. This enabled the elimination of all border controls between the participating states. [22]

Finally, on 9th April 2013, the new SIS II system entered into production. SIS II provides more options, new types of notifications (e.g., electronic payments, stolen planes, containers, or boats) and the possibility to register biometric data, including fingerprints and photographs. SIS II shall help the police and the government departments to reduce the criminality beyond the national borders. The information system also stores the movements of a wanted person within the participating states. With SIS II all police departments can also access the data and exchange it with other national authorities. Besides the new data types that can be stored with the new SIS II version, the way of storing data entries and how they are connected also changed. Each person entry can be linked to other data types - for instance, vehicle entries. This allows authorities to find relevant information about a person more quickly and to react more efficiently. SIS II guarantees a high level of data protection and meets the data privacy requirements of the European Commission. As mentioned before, the access is limited only to the responsible national authorities, European agencies, and police departments. [22]

The SIS system stores personal data including the following properties: first name, last name, sex, specific body characteristic, images, fingerprint, nationality, the unique identifier of the database entry, and issuing date of given documents. Furthermore, the information about the status of the person is also referenced. The person status has three states: missed, wanted, and violent. Moreover, SIS provides further information about why the personal data was stored in the information system, the responsible authority, the information about decisions made, the criminal offense, and the action to execute. [20]

2.2.3 Eurodac

As mentioned before in *Section 2.1.4*, the *Eurodac Regulation* was introduced in 2003 to enhance the Dublin Regulation with a central fingerprint database. Each asylum seeker must register the fingerprints when arriving at a European border. The data will be stored in the Eurodac central database, regardless of where the fingerprints have been recorded. This helps to determine which country is responsible for the current asylum application. Figure 98 (Appendix) illustrates the fingerprint register template used by each European border control. [23]

"To this end, it is necessary to set up a system known as 'Eurodac', consisting of a Central Unit, to be established within the Commission and which will operate a computerized central database of fingerprint data, as well as of the electronic means of transmission between the Member States and the central database." Paragraph 5 [23]

The Eurodac system consists of a central unit and a national unit. The central unit is responsible for processing the central database, including a computerized fingerprint recognition system. It also generates statistics for displaying how many fingerprints were taken and where they were scanned. Each national system is responsible for scanning, recording, and transmitting the fingerprint data to the central unit. Only persons with a minimum age of 14 years are permitted to be scanned with a fingerprint system. [23]

Before processing a newly registered fingerprint data, each national unit must compare the new data with already existing fingerprint records. This is one part of the process of applying the Dublin Regulation. Depending on where fingerprint data was previously stored, the country that processed the fingerprint data for the first time is responsible for the asylum application. The following data of applicants for asylum will be saved [23]:

- Member State that registered the fingerprints, including the date of application.
- Full data of the fingerprint record.
- Sex of the registered person.
- Fingerprint registration date.
- Time when the fingerprint data was transmitted to the central Eurodac unit.
- Time when the fingerprint data was entered into the central Eurodac unit.
- Further details or any comments about the person that was registered.

The storage time for a specific entry of fingerprint data given by an asylum seeker is limited to ten years. After that period, the full data shall be erased automatically by the central unit. Furthermore, the data of a person who received the citizenship of a specific European Member State must be deleted. When persons illegally cross the border, the regulations of storage and data handling change. In such a case, the fingerprint data will be kept in the central database unit for two years. The central unit will erase the data automatically. In case the individual leaves the national territory, receives a residence permit, or attains a citizenship agreement in another Member State, then the data should also be deleted before the two-year period expires. [23]

A new regulation called “blocking of data” will be applied when a person is recognized as a refugee who crossed the border. The central unit will handle the blocking procedure. As long as a decision about the asylum procedure status of a refugee was not reached, the fingerprint data shall not be transferred to the other Member States. [23]

In 2013 the Eurodac Regulation was updated with a new revised version Regulation *(EU) No 603*. Due to the Dublin Regulation updates, the Eurodac Regulation had to be revised: For instance, the transmission delay had to be decreased for some Member States. Data protection and the data exchange for important terrorism and severe crime information were enhanced between the European Member States. New time limits were set for transmitting fingerprint data from the national system to the central system. This aims to help reduce the time between registering and sending data to the central component of Eurodac. The new regulation also allows Europol and other police departments of a European Member State to compare the fingerprints with the Eurodac database. Police officers also have permission to use the Eurodac system, but only for criminal investigations against terrorism and serious crimes. The process of fingerprint data exchange is strictly controlled and defined to avoid misuse of private data. Furthermore, the new regulation permits police authorities to use the Eurodac system only if they had already checked the VISA Information System (see *Section 2.2.1*). Also, the sharing of personal Eurodac data with non-EU countries is not allowed. [24]

Due to the high pressure caused by the refugee flow in 2015, some Member States were not able to register all fingerprints of all persons. Therefore, many migrants remained invisible within the European borders and were able to make subsequent registrations or to stay irregularly in a specific Member State. That is why in May 2016 the European Commission drafted a new proposal for the extension of the *EU Regulation 604/2013*. The European Commission considered using additional biometrics identification methods for supporting the current Eurodac fingerprint registration, such as digitalized photo collections or facial recognition. Currently, the fingerprint registration is only permitted for persons who are 14 years of age and older. With the new proposal, the Commission suggests decreasing the minimum age to 6 years. The European Commission also proposed to store all three types of fingerprint data and to allow retaining the data of individuals who had not claimed for asylum within five years. The governmental authorities also have the possibility to request fingerprint data of individuals who had crossed a national border irregularly. [24]

2.3 EU Border Systems

This section describes the rest of the most relevant information systems responsible for managing data and authority communication beyond the national borders of European Member States. The high refugee pressure of 2015 led the European Union to rethink the current information system solutions and highlight the importance of information exchange between the European Member States' information systems. As mentioned in *Section 2.2*, eu-LISA already provides three critical information systems for increasing the security between national borders: SIS, VIS, and Eurodac. These three information systems are part of the European border management information systems. Several information systems were implemented due to the high number of government agencies and European partnerships between government and non-government organizations. [25]

The figure below shows a quick overview of the most relevant information systems, which are already in use or proposed by the European Commission. As can be seen in the figure, the European border management systems can be categorized into three domains: *European nationals*, *third-country nationals,* and *law enforcement systems.* The first domain represents all European information systems used to handle personal data of European citizens: *Stolen and Lost Travel Documents (SLDT)*, *Advanced Passenger Information (API),* and *SIS.* SIS will not be outlined because it was already described in Section 2.2.2. Furthermore, the figure shows which specific domains use European border systems. SIS contains data of European citizens and third-country nationals. The same applies to the SLDT system. One management system, the Advanced Passenger Information system, is essential for all three domains. [25]

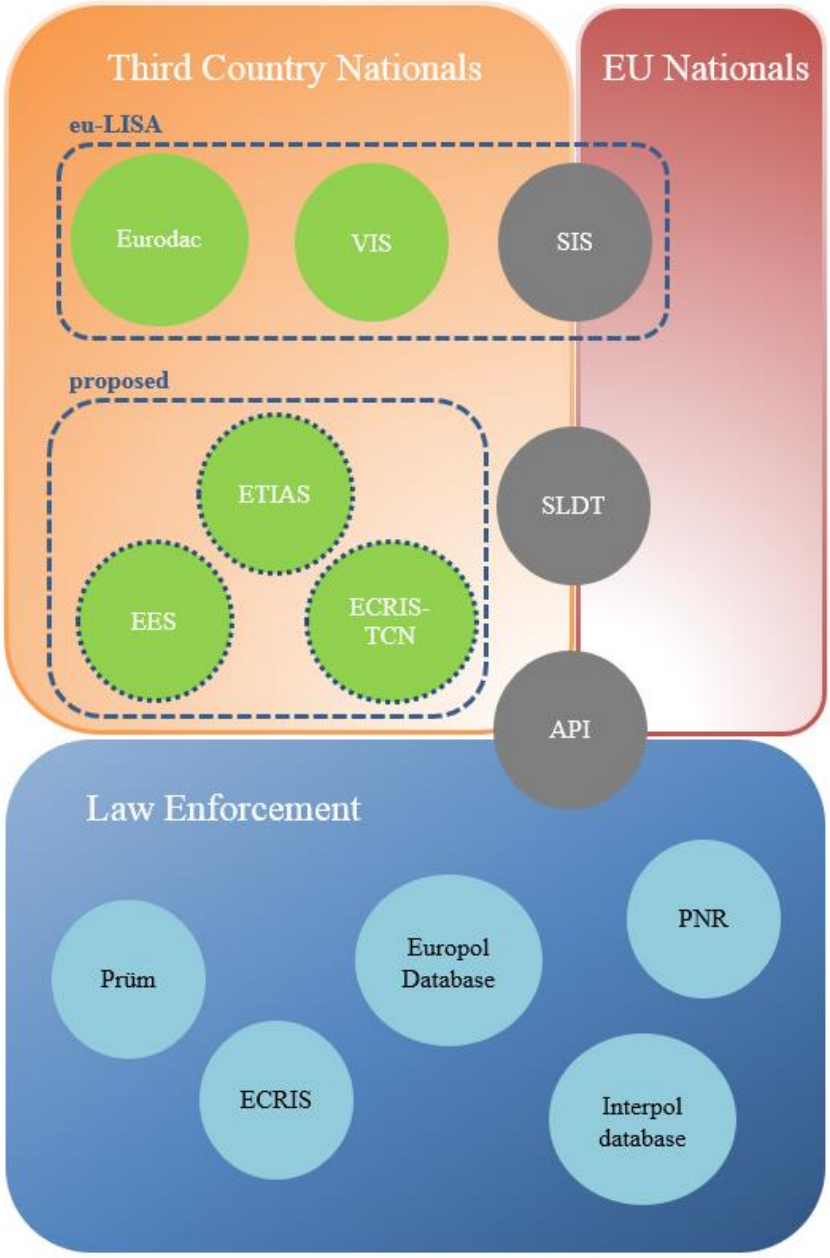


Figure 8: European Management Systems and Domain Relationship

As its name already implies, the *Stolen and Lost Travel Documents (SLDT)* stores all stolen and lost travel documents of all EU citizens and third-country nationals within the European border. The SLDT was enrolled by the international agency Interpol. The European Commission proposed to store not only data from European citizens but also data from other nationalities. The refugee crisis of 2015 enforced the importance of this database. To have an idea about the amount of the data processed within this system: in 2016, the SLDT database contained over 68 million records. The government agencies searched in this database over 1.243 billion times between January and September 2016. Due to the high migration and illegal border crossings, the number of stolen documents rose during the refugee crisis. [26]

The *Advanced Passenger Information (API)* collects data about flights taken by passengers of the EU Member States and third-country nationalities. To fight against illegal migration and enhance border control within the European Member States, the European Commission enabled the possibility to request API data from carriers. This is important when European agencies request passenger information about a specific person. Nevertheless, the European Commission noticed that not every data entry stored in the API database has the quality to enhance border control. The problem is that the data stored in the API system was added after the passenger crossed the check-in. This restricts data extraction time and hampers the execution of the pre-screening mechanism at the border control. Furthermore, carriers or travelers entering the data in the API system lead to a reduced information source. In some cases, the data was added after the departure of the passenger. [27]

The European border management information systems for *third-country nationals* of the figure above consists of all European information systems that are used to handle personal data of third-country citizens. The three already described information systems of the paragraphs before provide the possibility to store and exchange personal data of third-country nationals. That means the SLDT, API, and SIS are also included in this domain. The remaining systems are *Eurodac*, *Entry-Exit System (EES),* and *VIS*. Eurodac and VIS were already described in *Section 2.2*. [27]

The European Commission proposed an additional information system, the *Entry-Exit System (EES),* which should be finally implemented in 2020. This system will mainly address third-country nationals. EES should store the entry and exit date of third-country citizens. It will focus only on the person who will stay within the European Member States for a short time. The EES calculates the authorized duration of stay in the Member State and should replace the obligation of stamping each third-country national passport. The new system should enhance the management of external borders and help to prevent illegal immigration. The main task is to provide information about specific persons who are no longer to be granted to stay in the European Member State. The system will notify the government in case the accepted duration stay was exceeded. The system has the same architecture as the VIS system. It consists of a central unit, a biometric and alphanumeric database, and a *National Uniform Interface*. Additionally, it will be connected with the VIS system via an encrypted communication infrastructure. [28]

Moreover, the European Commission proposed the *European Travel Information and Authorisation System (ETIAS)*, a mostly automated system for verifying and retrieving information about requested VISA exemptions of third-country nationals. [28]

Finally, the proposed *European Criminal Record Information System for third-country nationals (ECRIS-TCN)* will exchange criminal entry information of third-country nationals who were previously convicted by a criminal court in the European Union. [28]

The last section of the European border management systems (as seen in the previous figure) includes all information systems used by law enforcement of the European Member States. Besides the already mentioned SIS, the law enforcement uses the *Europol* and *Interpol databases*, the *Passenger Name Records (PNR),* and the *European Criminal Records Information System (ECRIS)* to combat illegal immigration and terrorism. Furthermore, the *Prüm Decision* faces the main task of supporting law enforcement, the exchange of fingerprints, vehicle data, and DNA information. A fast and efficient transfer of crucial data such as DNA profiles is essential to fight against crime and terrorism in a coordinated manner. Therefore, the European Commission decided to enact the Prüm decision. This was important to enable cross-border cooperation within the European Member States. All states, which are part of the Prüm decision (as so-called "Prüm states"), can gather information about essential data as fast as possible. Norway and Iceland are also included in the Prüm decision. [29]

Europol supports the European Member States with their information systems and databases. The main task is to provide all European police authorities with valuable information. The *Europol Information System (EIS)* stores and provides information to combat serious crime and terrorism. Furthermore, Europol supports the exchange of information between the Member States and third parties (that have an agreement of cooperation with Europol) with the *Secure Information Exchange Application (SIENA)*. The main characteristic of SIENA is the high interoperability between other Europol systems.
Interpol supports law enforcement on an international level for European and Non-European Member States. One of the most critical Interpol information systems is the SLDT system, as mentioned before. [25]

The *Passenger Name Records (PNR)* system stores flight information of a passenger at the time of booking and check-in. Examples of recorded data are the date of reservation, date of intended travel, contact information, payment information, travel agency, baggage information, and much more. Air carriers directly submit the data to responsible law enforcement authorities. The central principle of PNR is the same as from API, the fight against serious crime and terrorism. PNR is used as a part of the border control management, but it reveals some weaknesses: the data is entered into the systems one or two days before the flight departures or immediately after the check-in. Therefore, the system does not provide information on when exactly a person crossed the border. [30]

The *European Criminal Records Information System (ECRIS)* is an information exchanging system of criminal records within the European Union. In the case of ECRIS, the architecture is decentralized. ECRIS consists of a national database located in each Member State, a common communication infrastructure, and interconnection software. The interconnection software has to be implemented by each Member State and fulfill the given requirements defined by the European Commission. That means each Member State is responsible for the storage of their criminal records. The data is not automatically available for all other Member States. The Member State itself is accountable for a reliable exchange of information with other partners. The transfer of data is only performed via a secure network. The so-called *Trans European Services for Telematics between Administration (S-TESTA)* provides standard protocols for implementing the interface to the exchange network. Information requests can be made via alphanumeric search queries or biometric data. [31]

2.4 Enhancing EU Information Systems

The European Commission presented a new proposal for enhancing the interoperability between European information systems on 12th December 2017. *Section 2.3* already listed the European border management systems and showed that there are many different databases providing specific features. Each European Member State has to face a complex network of different information systems. The information systems are used to provide information to border guards, law enforcement, and immigration officers. The data has to be reliable and accurate for providing correct data for government authorities. Some databases are not connected and are separately storing the information. This could prevent efficient data exchange. For instance, persons involved in terrorist activities can be stored in different databases with different aliases. Such types of data can cause information gaps between the information systems. Therefore, higher interoperability between the European Information systems is needed to provide an intelligent information network within the European Union. [28]

The European Commission charged a high-level expert group with the analysis of the European IT infrastructure and the needed enhancements for efficient interoperability between the involved systems. The expert group comprises IT experts, the *European Data Protection Supervisor*, the *EU Agency for Fundamental Rights*, and the *EU Counter-Terrorism Coordinator*. The final report was published in May 2017 with a set of recommendations. It came to the conclusion that the enhancement of the current interoperability between the border management systems would be technically feasible and deliver operational gains. Nevertheless, the proposal of the European Commission focuses on the following objectives [28]:

- Police offices, border control employees, and government authorities should have fast, reliable, and controlled access to information they need.
- Duplicate fingerprint data should be detected with a multiple identity validator, thus combating identity frauds.
- Identity checks should be facilitated and improved for police officers within the European Member State.
- Access by governmental authorities to non-law information systems should be enabled, in order to investigate crime and terrorism.

Furthermore, with the aid of the final report the European Commission evaluated four main concepts: *Shared Biometric Matching Service (shared BMS), European Search Portal (ESP)*, *Common Identity Repository (CIR)* and *Multiple-Identity Detector (MID)*. These four concepts will be described in more detail in the next paragraphs. [28]

The *Shared Biometric Matching Service (Shared BMS)* will centralize the querying of biometric data (fingerprint and facial images data) of the following European information systems: SIS, Eurodac, VIS, EES, and ECRIS-TCN. The additionally proposed ETIAS system (mentioned in *Section 2.3*) will not include biometrical data and thus will not be supported by Shared BMS. The matching service is a search engine, which compares biometrical data simultaneously. [28]

The use of one centralized matching service, instead of five different systems, will reduce costs, time, and complexity for the governmental authority working with border management systems. Instead of retaining biometrical data directly, Shared BMS will only provide mathematical representations of the data (biometric templates) and discard the retrieved data from the underlying systems. Each biometric template entry will give a reference to the information system of origin. Furthermore, each entry has to be validated via an automated quality check, executed by Shared BMS. This is important to exclusively provide data with high quality. With the aid of the mathematical representations, shared BMS will be able to detect connections between different types of identification entries submitted by the information systems. Nevertheless, the other three components (ESP, CIR, and MID) will not be able to function without shared BMS. Shared BMS is composed of a central unit that provides the search engine, the storage of data, and a secure communication channel between CIR, SIS, and shared BMS. [28]

The *European Search Portal (ESP)* is the central component that enables the querying of data sets from different information systems. It will centralize the search of data for the central SIS component, Eurodac, VIS, EES, ETIAS, and ECRIS-TCN. These systems were already described in *Section 2.3*. Additionally, Europol and Interpol databases will be included in ESP. Using the ESP system, the authorities will be able to search for personal data or travel documents. The query itself will be done using biographical and biometric identity data. Each reply of ESP will be unique and display all data referring to the search query. Furthermore, the user will be able to see which data was provided by which information system. Depending on the legal access of the user, the ESP will return the corresponding query results immediately. To be able to define several access rights, ESP will be fully configurable. It has to be mentioned that the entire ESP system will only act as an information delivery portal. Therefore, it will not provide any new data or other services for the user. Because of this, ESP depends on the data protection requirements of the used information systems. ESP will be composed of the following three components [28]:

- The central unit which provides the full functionality of searching through the different European information systems.
- A secure communication channel between the European Member States and the ESP.
- A secure communication infrastructure between the already mentioned information systems, those supported by the ESP, the Common Identity Repository, the Multiple-Identity Detector, and the ESP.

Nevertheless, ESP will enhance the information search for all governmental authorities working with European border management systems. The search response will be fast, secure, and reliable. ESP will also fulfill the legal requirements of the underlining information systems. [28]

Next, the *Common Identity Repository (CIR)* is a central component for persisting biometric and biographical identity data of third-country nationals. This data will be provided by the European information systems: Eurodac, EES, ETIAS, ECRIS-TCN, and VIS. Due to the high complexity of the SIS infrastructure, SIS data will not be included by the central storage component. The data obtained by the information systems will be stored in CIR, but it will still relate to the information system of origin. [28]

The purpose of CIR is to increase the efficiency and speed of data transactions within the European information systems. The so-called "hit-flag functionality" will be available for CIR. This functionality provides the possibility to mark an identity data set as available or non-existent. When CIR is querying data in other information systems and the data is not available, a user will receive a "no-hit" notification. Otherwise, when the data exists, the user will receive a "hit" notification. With the aid of this functionality, CIR will enhance the data access of law enforcement to non-law enforcement information systems. Because Eurodac, EES, ETIAS, and VIS are non-law enforcement information systems, police officers and other law enforcement authorities have only restricted access to these systems. Up until now, law enforcement officers were only able to access the data of these systems for the purpose of fighting against terrorism and serious crime. As mentioned before, the hit-flag functionality would enhance the access of law enforcement with the aid of the *two-step data consultation approach* [28]:

- The law enforcement authorities executed a search query about a specific person or object with given identity documents or travel data. As a result, the CIR returns a hit-flag notification and lists in which information system data has been found. At this moment, the officer has no access to the data.

- In the second step, the authority will explicitly request the data access to the different information systems that provide information about the queried person. The law enforcement authority must have a specific user ID and login to access the full data file of the queried person.

It has to be pointed out that the Eurodac system does not provide any biographical data and will not be supported by CIR. Eurodac will be enhanced with the functionality of storing biographical data at a later time. [28]

Finally, the *Multiple-Identity Detector (MID)* is the last main component of the European Commission's proposal. MID will provide a Multiple-Identity Check for all data stored via the CIR. That means, data persisted by Eurodac, EES, ETIAS, ECTRIS-TCN, VIS, and SIS will be checked for duplicated identity entries. Due to the different information and border management systems, multiple identity data entries were persisted for the same person. MID will provide the possibility to store different names for one identity. Thus, it will only show the biographical identity records, which have been multiply linked via other information systems. Shared BMS will evaluate the correct biometrical data and provide it to MID. After that, MID will display the numerous links of data connection to the other information systems. An authorized user will be able to confirm or reject the duplicated link. Four types of links exist [28]:

- A *yellow link* represents duplicated data that was created through different biographical identities referenced to the same person. These links have not been confirmed.

- The *green link* should be used to represent a link, which was stored by different information systems. Links that have similar identity data, but do not refer to the same biometrical data, must be evaluated. The links will be marked as green when the authority user confirms that these links apply to different persons.

- *Red links* define unlawful usages of different identities for the same person. Two cases exist: An authority user confirms that linked data refers illegally to similar identity data. The second case describes the scenario when an authorized user confirms the unlawful creation of linked data that relates to the same biometrical data and, at the same time, to different identities.

- Different biographical identities belonging to the same bona fide person will be categorized via the *white link*. That means linked data shares the same biometric data and the same identity data. Alternatively, the linked data shares a similar identity data, and one of the providing information systems does not contain biometrical data. In case an authority user confirms linked data as legally sharing the same biometrical data and different identity data, then it is also a white link.

The figure below shows an overview of the entire architecture proposed by the European Commission. Authority users will be able to retain data of all other European information systems such as Eurodac, VIS, EES, SIS, ETIAS, and ECRIS-TCN via the European Search Portal. As seen in the figure, SIS is not part of the Common Identity Repository and will be queried directly via ESP. [28]

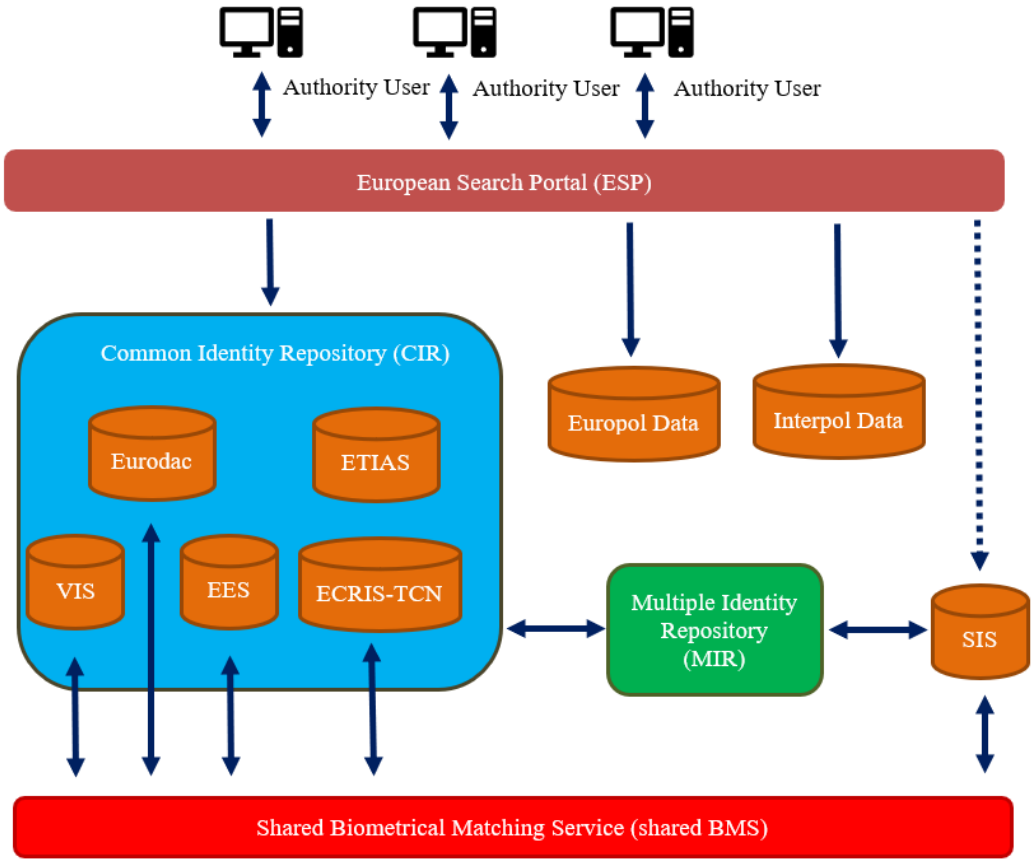


Figure 9: European Search Portal Architecture

2.5 Data Protection Regulations

This section gives a brief overview of the data protection regulations, which are crucial for this work. Data protection and privacy have become crucial since information technology is exposing private information to the public more than ever before [32] [33]. In the author's opinion, the consideration of data protection regulations is essential to provide a feasible refugee information system concept. The concept must adequately handle personal data. It is always important to know who is processing the data and for what purposes the data was processed. Therefore, this section describes the *General Data Protection Regulation*, the *Law Enforcement Directive,* and other data protection regulations related to executive authorities such as *Europol* and *Frontex*.

2.5.1 General Data Protection Regulation

The purpose of the General Data Protection Regulation (GDPR) is to standardize data protection rules within the European Union. GDPR is based on the old EU *Data Protection Directive 95/46/EC* [34] and replaced it in 2016 with the EU *Regulation 2016/679/EU* [35]. Each European Member State had to implement the requirements until 2018. One of the primary key points of this legal framework is that a natural person has the right to being forgotten. After being identified, the personal data should be anonymized or completely deleted by the data provider. Moreover, companies had to design their application following the GDPR. The data access to personal information has to be minimized. [33] [36]
The quote below describes the general purpose of the GDPR [35]:

> *"The protection of natural in relation to the processing of data is a fundamental right. Article 8(1) of the Charter of Fundamental Rights of the European Union (the 'Charter') and Article 16(1) the Treaty on the Functioning of the European Union (TFEU) provide that everyone has the right to the protection of personal data concerning him or her."* [35]

The companies and agencies in the European Member States had to adapt their systems until 25th May 2018 to fulfill the requirements of GDPR. In the case a company or agency was not able to adapt its systems within the deadline, high penalties had to be expected. GDPR was also developed to give individuals better control of their data. Additionally, it should harmonize the different national data privacy regulations to one European standard. Besides the high effort of adapting several systems for the GDPR, the new regulation could also increase the trust of customers for digital single market systems. The next paragraphs describe the critical components of the GDPR.
One of the key components of the GDPR is the *harmonization within and outside the European Union.* As mentioned before, the revised regulation shall provide a single set of privacy rules within the European Union. Organizations outside the European Union, which collect data of European citizens, have only to deal with one supervisory authority. It is important to clarify how "*Personal data"* is defined in the context of GDPR. [35]

"'Personal data' is defined in both the Directive and the GDPR as any information relating to an person who can be identified, directly or indirectly, in particular by reference to an identifier such as a name, an identification number, location data, online identifier or to one or more factors specific to the physical, physiological, genetic, mental, economic, cultural or social identity of that person." [35]

The consequence was all online providers, including a directly or indirectly identifier to an individual, were affected by the GDPR. For instance, IP addresses or cookies had been seen as an identifier for personal data. Also, GDPR does not distinguish the personal data between different domains. That means whether personal data is used during work, in public, or at home, GDPR will be applied. [36] [35]

The next key component included in the GDPR is the responsibility definition for *controllers and processors*. GDPR stipulates that all data controllers have the responsibility to choose only data processors that can provide personal data in compliance with the GDPR principles. The relationship between controllers and processors have to be documented. Every controller has to offer its data protection obligations to the processors. The processors have to meet the regulation on a technical and organizational level. The European Commission proposed some possible actions to meet the security regulations of the GDPR [35]:

- Encryption and pseudonymization of data.
- Restorability of data; be able to restore data after technical problems.
- Providing high stable and reliable applications that are processing personal data.
- Test and evaluation environment for keeping high system quality.

Data protection officers are designated for all authorities and organizations where a controller or processor stores and exchanges personal data, including very sensitive data such as race, political assessments, religion, and much more. Hence, many larger service providers in the marketing sector or research organization had to assign data protection officers. The GDPR limited the obligation of data protection officers for companies with more than 250 employees. These officers should have expert knowledge of data privacy practices and general data protection regulation. Every data protection officer has specific tasks such as informing data processors and controllers about their obligation of complying with the data privacy regulations, being the contact person for data privacy issues, monitoring the GDPR compliance, training employees on data privacy obligations, being in touch with the supervisory authorities of controllers and processors, and much more. Hence, data protection officers must be independent and have direct access to the company's highest management level. The company cannot limit or restrict the work of the data protection officer and has to provide every resource needed. Besides the internal data protection officers, officers from third-party companies can also be hired. [35]

Next, the *risk-based approach* emphasizes the need for more privacy impact assessments. In the early stage of software development, privacy issues should be taken into account [37]. The company shall develop a mechanism for controlling and monitoring the data processing according to the privacy regulations. The need for the controlling mechanism may vary by the level of risk. [35]

As mentioned before, pseudonymization helps to keep the benefits of big data processing while ensuring the privacy of persons. Companies with more than 250 employees are obligated to implement these controlling and monitoring mechanisms. The GDPR obligates the data controller and processor (especially in the marketing sector) to provide the possibility of giving *consent* about processing personal data. The regulation describes the definition of *consent* according to the next quote [35]:

> *"...'consent' of the data subject means any freely given, specific, informed and unambiguous indication of the data subject's wishes by which he or she, by a statement or by a clear affirmative action, signifies agreement to the processing of personal data relating to him or her..."* [35]

Hence, data processors need to describe how and why they will use personal data. The consent has to be clear and understandable for the user. Furthermore, the consent must not be obligatory for the user. When the consent was not accepted, the user should still be capable of utilizing the system without restrictions. Moreover, it should be possible to withdraw the given consent at any time. [35]

GDPR obligates data processors and controllers to provide a specific set of information: the identity and contact details of the controller, contact details of the data protection officer, the purpose of why data is collected, the legitimate interests pursued by the controller, the recipients of the data collected, and if the controller intends to copy the data and forward it to third-party organizations. In case a third party organization indirectly used personal data from a data subject, it has to provide information about the source of data. [35]

The GDPR specifies that *profiling* of personal data is only allowed when the data subject accepted it with its consent and when the profiling procedure was authorized by the European Union or Member State law. Profiling is mostly used by marketing agencies to be able to make automated decisions about a user. For instance, a user may be categorized into specific employment or interest sectors. This can help organizations to propose favorable products to customers. [35] [38]

The next key component of GDPR is *legitimate interest.* Besides the consent, a company can specify the use of personal data for direct marketing as a legitimate interest. This helps data controllers and processors to satisfy the principles of the GDPR. That means sending an email to costumers containing similar products is accepted, but only as long as no profiling was done. The next citation of GDPR describes legitimate interests in more detail [35]:

> *"... processing is necessary for the purposes of the legitimate interests pursued by the controller or by a third party, except where such interests are overridden by the interests or fundamental rights and freedoms of the data subject which require protection of personal data, in particular where the data subject is a child."* [35]

Next, GDPR provides some rules for data controllers regarding situations when personal data was alternated, exchanged, and disclosed without being aware of it: a security *breach*. In this case, the data controller has to inform the responsible supervisory authority about the violation within 72 hours after the security issue detection. If the controller could not notify the authority in time, a substantial ground for that has to be given. Furthermore, when the data breach may result in a threat to the personal freedom or rights of the data subject, he/she has to be informed immediately. However, when the data breach has no impact on freedom or rights, no notice is needed. The European Commission provided some exceptions for the obligation of sending notification after a personal data breach: the data controller can provide a security mechanism that makes stolen data unreadable (e.g., with encryption), or an exception can be made if the effort of sending a notification is very uneconomical for the data controller. Also, a customer shall be able to request access to personal data (*data subject access right*). Companies must provide the data reasonably and understandably. The data must not be older than one month since the data subject request was given. Furthermore, the data controller can charge fees for the data access request. [35]

As mentioned before, data subjects have the right to revoke the given consent. In that case, the data controller has the responsibility to delete all data corresponding to the data subject and inform all companies or data processors of the deletion request. Hence, GDPR gives the data subject the *right to being forgotten*. [39] [35]

The GDPR also applies to the processing of personal data of asylum seekers and refugees. Hence, when these people are identified and registered in a European refugee camp, the responsible authorities have to process their data within the scope of the GDPR.

2.5.2 Law Enforcement Directive

Besides the already described GDPR, the *Law Enforcement Directive (LED)* also applies to refugee camps. The scope of the LED is defined in the *European Union Directive 2016/680* and was defined at the same time as the GDPR. This directive aims to cover all law enforcement regulations about data privacy that are not in the scope of the GDPR. The directive came into force at the same time as the GDPR in May 2018. The next quote from the LED emphasizes that the GDPR cannot be applied for all cases [40]:

> *"...applies to all processing of personal data in Member States in both the public and the private sectors. However, it does not apply to the processing of personal data in the course of an activity which falls outside the scope of Community law, such as activities in the areas of judicial cooperation in criminal matters and police cooperation."* [40]

Hence, when the data controller is a competent authority, the LED has to be taken into account. Every police and authority instance can process personal data without being restricted through the GDPR. Two steps have to be fulfilled [40]:

- The data controller must be a competent authority.
- The processing of data is only permitted for law enforcement purposes.

A competent authority is (as defined in LED) any public authority or other body entrusted by Member State law responsible for the prevention, investigation, detection, and prosecution of criminal offenses. Moreover, the prevention and safeguarding of threats to public security are also included.
In case only the first bullet point is fulfilled, but not the second one, the GDPR has to be considered. Furthermore, national security is not included in the Law Enforcement Directive because the European Union has no competences in this field. [40]

As mentioned before, the GDPR requests that a supervisory authority for data controllers be defined. In this case, the supervisory authority is the *Data Protection Commission (DPC)* defined by the European Commission. Hence, all complaints about the Law Enforcement Directive have to be made to the DPC. [40]

The application of the GDPR and the LED in refugee camps can be very confusing. The LED is applicable in the law enforcement context, whenever a police officer (or other competent authorities) processes personal data for law enforcement purposes. The scope of the LED and the GDPR can be very blurred in the area of migration. For example, in the Member States where an illegal entry is a criminal offense, police officers could process personal data of the person who entered the country illegally within the LED scope. However, once the person applies for asylum, the GDPR must be taken into account.

2.5.3 Refugee Camp Authority Regulations

This section gives a quick overview of other regulations that may affect personal data processing in a European refugee camp. In European refugee camps, agencies such as Frontex, Europol, and EASO work closely with governmental and non-governmental authorities. The collaboration of the different agencies is very important for the efficient support and processing of refugees seeking international protection. To support the refugees properly, non-governmental agencies have permission to use specific services and request information from the European departments. [25]

Each department has a specific role and function: Frontex supports the national authorities in identifying, recording, and fingerprinting incoming refugees. The UNHCR and EASO assist the government authorities in identifying persons with specific needs and processing the relocation procedure. They also inform the arrivals with all information about the international protection and relocation procedure. In case a person is channeled into the relocation program, the EASO team supports the governmental agencies in executing the relocation as fast as possible. Another important task of the two agencies is the effective application of international protection. The European police agency Europol provides professional support for the database information exchange and investigation of essential information. In case an arrival does not request the state of international protection, Frontex helps the national authorities to perform the return procedure if it is applicable in that case. Furthermore, Europol and Eurojust support the national agencies in the investigation of smuggling networks and dangerous criminal activities (also terrorism). [25]
Hence, there are many authorities and information systems involved in the European migration domain. In this regard, the *Europol Regulation* and any regulation related to *Frontex* have to be considered.

Aside from the LED, there are other regulations for specific authorities, processing personal data in European refugee camps. As mentioned before, two of them are Europol and Frontex. The *Europol Regulation (EU) 2016/794* [41] will be applied when the Europol staff processes personal data. In case Frontex employees have to retain data from refugees, the *Regulation (EU) 2018/175* [42] and the *European Border and Coast Guard Regulation* will be taken into account.

The Europol regulation entered into force on 1st May 2017 and affected every European Member State. The regulation increased the power of Europol to establish resources to combat terrorism, cybercrime, and other severe crimes. Furthermore, the regulation establishes Europol as the European Union Agency for Law Enforcement Cooperation, coordinating the communication between law enforcement authorities. Europol's data protection regulations are based on the GDPR and LED. One of the most significant changes was that Europol has its own data protection supervisory authorities. Nevertheless, the national supervisory authorities still influence the control and processing of personal data demanded by Europol. The national data protection authorities will be part of a *Cooperation Board* in charge of Europol. As can be seen in Article 24 below, Europol has the permission (given by the European Commission) to process any personal data related to a specific crime [41]:

> *"... in order for Europol to fulfill its mission, it should be allowed to process all personal data received to identify links between multiple crime areas and investigations, and should not be limited to identifying connections only within one crime area."* Article 24 [41]

At the same time, Article 26 restricts the power of Europol by giving other authorities or the Member States the possibility to revoke the processing of specific data sets if needed [41]:

> *"To respect the ownership of data and the protection of personal data, Member States, Union bodies, third countries and international organizations should be able to determine the purpose or purposes for which Europol may process the data they provide and to restrict access rights."* Article 26 [41]

This article's purpose is essential because personal data processing in the context of law enforcement cooperation may negatively affect the life and freedom of the data subject. In addition to the Europol Regulation, the Regulation (EU) 2018/175 and the European Coast Guard and Border Regulation also increase the extent of data access for Frontex. Like other institutions, Frontex announced a data protection officer (requested by the GDPR), coordinating the internal processing of personal data. The data protection officer and additionally, if needed, the European data protection supervisor supervise all transactions of personal data. Frontex has to guarantee that personal information is only used for internal purposes. [42]

Following Regulation (EU) 2018/175, the data should only be processed by Frontex employees of the corresponding processing operations. Data subjects have the right to contact and consult the Frontex data protection officer or other data controllers. Moreover, redaction of the data may be requested of the European data protection supervisor [42]:

"The data subject shall have the right to obtain from the controller without undue delay the rectification of inaccurate personal data concerning him or her…" Article 18 [42]

The European Coast Guard and Border Regulation enables Frontex to have additional options for processing personal data. The main task of Frontex is the administrative work in the domain of migration and cross-border crimes. The regulation allows for more access to personal data of specific groups of returnees and people who might be suspected of being involved in illegal migration, human trafficking, cross-border crimes, and so on. Furthermore, Frontex can provide personal data to air carriers and utilize ticketing applications to obtain flight or travel data. Nevertheless, personal data shall never be passed on to other international institutions or third countries. Frontex deletes or anonymizes personal data after 30 days. Aside from that, financial and flight data are kept by Frontex for further verifications. [43]

The next figure gives a brief overview of all data privacy regulations mentioned in *Section 2.5*.

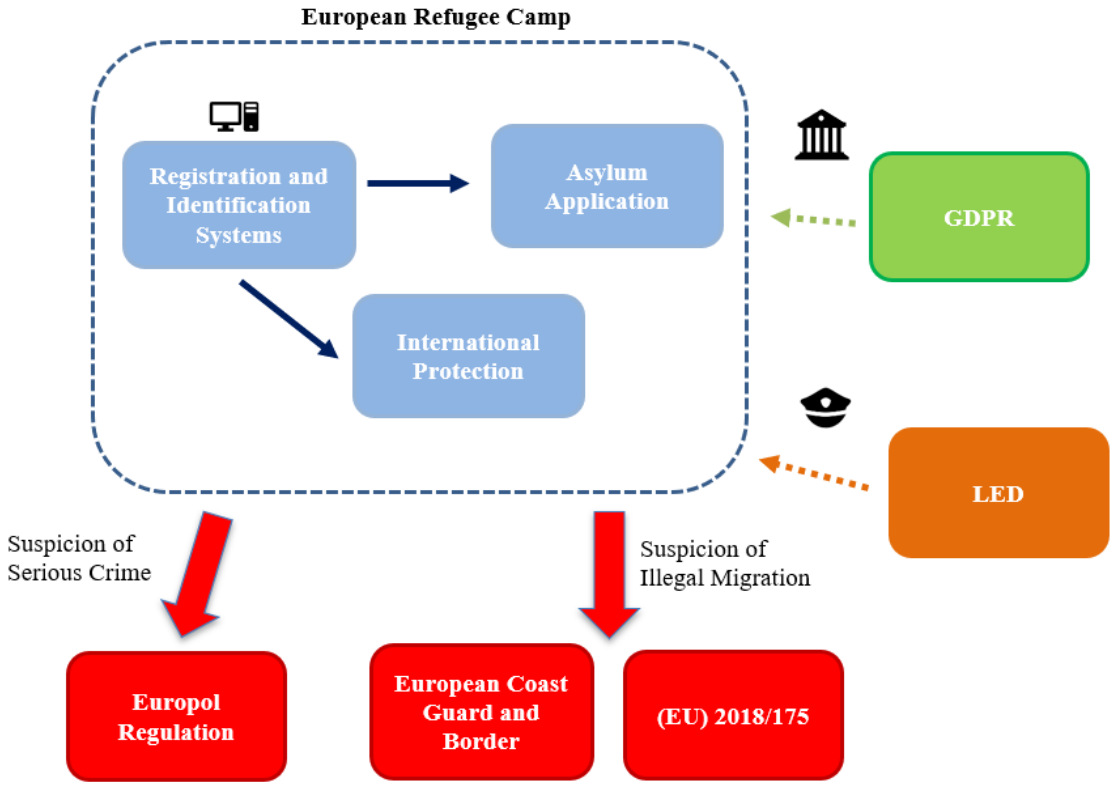


Figure 10: Data Protection Regulations in Refugee Camp

As can be seen in the figure, the application of the data protection regulations can vary and depend on specific conditions. In summary, the information systems used in the refugee camp and the corresponding European information systems have to comply with the GDPR. In case the refugee requests asylum or international protection, authorities have to fulfill the GDPR specification. Under the Law Enforcement Directive (LED), police officers or other competent authorities have the right to process personal data in case of criminal actions. Thus, the LED overrules some articles of the GDPR. Other institutions, such as Europol and Frontex, have their own data protection regulations. In case of terrorism or serious crime, Europol can process personal data of refugees following the Europol Regulation. On the other hand, when Frontex have a well-founded suspicion of illegal migration or human trafficking, the European Coast Guard and Border Regulation will be applied. Nevertheless, the information systems themselves still have to comply with the GDPR. However, access to the data depends on the given situations, as mentioned before.

2.6 Requirements Engineering

This section describes the relevant topics about requirement engineering for this doctoral thesis. It gives a quick overview of the *requirement engineering steps*, *functional* and *non-functional requirements*, the several *requirement techniques* of the last decades, *use case diagrams*, *qualitative* and *quantitative research,* and *prototyping*.

Requirement engineering defines the process of determining, documenting, and maintaining requirements. Requirement engineering is also known as requirements analysis. It is a crucial step in engineering a system or software. Engineers analyze given information about the processes and characteristics that a system or software should have. Depending on which development model is used during the system or software development phase, requirement engineering is done in the beginning or during the entire lifecycle. The requirement engineering process is mostly done with the customer. That means the customer defines the tasks that the system or software must provide. Therefore, it is essential to be able to identify the given stakeholders before the project begins. Stakeholders are directly or indirectly related to the project and are not only limited to an organization. Several types of stakeholders exist [44] [45] [46]:

- Maintenance operators of the given system.
- Political, functional, social, and financial entities that benefit from the system/ software.
- Persons who regulate the system in the domain of safety, finance, and so on.
- Negative stakeholders that are opposed to the system.
- Procurement and purchasing groups involved in the project. For instance, marketing, product management, or sales departments of the involved organization.

Typically, software engineers from a company try to elaborate on the given customer's information and create precise requirements. The last decades demonstrated that understanding the purpose of an objective differs between the customer and the software engineers. Requirement engineering tries to bridge this gap. Next, six activities are described, giving a small overview of the steps involved in requirement engineering. It should be considered that these steps can vary depending on the company or product [47]:

Requirement inception/elicitation is the first step, where customers/stakeholders and software engineers meet up together to specify the goals and objectives of the product. One of the challenges is to find a clear consensus between the stakeholder and the software engineer. [48]

Requirement analysis and negotiation describes the step where all requirements are defined. This depends on the project lifecycle model, e.g., iterative software development. It is essential that in this stage, all conflicts between stakeholders and software engineers are resolved. [47] [49]

The requirements are written and designed with graphical tools. *Use-Case diagrams* are one of the modeling tools used in this doctoral thesis (more information provided in *Section 2.6.2*). [50]

Furthermore, *system modeling* describes the step where software engineers try to design the entire system in the first place. In some cases, the customer or the requirements of the system need such a predesigned plan to confirm the contract and objectives. It can be compared with the design of blueprints for a new building. However, most modeling processes are defined as design engineering and not requirements engineering. [47]

Specification of requirements is the next step in requirements engineering. Each requirement is written in a documented artifact, the requirement specification. It has to be considered that requirements are only valid after the validation process. Which types of requirements exist and how they have to be described, is defined in *Section 2.6.1*. [51]

As mentioned before, *requirement validation* accepts or declines the given requirements that are provided by the requirement specification document. All requirements must fulfill the needs of the customer and the proposed system. [52]

Lastly, *requirements management* is the process of supervising all given requirements during the entire development lifecycle. [53]

2.6.1 Functional and Non-Functional Requirements

This section gives a quick overview of the difference between *functional* and *non-functional requirements*. These two types of requirements are used to define the system application concept in this doctoral thesis. Various approaches to the definition of requirements exist. The most commonly used types are functional and non-functional requirements [54]:

- Functional requirements describe what the system should do and how they should behave in specific situations. In some cases, functional requirements also define what the system should not do.

- Non-functional requirements represent constraints for the entire system: constraints due to standards, development constraints, or timing constraints.

However, the distinction between functional and non-functional requirements is not always obvious in real-world scenarios. For instance, a functional security requirement that limits the access rights of users seems to be non-functional. Nevertheless, during the development phase, requirements can lead to sub-requirements, which can be functional or non-functional. Hence, requirements are not independent from each other and can produce new constraints. In addition to specifying which services must be provided, requirements also determine the correct functionality for accurately delivering the services needed. [55] [56]

As mentioned before, *functional requirements* describe what the system should do. Depending on the type of requirements, they can be very detailed or abstract. Abstract requirements describe the behavior of a service in an understandable format for the system user, sometimes in combination with *mock-ups.* Mock-ups are used as graphical tools for defining the user interface of a given area of functionality. On the other hand, more detailed requirements define the implementation type of services, inputs, outputs, potential exceptions, and much more. [47] [57]

Sommerville et al. emphasized that customer and system developers may understand the application of requirements differently (see citation below). The customer tries to define as much functionality as possible to satisfy their clients. Developers instead try to implement a requirement in an efficient and reusable way. It often happens that the behavior of a requirement changes during the implementation of the required features. In such a case, developers and customers have to reanalyze the purpose and behavior of the requirement together. [47]

> *"It is natural for a system developer to interpret an ambiguous requirement in a way that simplifies its implementation. Often, however, this is not what the customer wants."* [47]

The figure below shows an example of a standard requirements structure. The *requirement number* is always unique and is used to identify a requirement. The *description* explains the requirement's purpose and can be abstract or detailed. The *problem description* explains the issue that has to be resolved when the requirement is implemented correctly. *Fit criterion* describes the measurable property that can be used to check if the requirement was resolved correctly. [47]

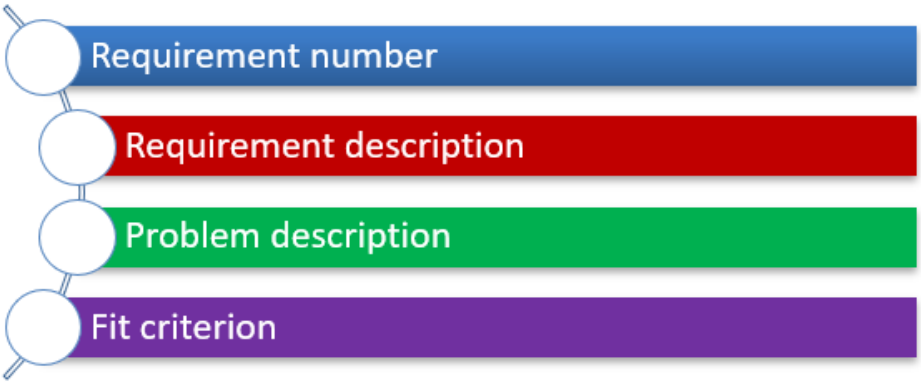


Figure 11: Functional Requirement Structure [47]

Non-functional requirements do not directly represent the services or features that are specified for users. Usually, non-functional requirements describe system properties such as reliability, data storage, and response time. Furthermore, they also describe important points, such as security, performance, and availability.
Compared to a functional requirement, the failure of a non-functional requirement is much more critical and may block the entire system. Additionally, it is often difficult to define which non-functional requirement relates to a specific component of a system. This is because a requirement can affect the entire system or more than one component: e.g., performance. To increase the performance of a system, the communication between several components has to be reduced. Another reason is that one non-functional requirement could lead to several functional requirements (e.g., security). [58] [59]

Sommerville, et al. describe a very complicated hierarchy structure of non-functional requirements (see the figure below). As can be seen in the figure, non-functional requirements may be defined by *product*, *organizational,* or *external requirements.* [47]

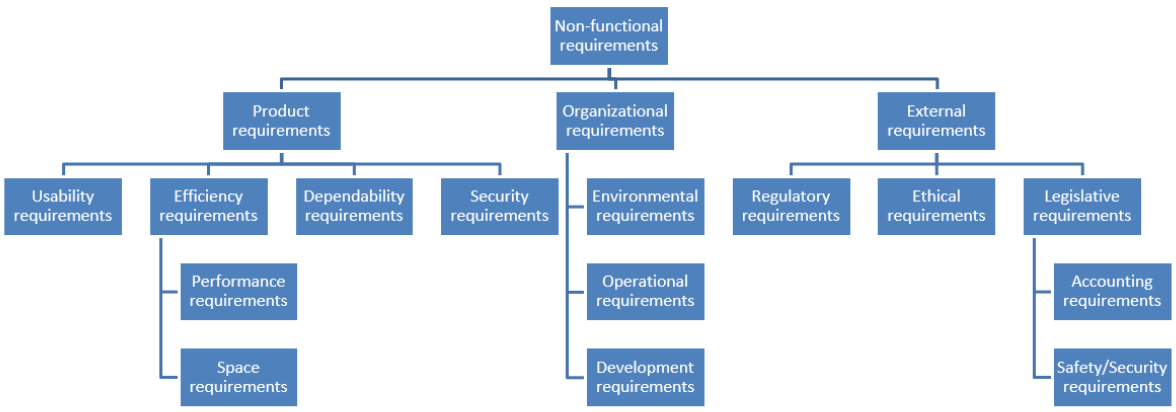


Figure 12: Non-functional requirements hierarchy [47]

Product requirements encompass all requirements that define the constraints for the behavior of a system/software. For instance, product requirements determine how fast a system should be (*performance requirements*) and how much memory space is needed (*space requirements*). The *dependability requirement* defines the acceptable failure rate. *Usability* and *security requirements* are also part of the product requirements.
Organizational requirements define the requirements obtained from the rules/policies of the customer and developer organization. For instance, the *development requirements* specify the programming language, architecture, database system, and so on. The *operational requirements* describe how the stakeholders, including the developers, will use the system/software. Lastly, *environmental requirements* specify the operating system environment.
External requirements are composed of *regulatory, ethical,* and *legislative requirements*. Regulatory requirements categorize all requirements that describe the regulation of something that has to be accepted or approved (e.g., central bank regulations, certifications by third-party organizations, and so on). Legislative requirements help to define the legal boundaries for the current system. Ethical requirements define the system acceptance level of the users. [47]

Nevertheless, to measure the behavior of the system, non-functional requirements should be defined in a quantitative form. The table below shows some examples of metrics and how they can be measured. Such metrics could be used to determine if the system meets the non-functional requirements during a test.
Sometimes it is difficult to translate the customer's goals into measurable requirements. In some cases, such as maintainability, no measurable units exist. Furthermore, the costs of analyzing and defining non-functional requirements can increase significantly. Often, this effort will not be compensated by the customer. The problem is that aside from functional requirements, non-functional requirements may also not describe the needed use-cases of the customer. [58]

Table 1: Measurable non-functional requirements [47]

Property	*Measure*
Speed	Processed transactions/ second User/ event response time Screen refresh time
Size	Mbytes Number of ROM chips
Ease of use	Training time Number of help frames
Reliability	Mean time to failure Probability of unavailability Rate of failure occurrence Availability
Robustness	Time to restart after failure Percentage of events causing failure Probability of data corruption on failure
Portability	Percentage of target-dependent statements Number of target systems

2.6.2 Requirement Engineering Techniques

This section gives a quick overview of requirement engineering techniques utilized in the last two decades. Some of them are used in this doctoral thesis. In their work, Souhaib et al. presented a very detailed overview of the different requirement engineering techniques and their impact. The authors elaborated on a survey with 217 participants working in the software industry. The table below shows an excerpt of the analyzed requirement engineering techniques and their rating as provided by the survey participants. The score was defined as "strongly disagree" (1), "disagree" (2), "neutral" (3), "agree" (4), and "strongly agree" (5) regarding usefulness of each technique. The participants defined the scores based on their experience and software industry perspective. The objective of this paper was to identify the best-fitting requirement engineering technique for a company. An efficient technique could decrease the challenges in requirements engineering and reduce costs. [60]

Table 2: Requirement Engineering Techniques [60]

No.	*Requirement Technique*	*Level*
T1	Interview	4.39
T2	Observation	1.89
T3	Brainstorming	4.02
T4	Structured Natural Language (NL)	4.08
T5	Joint Application Development (JAD)	4.35
T6	Ethnography	2.18
T7	Activity Diagram	4.09
T8	ERD-Based Specification	4.23
T9	Use-Case	4.17
T10	Misuse-Case	4.06
T11	Questionnaires	Not available
T12	Prototyping	Not available

Requirement techniques that achieved a score of four or more are defined as "supported." All other techniques below the proposed score have a weak acceptance by the participants. Therefore, *Observation* and *Ethnography* have the worst classification. The requirement technique *Interview* has the best acceptance and is also used in this doctoral thesis. The same applies to the *Use-Case* technique with a score of 4.17. [60]

Interviews (T1) are often used by requirements engineers to ask questions to stakeholders about the system properties that have to be fulfilled. Afterward, all requirements will be derived from the answers to the given questions. Two types of interviews have to be distinguished [47]:

- Closed interviews with a pre-defined set of questions for the stakeholder.
- Open interviews without any specified agenda.

In practice, both interview types are used by the requirements engineering team, which leads to an effective methodology (see the score table before). This is because several pre-defined questions lead to other issues and features. On the other hand, performing only an open interview may not be as effective as a closed interview. In each interview, it is essential to know how to begin and which questions may be required [47]:

> *"You usually have to ask some questions to get started and to keep the interview focused on the system to be developed."* [47]

It should be considered that interviews are an excellent tool to obtain an overall understanding of the stakeholder's needs and how they will work with the system. However, interviews are often not helpful in gathering detailed knowledge of the application domain itself.
In sum, a good interviewer should be open-minded and listen to the stakeholders. The interviewer also takes requirement proposals into consideration and supports the discussion with a prototype. Nevertheless, the interview method could miss some hidden requirements that have not been discussed with the stakeholder. It is recommended to use the interview method in combination with other requirements engineering techniques. [47]

Observation (T2) is a requirement engineering technique, where the engineer observes the people doing their work and tries to define requirements. This technique is often used to define requirements that the stakeholder cannot explain. Four types of observation exist. *Passive Observations* are performed with the aid of surveillance or video cameras, recording the daily work of the stakeholder. The requirement engineer is not involved. In *Active Observations,* the observer is involved and explains the new product or prototype to the customers. Of note is the observation of how the stakeholders interact with the new system or prototype. During the *Explanatory Observation,* users explain what they are doing. The observer takes notes about the explanations of the customers. Lastly, in *Ethnography (T6),* the observer is completely immersed in the stakeholder's domain/society. [55]

In *brainstorming (T3),* a group of people (usually 5-10) sit together and discuss a specific idea or requirement. Each participant receives a notepad to write down their thoughts or solutions. Generally, the organizer defines when and how long a participant can talk. A solution should be defined by voting at the end of the meeting. The following questions could be answered in the context of requirement engineering [55]:

- What should the system do?
- What are the operational and organizational rules?
- Which questions may be asked in the interviews or questionnaires?
- What are the risks?

Structured natural language (T4) restricts the requirements writer to a specific form of describing style. The writer uses the same defined language or template for all requirements. That means the used language could provide specific notations such as iterations or if-else statements (like a programming language). [61]

Joint application development JAD (T5) is similar to brainstorming, but in this case, stakeholders and users are also involved in the meeting. They also have the right to decide how the system should work and how the design should look. The meeting should not exceed 20-30 participants. The JAD leader is mostly responsible for the meeting's outcome because each discussion should be well-structured and organized. [62]

Ethnography (T6) is an observation technique, where the observer is completely immersed in the stakeholder's society. That means the observer participates in the working environment day by day. This is very time-consuming and expensive, but the observer will gather detailed knowledge about the stakeholder's social and organizational structure. It can help define precise and proper requirements for the new product, which must be developed. The observer can see how the users are working and which components or groups are related to each other. [63]

The *activity diagram (T7)* is based on the unified modeling language (UML)[15]. UML is used to describe the stakeholder's requirements with diagrams and layers. Two types of diagrams exist: structure and behavior diagram. [64]
The activity diagram is used to demonstrate how a specific system process works and shows the control flow from one activity to another. The next figure illustrates a simple example of an activity diagram. The picture shows an example of e-mail communication between two actors, where the filled black circle represents the start state of the entire process. The filled circle within another circle is the end state. The rectangles with rounded corners represent the activity.
Each activity defines the current state. The arrows denote the direction of the flow from one activity to another. The solid bar, in this case, represents a parallel execution. For instance, the activity "Send E-mail" and "Receive Response" are done in parallel. The solid closing bar defines that the left control flow and the right control flow have to be completed. Otherwise, the flow will not proceed to the "Communication Established" action. The squares are decision points. E.g., the decision point after "Send E-mail," distinguishes between two flows. When the e-mail contains private content, execute the activity "Encrypted E-mail." Otherwise, when the e-mail does not contain any private content, go to "Regular E-mail."
Afterward, the second square closes the two flows together to one. As seen in the figure, the activity "Receive Response" is followed by a time symbol. This symbol blocks the flow for a specific time (in this case, 2 hours). The circle with a cross within represents an error case. The process will also end in this case. [62]

[15] http://www.uml.org/

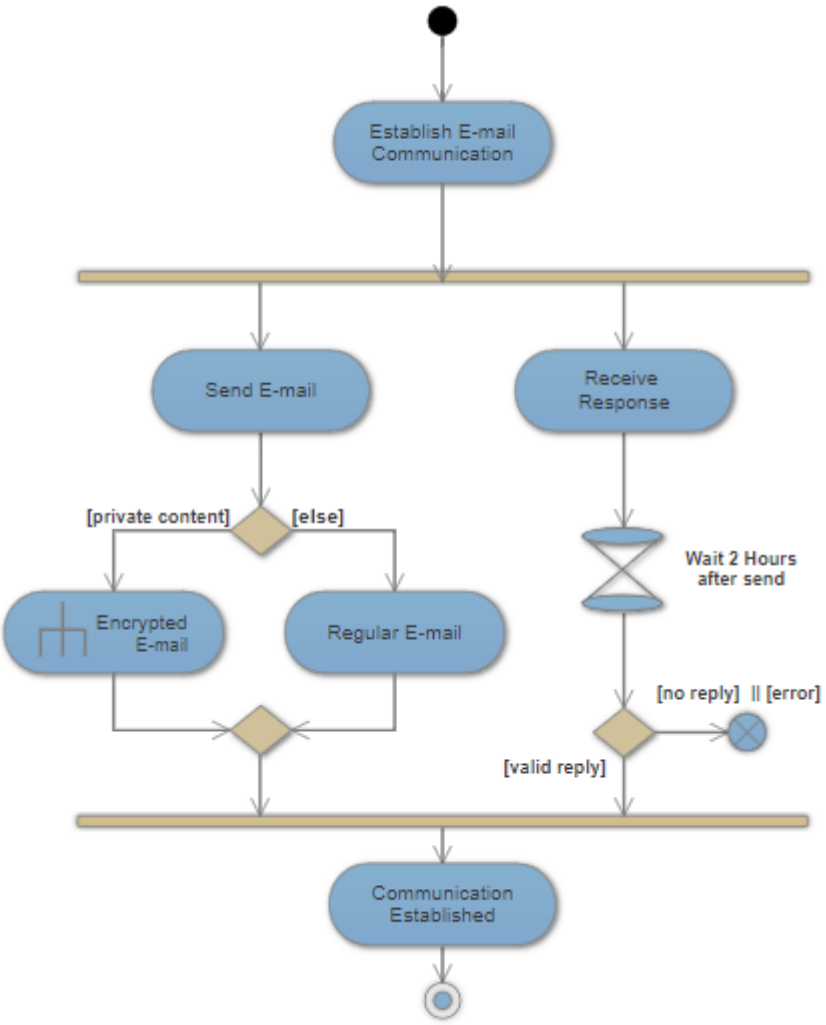


Figure 13: Activity Diagram Example [62]

The *ERD-based specification* (T8) uses the *entity-relationship diagram (ERD)* to define the possible requirements. ERD is used to identify business concepts and to apply them to a database structure. It is used to clarify the relations between specific business entities and their properties. ERD is also useful to describe database structures to customers. The figure below shows a simple example of an ERD. It describes the relationship between a customer and his bank transactions to a branch. Each entity, defined as a rectangle ("Customer," "Deposit," "Branch" and "Loan"), is related to another entity. A solid line models the relation. A relation can contain verbs or nouns and be numerical. The types of relations are described in the left upper corner of the figure: An entity can be related to exactly one other entity or related to zero or more other entities (optional). Lastly, an entity must be connected to more than one other entity. For instance, a branch is related to more than one loan, and a customer can have multiple loans. Attributes, defined with an oval, describe characteristics and properties of an entity. Each customer has a name, address, and social security number. [55] [65]

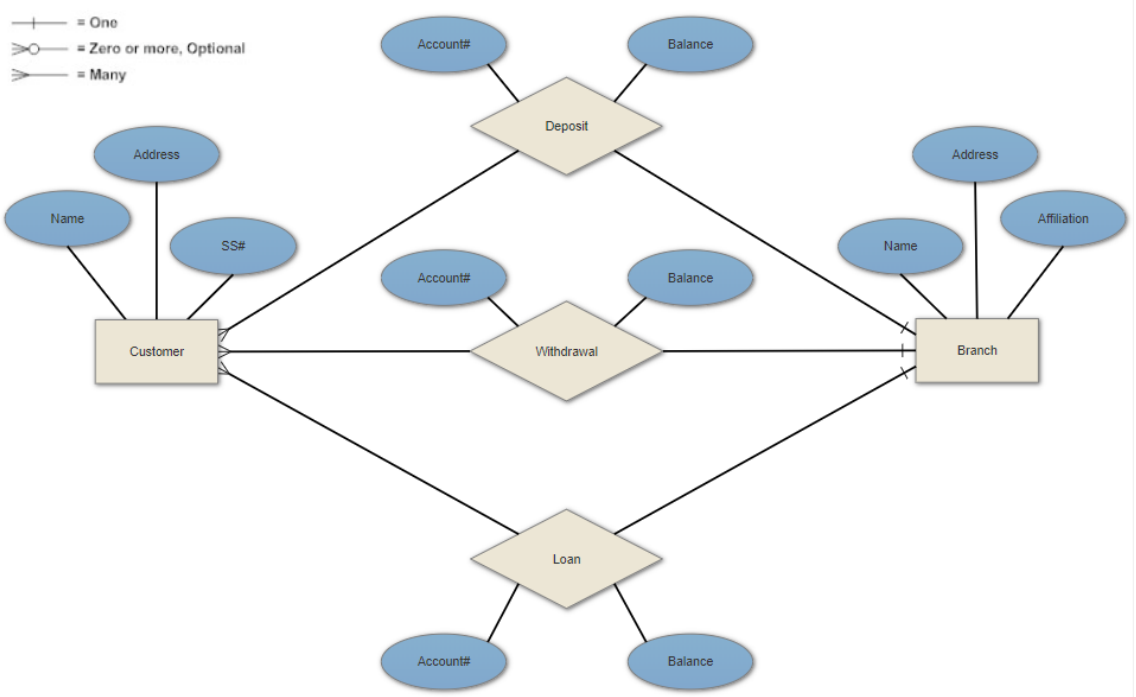


Figure 14: Entity Relationship Diagram [55]

Use-case diagrams (T9) are used in this doctoral thesis to describe the user interactions within the proposed application. Use-Case diagrams are based on the UML language, as with activity diagrams. A use-case is defined as a list of steps with interactions between a system and roles. The goal is to cover all possible interactions within a specific requirement or feature. Roles can be human beings, but also systems (defined as actors). As can be seen in the next figure, actors are modeled as stick figures ("Cell Phone User"). An interaction is defined with the aid of a named oval: e.g. "Add New Contract," "Call," and so on. In this example, the "include" type defines that the use-case "Search Phone Book" includes several other use-cases defined on the right side. A cell phone user can search through the phone book and additionally contact or modify contact entries. [64]
The keyword "extend" works similarly to "include" and defines which use-case depends on or is a subset of another use-case. "Edit Entry," "Contact Person" or "Delete Entry" are such subsets. As can be seen in the figure, option properties such as "option == edit" can be added to the interaction lines. In this example, "Entry Manipulations" distinguishes between the sub-interactions with a specific option provided by the cell phone user. For instance, if the user selects the option "edit," the "Edit Entry" use-case will be triggered. Each use-case diagram should be documented in more detail with a textual description. Such a description may be referenced by the use-case diagram. Besides the definition of business or domain requirements, use-case diagrams are useful tools to describe functional requirements. That is because they focus on the system interaction with the user. Today, the definition of requirements with the use-case technique is widely used. [47]

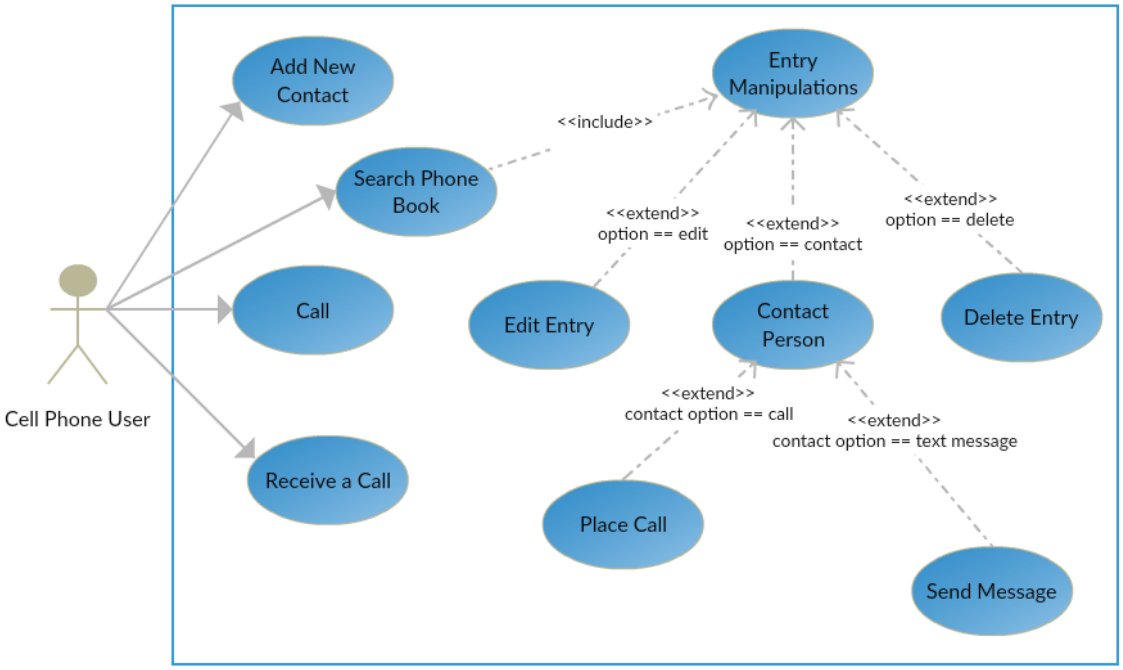


Figure 15: Use-case diagram

The *misuse-case (T10)* technique is the next described requirements definition methodology. It is a special kind of use-case diagram and describes the behavior of what the system and user should not do. It is the opposite of a use-case. The misuse-case is often modeled in the same diagram as the use-case. To be able to differentiate between the two types, a misuse-case often has inverted colors. In the example above, a misuse-case would be colored black within the circle and have a blue or white text. The misuse-cases are triggered by the mis-actor, which also has an inverted format. The mis-actor triggers misuse-cases either with a specific intention or unintentional. In the worst case, a misuse-case can block a use-case and harm the system. For instance, a mis-actors could be a "Hacker User," who willfully deletes or changes contact information in the phone book. The deletion of contact would block the use-case "Search Phone Book" and all other included use-cases. [66]

Next, *questionnaires (T11)* are, in addition to interviews and observation, a part of the *quantitative research* method (described in the next sections). Unfortunately, Besrouret et al. did not add questionnaires to the requirements engineering technique evaluation, and therefore, no efficiency score is available in *Table 2*. Questionnaires can help to obtain overall requirements with low costs and effort. The designer chooses questions or recommendations that have to be answered by the participants. It is recommended that score tables be used to define the importance of a requirement. Depending on the honesty of the participants and the design, the questionnaires' results have to be analyzed properly. A well-designed questionnaire can help to obtain reliable data for eliciting requirements for a system. This strongly depends on how the questions are defined. [60]

The last described technique is *prototyping (T12).* A prototype is the visual representation of the system to design. The stakeholder involvement is needed in the early stages of the design process and is called *user-centered design*. Prototyping is a part of user-centered design and precisely describes the system according to the customer´s suggestions. [47]

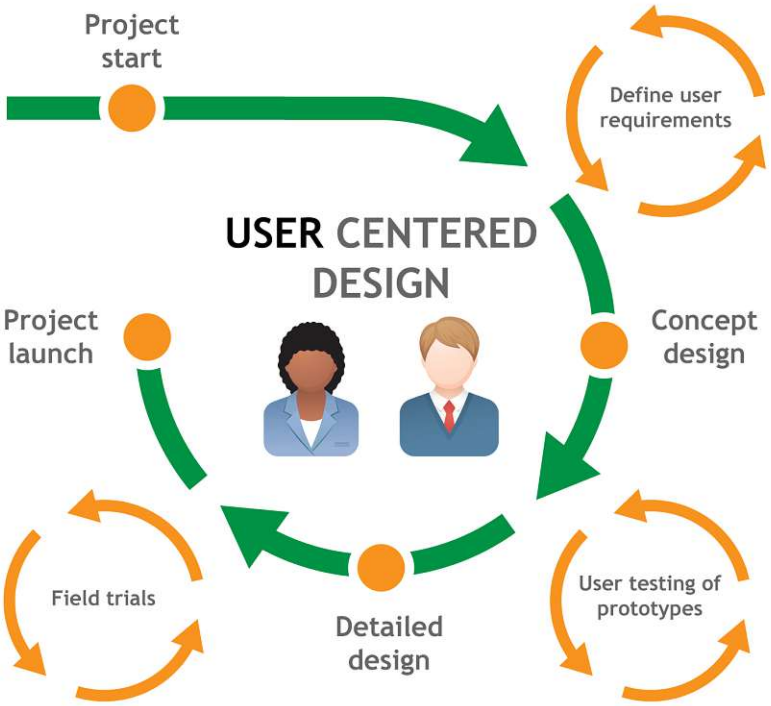


Figure 16: User-Centered Design Process[16]

With the aid of a prototype, users can evaluate possible advantages or disadvantages of the proposed product. In some cases, specific requirements can be proven false or specifications shown to be invalid. Thus, prototyping allows users to see the combination of different components. This again leads to new requirements and combinations. Usually, the engineer does not try to change the behavior or the structure of the prototype until all requirements have been defined. The advantage of prototyping is to reduce the costs during the requirements engineering and development phase by finding needed changes or inconsistencies in the proposed design. The costs of changing the prototype design during the design phase are much lower than when changing it during the development or production phase. This requirement engineering technique will be used for the evaluation of the proposed information system in this doctoral thesis. [67]

Two types of prototypes exist: the *low-fidelity* and *high-fidelity prototype*. The level of fidelity defines the degree of detail of the proposed prototype. The low-fidelity prototype provides only a straightforward design without special formatting, containing only the essential features and elements. The main objective is to present the overall structure and features to the stakeholder in the early design phase. The advantage of such a simple mockup is that it can be changed quickly and with low costs. Different approaches to create a low-fidelity prototype exist: paper prototyping (hand-drawn) and clickable wireframes. The figure below shows a clickable mockup example of a web application with a simple navigation bar on the left. The page shows a form with text fields, tables, and buttons with specific functionality. Notes and comments are useful to provide a better understanding of the customer and the designer. [68]

[16] https://mattborghidesign.com/wp-content/uploads/2020/02/lansing_web_design_ux.png

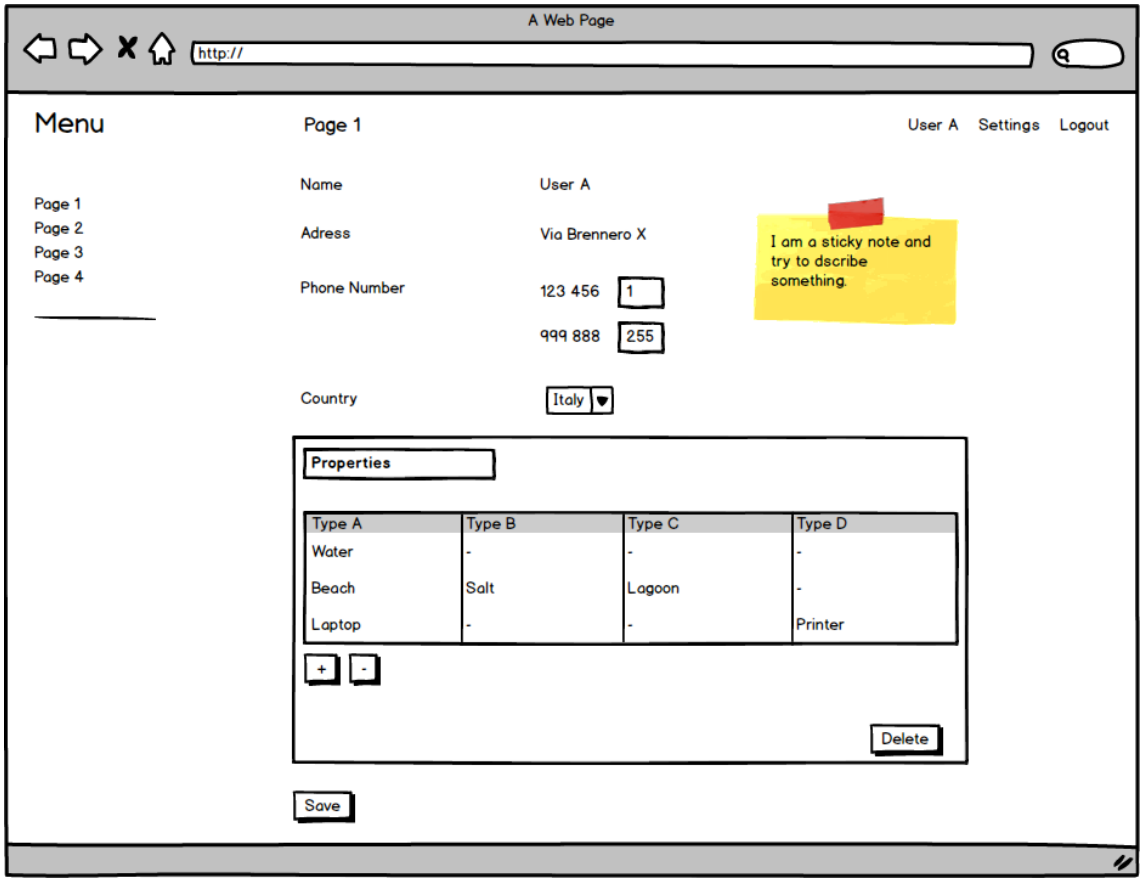


Figure 17: Low-Fidelity Prototype Example

The high-fidelity prototype, on the other hand, is more comprehensive and detailed than the low-fidelity prototype and tries to simulate the wanted product as realistically as possible. Usually, the design team has a good understanding of the defined requirements when developing a high-fidelity prototype. The primary purpose of this type of prototype is to retrieve as much information as possible from the stakeholder. The high-fidelity prototype is mainly tested by the customer, which can navigate and interact. The design and user interface are very similar to the end-product. Therefore, it can be very time consuming and expensive to change the structure or functionality afterward. High-fidelity prototypes are designed with special modeling tools or implemented by the developing team. Implementing the prototype in code can efficiently reduce the time and effort of creating the real product. In the best case, the high-fidelity prototype will be used as preliminary work for the real product. However, the high-fidelity prototype is much more expensive as compared to the low-fidelity prototype. It must be decided accurately which level of fidelity is wanted and needed in the early phases of a project. [69]

2.7 Software Architecture

The proposed refugee management system also includes a software architecture, so this section gives a quick introduction. Software architecture is a fundamental structure in software engineering and provides information about the communication and relationship between elements. Elaborated software architecture can be seen as a blueprint for the following software implementation and the resulting product.

Software architecture has many official definitions; the author chose this one from Bass et al. [70]:

"Structure or structures of the system, which comprise software elements, the externally visible properties of those elements, and the relationships among them." [70]

Thus, software architecture identifies the components and defines the interconnection between them. The interconnection can be realized with functional and non-functional requirements. Software architecture has reached a level of importance that the person who is in charge of the definition and monitoring of the architecture is called a "software architect". According to the definition of Stephen T. Albin, creating a software architecture is called "architecting". His description of "architecting" gives a general understanding of the fundamental nature of creating software architecture. [71]:

"... architecting is the creation of descriptions of a system that are suitable for evaluation and serve as plans for implementation. The description of a system must include the specification of quality attributes and the description of the design in terms of software structures that will implement those properties." [71]

Every software system has an architecture, no matter how small or simple the system is. However, the software architecture is not a system. In former times, the main focus of the architecture was laid on functionality, portability, and performance. Functionality was analyzed by just looking at the source code. The system's portability was realized with the aid of high-level and general programming languages. Finally, the performance was checked by executing the system. Modern development of complex software systems, however, cannot simply be implemented from scratch. Comprehensive software architecture can help to avoid long-term financial risks and unpredictability of the implementation. Modern software systems have to be more modifiable, reliable, and reusable then before. Object-oriented programming techniques have been developed to handle these new properties. [71]

Four main types of software architecture exist, according to Stephen T. Albin [71]:

- *Business Architecture*: Analysis and design of business strategy decisions within an enterprise. The focus is laid on business, governance, organization, and business processes.

- *Application Software Architecture*: Blueprint for a specific system, including the specification of the interactions and relationships to the business processes.

- *Information Architecture*: Describes the management resources and information assets such as physical data.

- *Information Technology IT Architecture*: Defines the overall communication design of the hardware and software components of an organization.

Architectural decisions are usually made at the beginning of the software engineering process. Hence changes and adaptations can be complicated and expensive. Architectural issues that arise during the development lifecycle should be addressed in the early stage. The architecture-based development process model, described by Babar, et al., is an integrated approach that tries to reduce architecture issues. The next figure illustrates a high-level version of the architecture-based development process that is composed of six steps. The first step describes the elicitation of architectural requirements that invoke cross-functional implications. The identification of such requirements is made via quality-sensitive scenarios. The architectural design is defined by an iterative process, where an architect makes incremental decisions to architectural and functional requirements. These requirements are then used for the architectural analysis. Next, architecture is documented in different perspectives and views. The three mentioned steps, *Design Architecture*, *Document Architecture*, and *Analyze Architecture* are iterative. Finally, the real project can be realized with the given architecture, assuming it was suitably designed, documented, and analyzed in detail. After the implementation of the project, the architecture has to be maintained according to the decisions and principles defined in the first place. [72]

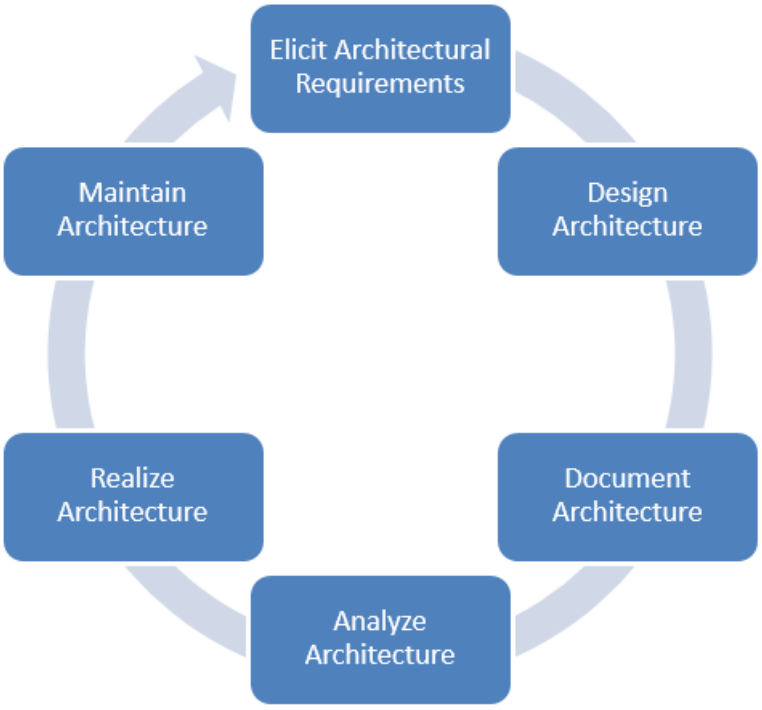


Figure 18: Architecture-Based Development Process Model [73]

2.8 Ethics in Software Engineering

Information systems in a refugee camp have to provide and exchange very sensitive data. The technical and organizational processes in European refugee camps can be very extensive. It has to be noted that all these systems have to serve and support human beings. Hence, this section will give an introduction to ethics in software engineering. Also, the perception of *Identity* and *Otherness* (both popular in postmodernity) will be described. These two topics should help to attain a better understanding of the relation between IT and identity. Moreover, they may help respond to the question of why someone may have ethical concerns about registration applications in refugee camps.

Ethical issues have become more and more critical for modern information systems. The development of emerging technologies needs more awareness of ethical problems. Online services and applications are highly integrated into social processes and depend on the user's behavior. The last years demonstrated a cultural change in the perception of what is appropriate and what should not be accepted by the community. The example of *Facebook*[17] and other social platforms illustrated how fast information systems might grow and change. Due to the close connection between data and society, problems regarding data privacy regulations, information misuses, and inappropriate content exchanges may arise. The advantage of emerging technologies is the support and facilitation of daily life, but at the same time, they may disclose personal data or procedures. For instance, modern robot vacuum cleaners can identify the structure of the entire apartment and store the data in the cloud. With that, third-party organizations may use the data to identify how their customers live and to exchange information with other online marketing organizations. On the other hand, a robot vacuum cleaner may help the customer in their daily life.
Hence, software engineers have to consider ethical issues before implementing a product, especially when developing comprehensive and emerging information systems. Moreover, the implementation of a decentralized database and the use of big data systems has created ethical issues that before had never existed. Nevertheless, ethics can serve as a mediator between information systems and sociological science. Ethics describes which human behavior or action is right or wrong, depending on a specific situation. Ethics investigates the rational decision that causes a specific human action. The application of ethical principles, such as right and duty, obligations, and free will, may have various manifestations. These manifestations depend on the perception of right or wrong. Furthermore, every principle can be assigned to a specific sociological context or problem. Ethics itself is composed of three sub-branches [74]:

- Meta-ethics defines the origin of ethical principles.
- Normative ethics describes moral standards for human actions (right or wrong).
- Applied ethics identifies moral issues in specific situations.

[17] www.facebook.com

The ethical issues caused by the implementation and application of emerging technologies can be categorized in the classical normative ethics domain. For instance, collecting private data of a specific individual and exposing the private pictures on a public domain without the consent of the customer may be seen by the community as a wrong action. It can be assumed that the significant part of the community tends to categorize such action as bad (moral standard). Normative ethics consists of three fundamental approaches:

- The primary purpose of the utilitarians is to maximize the level of happiness by considering the consequences caused by their actions. The utilitarian approach proposes to evaluate all possible alternatives and to choose the one with the best outcome. [75]

- The deontological framework complies with the application of duties and rules. According to that, it defines what is wrong or right. The deontologist acts in the way as the community would do. [76]

- Virtue ethics theory stipulates to act in a humane way for the benefit of the community. The primary purpose is to reach a good character for oneself or a specific group. [77]

Emerging technologies are becoming more and more complex and comprehensive. The direct application of the classic ethical approaches does not fit for every ethical issue. One of the main problems is that the complexity and dynamic nature of social information systems causes unpredictable results. The orientation and behavior of a large community or customer group may change from one day to another. A proper evaluation of ethical issues depends strongly on the given possibilities and variables. Hence, the forecast for collective decisions can be very challenging. Moreover, the modern tendency toward decentralized databases and systems enables a more stable and agile infrastructure, but at the same time, it results in a high distribution of responsibilities. Due to decentralization, a client or customer may feel responsible only for a small part and ignore all other consequences. [78]

Many people (who were involved in the refugee registration domain) brought up several ethical issues about registering and identifying refugees in European refugee camps. Giving refugees an identification bracelet, as it is done in Italian Hotspots, or taking fingerprints for further data investigation, may produce ethical problems for someone. For instance, giving refugees bracelets to be able to identify them during the registration process may make someone feel like an object. What is the reason for such an assumption or feeling? To understand why someone may dislike or actively reject the use of information technologies to identify or register persons in a refugee camp, the author tries to emphasize the role of *identity* and *otherness* (which have the origin in postmodernity).
The philosophers of postmodernity tried to describe the definition of their own identity. At the same time, the postmodern era is strongly influenced by information and communication technology. Postmodernity emerged after modernity in the late 20th century. Kroeze described postmodernity as a paradigm that focuses on assumptions about the axiology, epistemology, ontology, and methodology. Hence, postmodernity is not a philosophical position that can be accepted or rejected. Furthermore, it tries to postulate the implications for individuals, which can arise in society, literature, culture, and art. [74] [79]

Compared with modernity, postmodernity strictly avoids given rules from culture and society and thereby provides more freedom to individuals. The enhancement of liberty is a positive characteristic of postmodernity, but it can also increase insecurity and anxiety. Increased uncertainty could produce more ethical issues and problems than before. However, philosophers such as Zygmunt Bauman tried to emphasize the application of the newly obtained freedom to enforce more responsibility for others. This responsibility is a human characteristic that is unchangeable by others. Furthermore, postmodernity aims to explicitly emphasize and highlight known ethical issues and not to solve them. The society should be aware of the problems and moral circumstances that exist. Each should face these issues and reflect on their consequences. [80]

Zygmunt Bauman discussed many topics in the postmodernity, where the reflections about identity and otherness mostly influenced this dissertation topic. During this dissertation research, many researchers and experts emphasized the possible ethical issues that can arise when working with refugees in a European refugee camp. So, how are identity and otherness defined in postmodernity? Zygmunt Bauman declared that identity always has an object or individual as a counterpart, the *Other*. He described several counterpart examples: the Good has the Bad as the counterpart, health has the illness as a counterpart, the counterpart of humans are the animals, insanity is the Other of reason, and so on. Hence, the Other can be seen as the suppressed, degraded, or exiled opposite of the origin. What are the criteria to be able to define what is the Other and what the origin? The past demonstrated that the allocation of power is one of the main factors for classifying objects or individuals to a specific group. Moreover, identity strongly relates to the variety of human beings. Every individual creates their personality or identity through the affiliation to particular groups. Such groups are defined by the culture, but also by organizations and institutions. Besides that, uniqueness is an essential characteristic for describing their own identity. The way that people feel and act contributes to the creation of a unique personality. Hence, information technologies or identification mediums might suppress uniqueness by anonymizing users with codes or numbers. [74] [80] [81]

2.9 Quantitative and Qualitative Research

In this doctoral thesis, *quantitative* and *qualitative research* methods define the requirements and services for the proposed concept. Therefore, this section provides a basic knowledge of quantitative and qualitative research methods. The empirical research is widely used in software engineering, followed by empirical evaluations. [82]

Quantitative research is used to collect data and generalize the result. The research should provide information about the opinion of the participants on a specific topic. The data sample is usually produced by a large number of individuals, which are selected randomly and anonymous. Depending on the topic, the researcher has to choose a specific set of participants. Sometimes the participants must know the research domain. There are different methodologies for performing quantitative research: interviews on the street, questionnaires (opinion surveys), telephone interviews, and many more. [83]

Like other scientific research methods, quantitative research tries to confirm or disprove a specific hypothesis with the correct interpretation of the result. The result is often analyzed with a statistical calculation of the standard deviation or mean. A widely used method is opinion surveys, composed of clear questions and graphical illustrations. In the literature, quantitative research is sometimes criticized as not being specific enough. That is because the participants can interpret the asked questions differently. For instance, quantitative insights provide statistical significance about the research topic, but in some cases, this is not enough to explain the observed phenomena. Observations, experiments, or other qualitative research methods are additionally used to affirm the results. [84]

The quantitative research method includes the following steps [85]:

- Creation of hypotheses, models, or theories.
- Development of instruments of measurements: such as statistical calculation.
- Manipulation of variables.
- Collection of data, for instance, the application of surveys.
- Lastly, the analysis of the given data. In some cases, resulting data can also be modeled and combined.

Qualitative research is useful to understand the reasons and motivations of individuals. In some cases, qualitative research is used to determine the keys and issues for quantitative research afterward. Due to the detailed analysis of the individual's opinion, the number of participants is much less than for a quantitative survey. The participants are not randomly selected. Instead, they are often chosen carefully. The quality of the result depends strongly on the participant's expertise. Depth interviews or group discussions collect the data. In contrast to a quantitative survey, the results cannot be generalized. Usually, the outcome helps to gain better understanding of the topic or to make further decisions. [82] Qualitative research methods are often criticized as not specific enough, due to the small number of participants. Qualitative research methods do not cover validity, reliability, and objectivity. On the other hand, a supporter of qualitative research methods emphasizes that social phenomena can only be evaluated with qualitative research methods. [83]

Depending on the research topic, qualitative research methods can be used as a counterpart to quantitative research methods or as an extension. The researcher has to decide if qualitative or quantitative research is appropriated for their study. Sometimes, both research methods can together provide a more efficient evaluation of the result and complement each other. [84]

3 State of the Art

This chapter describes relating refugee management solutions in the scientific and commercial domain. To define valuable requirements for a standardized and common European refugee camp solution, the analysis of and confrontation with current refugee management solutions is an essential step. The described solutions are used to derive general requirements for a refugee management system.

3.1 Refugee Management Solutions

This section describes some refugee management solutions that influenced the proposed refugee information system concept. The section describes the process of Italian Hotspots, and two commercial refugee registration and management systems applied in Austria and Germany.

3.1.1 Italian Hotspots

This section describes the operational overview of an Italian Hotspot, the registration and security procedure, how the fingerprint data is processed and sent to the European Border Systems, and an evaluation of the current Hotspot application. In November 2015, the Italian government introduced a coordinating group of several European agencies (such as EASO, Frontex, and so on) and non-governmental departments (such as UNHCR) to implement Hotspots in Italy. [86]

Due to the refugee crisis of 2015, the European Member State and the European Commission had to develop a standardized solution for refugee camps on the borders of the European Union. The idea was to be able to coordinate the refugee stream as early as possible and relocate refugees from Italy and Greece to the other European Member States. Italy, Greece, and Spain are the European Countries that have the first contact with refugees from Africa and Turkey. The relocation of refugees and international protection seekers is required by the EU Regulation Dublin III 604/2013 (as mentioned in *Section 2.1.4*). That means that refugees who arrive in Italy and Greece can be relocated to another European Member State, after being registered and fingerprinted. The Council Decision 1523/2015 (as mentioned in the previous sections) requires that the relocation process be finished within two months after the relocating European Member State has accepted the refugee status.

The European Commission requested that Italy and Greece develop a concept for an efficient refugee registration camp, where all international protection seekers can be registered and relocated from Italy (or Greece) to the other Member States. The concept of a *Hotspot* was developed.
After the pre-identification of the refugees, their fingerprints have to be registered. Furthermore, arrivals are informed about the procedure of international protection, the relocation process, and the *Assisted Voluntary Return (AVR)*. In case a visitor seeks international protection, he/she will enter the asylum procedure and, if necessary, to the relocation process. However, if a refugee was not accepted to join the asylum procedure, he/she will be channeled to the return process. Consequently, three possibilities for a refugee exist [1]:

- International protection accepted and processed to the relocation procedure
- Asylum request not approved and processed to the forced return process
- Special protection when refugee has special needs (children, etc.)

The figure below shows the Hotspot camps in Italy. The information was obtained from the official European Commission Homepage[18]. As can be seen in the picture, the Hotspot in Messina is not yet finished. The largest Hotspot camp is the Hotspot of Lampedusa, with a capacity of 500 persons. Taranto and Trapani follow with a maximum capacity of 400 refugees. The smallest one is Pozzallo with 300. [86]

Figure 19: Italian Hotspots and Capacity 2018

As demonstrated in the next figure, the operational procedure of a Hotspot is proposed by the official *Standard Operational Procedure (SOP)* document. This document was elaborated from the Italian government and the European Commission to define a standardized way of implementing Hotspots in Italy. [1]

Frontex and non-governmental organizations help to find and rescue people in need. This action is called “Search and rescue operations” (SARs). Frontex is also responsible for landing operations. [1]

As can be seen in the figure below, the first step is *Health Screening*. In this step, persons who need medical care (very vulnerable people), will be identified as soon as possible. Medical checks will be performed to avoid the spread of infectious diseases. After the test is done, the refugee can leave the boat. [1]

[18] https://ec.europa.eu/home-affairs/sites/homeaffairs/files/what-we-do/policies/european-agenda-migration/press-material/docs/state_of_play_-_hotspots_en.pdf

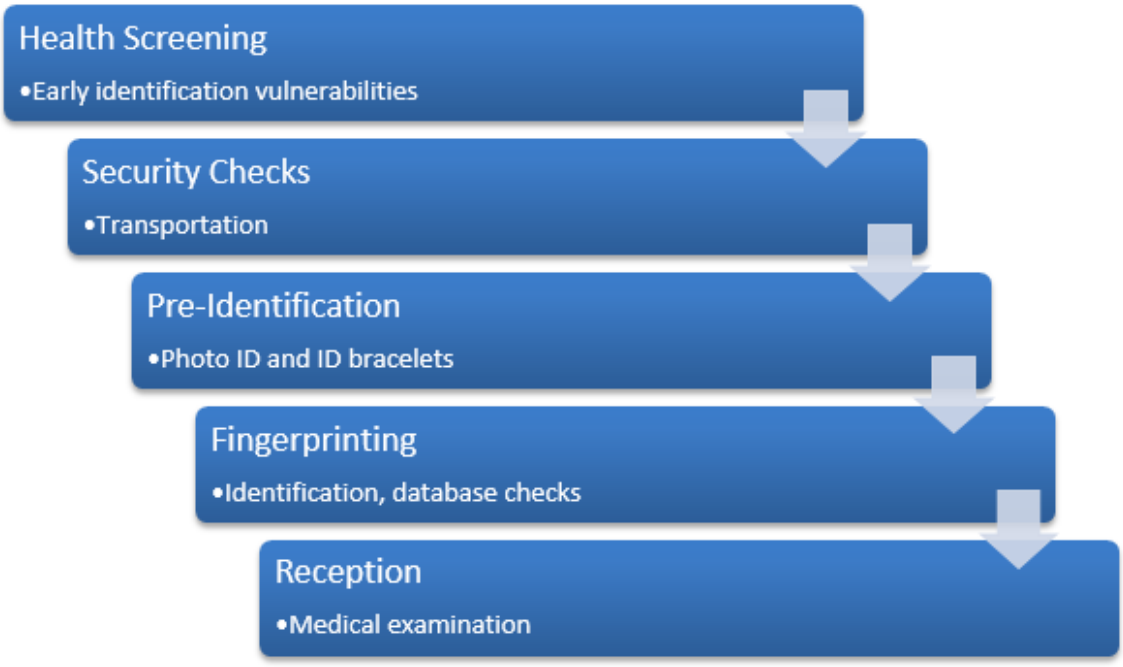


Figure 20: Italian Hotspot Operational Overview

The next step is to transport the refugees from the boats to the Hotspot and the *Security Checks.* The checks are done based on current local conditions. Additionally, each refugee receives a leaflet, including information about the legislation on the asylum process in Europe, immigration, and how the refugees can request international protection. [1]

The *International Coordination Centre (ICC)* and the *Maritime Rescue Coordination Centre in Rome (MRCC)*[19] receive a detailed report in regular intervals about the nationalities, gender, number of minors, vulnerabilities, and medical needs by Frontex. The coordination and preparation of resources will be facilitated with the aid of the given reports. Furthermore, EASO receives additional reports to identify potential relocation candidates and prepare all relevant data needed by the incoming refugee. [87]

The *Pre-Identification* step is a necessary action due to efficiently managing incoming refugees to the Hotspot as soon as possible. In the years between 2015 and 2017, many persons arrived at the Hotspot entrance, so it is essential to have an identification medium to process and adequately coordinate a person. Moreover, this is why Frontex and medical employees perform the first pre-identification for each refugee after landing. Medical personnel gives each refugee a numbered bracelet with a unique number (ascending). On Italian coasts, refugees are separated with the aid of the colored bracelets. This is important to identify and therefore prioritize children, pregnant women, and vulnerable persons. The regional police authorities mostly do the *pre-identification* with the support of Frontex employees. If needed, cultural mediators help the police by explaining the current situation to the refugees. A cultural mediator supports communication and conflict management between authorities and people seeking help. [87]

[19] https://sarcontacts.info/contacts/mrcc-rome-5809/

Furthermore, the pre-identification serves as a separator between people requesting international help and those applicable to the return procedure. Finally, each refugee will be photographed with the given bracelet. The "Foglio Notizie" (Figure 99) is handed out by a police officer or Frontex employee. The "Foglio Notizie" serves as the first information document about the general information of the refugee. As seen in the Appendix, the following data should be filled out by the refugee [87]:

- Name and surname.
- Sex.
- Date and place of birth.
- Nationality.
- Reason for leaving the country of origin (multiple choice questions).

As proposed from the SOP document, it is important to identify unaccompanied children and family members as early as possible, to avoid family separation in the Hotspot. Each refugee has to fill out the "Foglio Notizie." In case the refugee refuses to give the needed information, further interviews with EASO experts and cultural mediators will be done. The same is the case when a police officer has doubts about the declared nationality. The status for international protection or asylum application depends on the correct evaluated nationality. Besides the numbered bracelet, photographs, and the Foglio Notizie, all documents for identification brought by the people are checked to detect any forged documents. Frontex provides professional employees that are specialized in detecting forged documents. These employees support the police officers and Italian authorities during the landing phase. They are equipped with spectrum displays, laptops, and microscopes for analyzing documents. Each given identification or travel document will be checked via the Italian, European, and Interpol databases (further details in the next step). [1]

The step *Fingerprinting* was proposed by the European Commission (Dublin regulation) to identify all refugees after the Hotspot procedure and efficiently relocate all granted asylum applicants to the other European Member States. The fingerprint registration is stored in the national AFIS and the Eurodac system. The fingerprints are registered during the security checks performed by the police authorities. The data stored in AFIS and Eurodac helps the police to investigate crime and terrorism. In case an individual shows an identification document, the document will be checked with the aid of the Italian *investigation database SDI (Systema Di Indagine)*, SIS, SLTD, and VIS. The SDI was introduced in 2001 and now serves as a national investigation database for Italian police authorities. The system stores and coordinates all data provided by Italian police forces. It also enables access to external systems such as SIS. [88]

As described by the Dublin regulation of 2015, the European Commission requested that Italy increase the rate of fingerprint registrations. With the aid of the Hotspot implementation, this amount increased gradually. In case of complications, the European Commission permitted Italy to use force or detention to obtain the fingerprints of refugees. Police authorities are responsible for the registration and fingerprinting process of refugees. Frontex employees and cultural mediators support them. Each Hotspot has several Eurodac machines in order to register the fingerprints. [87]

The Italian authorities can only store the registration entry in the Italian AFIS system. As mentioned before, the AFIS (Automated Fingerprint Information System) stores the fingerprint data and performs identification checks. The data stored in AFIS will also be checked with the Eurodac system to find any criminal entries. [87]

The European Commission defined that all persons older than 14 years must be fingerprinted. As mentioned before, each fingerprint entry will be stored in the AFIS system. For each case of fingerprint registration, the AFIS system generates a *CUI (Codice Unico Identificativo)*. This is a unique identification code representing the actual fingerprint registration. If the AFIS system finds already stored fingerprint data related to the current fingerprint data, it returns a set of previous data entries, including the actual CUI. If present, personal data will also be returned. Therefore, the police authorities can immediately check if a person has already registered the fingerprints before. The data obtained by the AFIS system is also used to perform checks in the SDI database to find any criminal records. Furthermore, the AFIS system can process newly registered fingerprint data to the Eurodac system. The Eurodac system checks the fingerprint data for already stored entries by the other Member States. The comparison of fingerprints will be done with Eurodac category 1 (international protection requests) and category 2 (illegal entry into national territory) data. This helps to find any persons who crossed the European Border in the other Member States multiple times. The police authorities will check all data referenced to the registered and photographed person via different information systems. These systems use the list of previous fingerprint data retrieved by the AFIS system. [1]

The SDI not only checks given document data, but also the fingerprint data. In case nothing was found when the documents were checked, the SDI again searches for information about the data obtained from the individual and provides, if present, reports about any information and measures referring to the person. The police officers also use the SIS II system to check if the current individual relates to any wanted or missing person data provided by the Schengen countries. Moreover, data will also be searched in the *Interpol query system*. This system enables data access with the aid of the *Inter-force Data Bank* portal. The data obtained by the Interpol query system provides information about any dangerous or internationally searched individual. The investigation itself is done by the *International Police Cooperation Service,* which uses the *Lyon Database* to coordinate the data provided by the reports of the member states of *ICPO-INTERPOL (International Criminal Police Organization)* [20]. [1]

The next figure shows all key steps performed during the pre-identification and fingerprinting step. The green-colored fields are essential points for this work. They show how the registration and identification are made in an Italian refugee camp. They will contribute valuable information for the analysis of possible requirements of the proposed concept in this work.

[20] https://www.interpol.int/About-INTERPOL/Name-and-logo

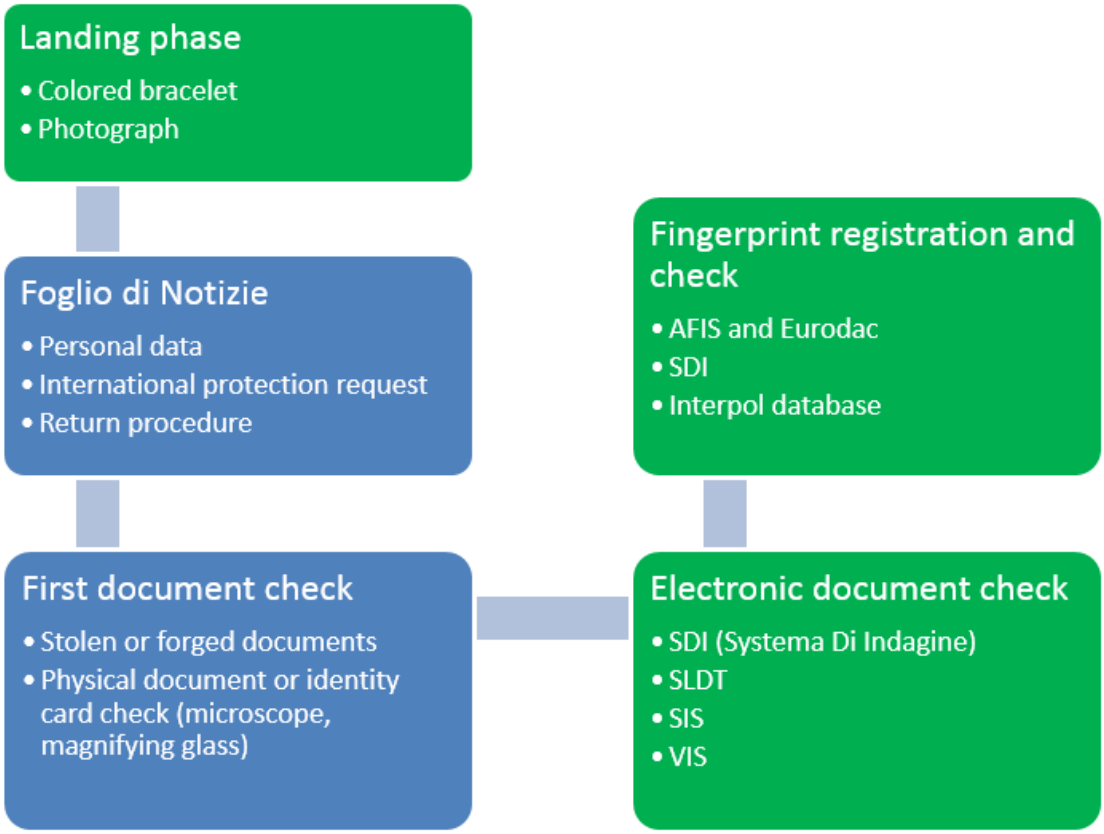


Figure 21: Identification and Registration Key Activities in Italian Hotspot

Considering Figure 20, the last step defines the *Reception* in the Hotspot accommodations and medical checks. Depending on the medical triage during the landing phase, medical personnel performs further medical checks if needed. EASO and UNHCR provide additional information about the process for the request of international protection and relocation. In case a person was not granted international protection, Frontex supports the police authorities in preparing and executing the forced return. However, if the refugee was granted for the asylum application, he/she will be transported to the next refugee accommodation outside the Hotspot or applied to the relocation procedure. [1]

3.1.2 Refugee Management System QMM

In 2015, the company cevisio®[21] built a refugee management system applicable in Germany. This system is called "*Quartiermanagement*" *QMM*[22]. This product was already used in several federal states of Germany. The main services of QMM are the registration of refugees, management of home units, and other services such as food and medical supply delivery. The registration of the refugees is done via an RFID chip. The next figure illustrates a workstation with a card reader, the QMM application, and a card printer. Every refugee receives a unique card with a picture. The card can be offered as an RFID card or a barcode card. The following personal data will be stored: first name and last name, country of origin including the complete address, birthday, family status, sex, religion, language, medical information, unaccompanied minor (yes or no), employment, and other details.

Figure 22: Workstation © cevisio Software and Systeme GmbH & Co. KG, 2001-2017

The refugee data is stored in a central refugee database and exchanged between the refugee registration departments or the refugee camp. The data can be stored locally without an internet connection or directly over the server. Since 2016, the data can be synchronized with an integrated BAMF[23] interface. The refugee data entry can be used for other services such as food and medical supply distribution, assignment of a specific house unit, money delivery, access control, and so forth. According to food distribution, the application distinguishes between breakfast, lunch, and dinner. Depending on the house rules, every refugee can consume a specific amount of food deliveries. Furthermore, the QMM application enables the integration of NGOs, generation of statistics and administration of the entire application (including access rights), and management of documents.

[21] https://www.cevisio.de/
[22] https://www.quartiermanagement.info/
[23] http://www.bamf.de

The actions that can be protocolled within a housing unit are registration and de-registration, house unit movement, incoming, outgoing, food consumption, goods delivery, pocket money, initial medical inspection, costs management, and charitable work. The next figure shows the main user interface of the QMM application. The interface is composed of several tabs. The user interface header provides actions like printing, synchronization with the BAMF interface, sending messages, creating notifications, and updating data changes. The main information is provided in the tabs. These essential tabs are listed below:

- "Allgemein" (Common) includes the most important information, such as the personal data of the refugee, registration information, the stored picture, and the house unit information (on the right "Unterbringung").
- "Registrierung" (Registration) provides the functionality for registering a new refugee in front of a workstation.
- "Familie" (Family) includes all information about the family status of a refugee. The user can define how people relate to each other (mother, brother, father, and so on) via the user interface.
- "Anweisungen" (Instructions) is used to inform the user about specific situations, for instance: "Please consider diabetic issues before serving food!"
- "Aktionen" (Actions) provides functionality for scanning and summarizing of all actions done within the refugee camp (such as incoming, outgoing, food consumption, and so on).
- "Kennzeichen" (Medical Information) gives the possibility to set any critical medical information about the refugee.

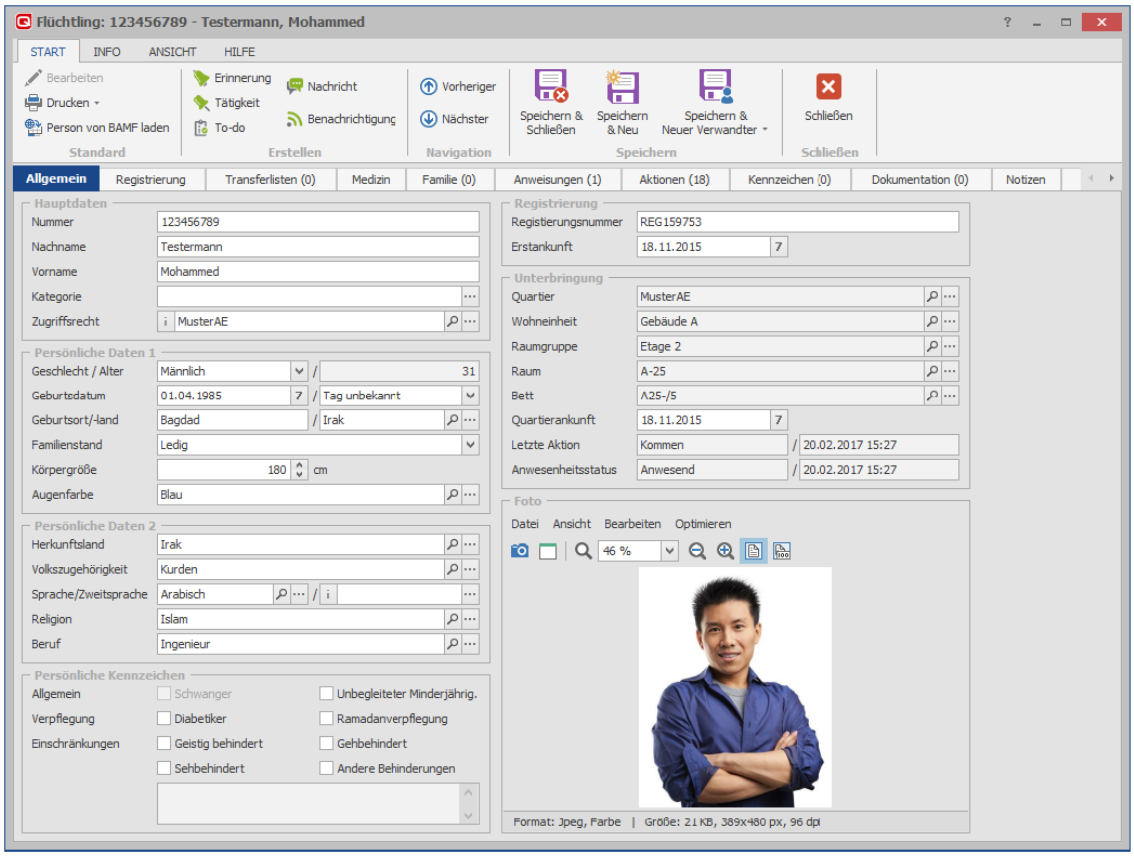


Figure 23: User-Interface © cevisio Software and Systeme GmbH & Co. KG, 2001-2017

3.1.3 Accreditation System

The accreditation system (“*Akkreditierungssystem”)* implemented by the Austrian company RISE (Research Industrial Systems Engineering)[24] has essential features that are useful for the identification and registration of persons. The information about the product was obtained by interviews with the project leader and developers of the accreditation system. The project provides a web-based and flexible event-management system which can create and manage different kinds of accreditations. The main task is creating specific events, registration of participants, identification of persons during the event, security checks, and printing process for QR code cards and badges. The software was developed with the collaboration of the Austrian ministry of the interior.
The primary use-case of this product is as follows: an employee creates a new event with specific restrictions. The event has to be activated for a particular period (for security reasons). Some participants receive an invitation before the event, whereby the rest can register later during the event day. Different categories exist for people who have specific security levels. In some cases a pre-check is obligatory and defined by the authorities. This requirement was essential because the Austrian ministry of the interior held some very significant events. The next figure illustrates the overview page of the accreditation system. In this scenario, the event has the name “EvaEvent1,” and seven persons were registered. The primary tabs are “*Statistiken*” (*Statistics*), “*Daten*” (*Data*), “*Aktionen*,” and “*Einstellungen*” (*Settings*).
As seen in Figure 24: Accreditation System Overview RISE©, the tab Statistics is selected: it contains an overview of all scanned persons within a specific period. The diagram demonstrates how many person-IDs were added (green bar), controlled, or deactivated.

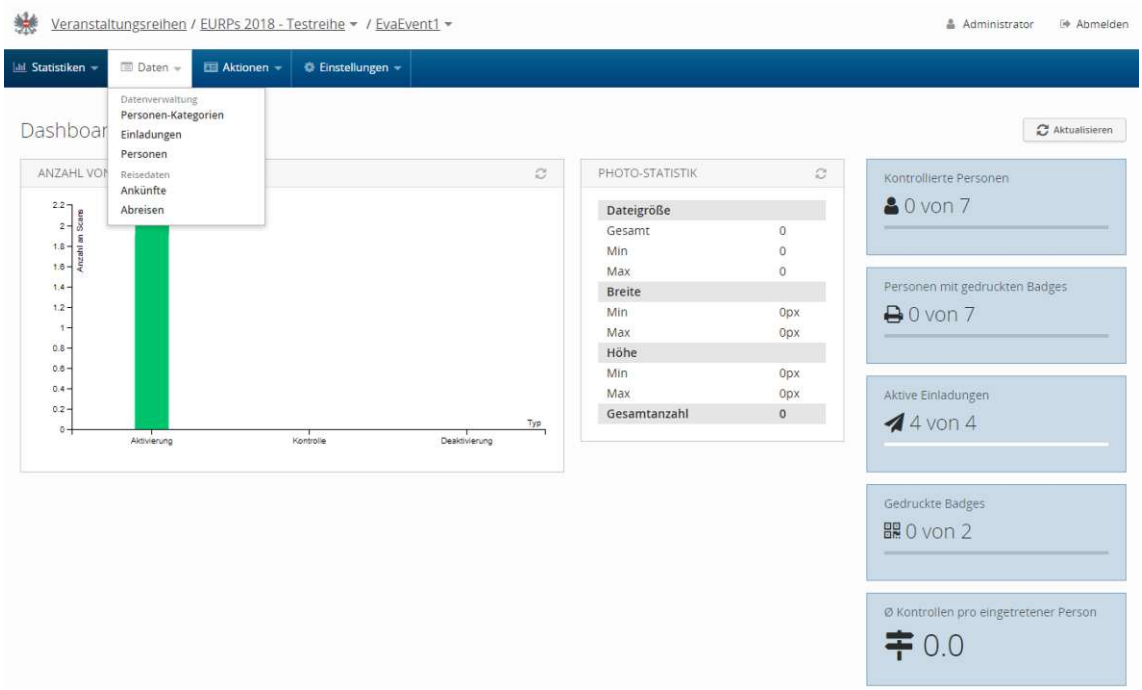


Figure 24: Accreditation System Overview RISE©

[24] https://www.rise-world.com/

Regarding performance issues, the card "*Photo-Statistik*" (*Photo-Statistics*) shows an overview of the data usage and height and length properties of the uploaded pictures. Moreover, the user has an overview of some essential quantities: how many persons were scanned by an employee ("*Kontrollierte Personen*"), how many persons have an ID badge instead of a card ("*Personen mit gedruckten Badgets*") and the arithmetic mean of how many checks were made on an incoming person ("*Kontrollen pro eingetretener Person*").
The next tab Data provides different features, such as a table of the different types of person categories, a table of all persons including a search interface, and a list of entry/exit protocol entries for the entire event.
The tab *Actions* is primarily used during the event. Four actions exist: "*Registrieren*" (*Registration)*, "*Kontrollieren*" (*Control)*, "*Badge Suche*" (*Badge Search*), and "*Deaktivierung*" (*Deactivation)*. The next figure illustrates the registration step. A scanned identity document was uploaded in the card "*Ausweis*" (*Identity Document*). The application automatically fits the picture to the correct size and trims unnecessary white spaces. Moreover, it recognizes the face and copies it to the "*Passbild*" card (*Passport Photo*). This photo will be used for the badge. The card "*Personendaten*" *(Personal data*) is on the left-hand side of the screen. It is also possible to connect a webcam to the workstation and use it for photographing the identity document or the face of the participant. In some cases, the participant does not want to use the same picture as from the identity document. Furthermore, the user must provide all required data (first name, last name, nationality, and email address). When clicking on "*Speichern*" (*Save*), a new badge with a unique QR code will be printed. The ID is ready to use for the corresponding event. The action Control enables the scan of the QR code with a webcam or a mobile phone. Security authorities mainly use this feature during an event. The action Badge Search provides a search service for finding currently active badges registered for the event. The user can deactivate a specific badge for security reasons. This can be done via the action Deactivation with the QR code in written form or with a scan.

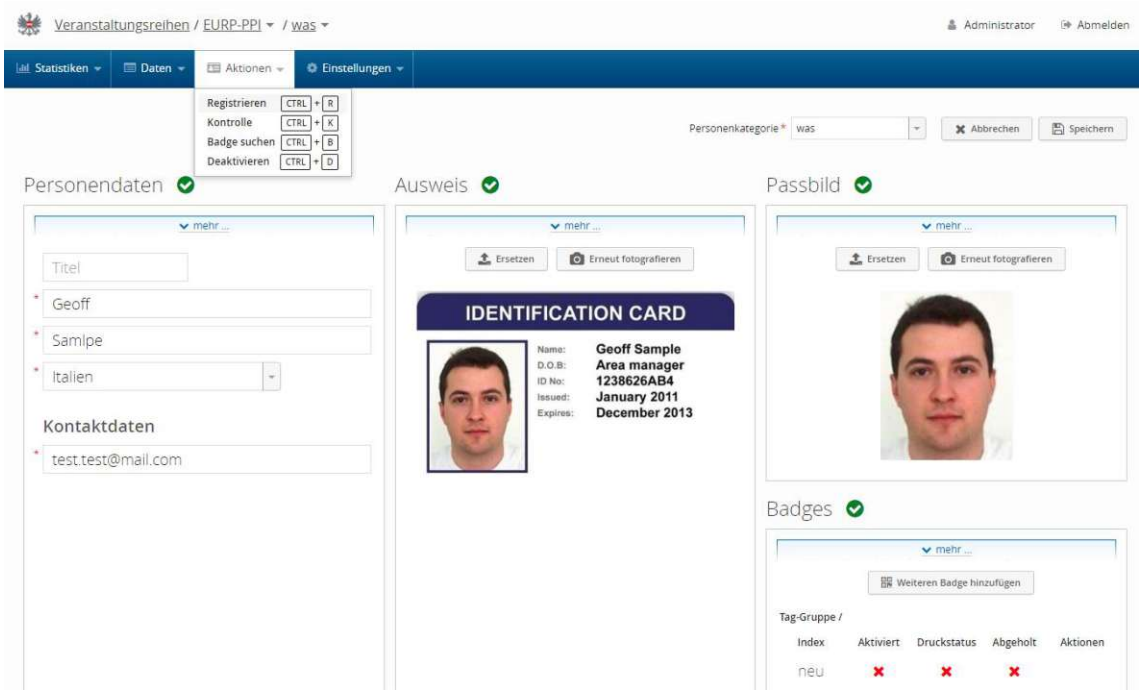


Figure 25: Accreditation System Registration RISE©

3.2 Related Scientific Solutions

The current state of the art about the European identification and registration process of refugees will help understand and analyze the requirements. Some interesting scientific papers about this topic exist. The next described papers in the following sections influenced this work.

3.2.1 RFID Information System

The RFID information system of Miguel A. Wister et al. includes essential services for registering and identifying refugees in a temporary refugee camp [89]. The paper emphasizes the experiences made with RFID technology to manage information during natural disasters. The paper describes a prototype that includes *Radio Frequency Identification (RFID)* bracelets and the management of food and sanitary products consumption. RFID technology uses radio waves to read context data located in RFID tags. This data is used for several purposes, such as identifying objects, humans, animals, and so on. The *Near Field Communication (NFC)* was introduced in 2002 and is based on RFID technology. It is mostly used in mobile phones for daily activities such as registration and identification in museums, conferences, supermarkets, and so forth. [89]

The primary motivation of this project was to avoid chaotic situations in refugee camps, for example during the flood disasters in Mexico 1999 and 2007. The temporary refugee shelters had basic infrastructure for auditing and coordinating different services: security, childcare, communication, food, medical support, recreation, transportation, and much more. The authors identified one of the most crucial problems in the refugee shelters: log entries were done mostly in printed form. That means, the shelter employees logged every entry such as food consumption or entry/exit checks on a piece of paper. The problem was that log files in printed form could be lost very quickly. Moreover, errors were made when typing the information. Hence, the new proposed project proposes the utilization of RFID technology to identify refugees and manage essential services for temporary refugee shelters. The described prototype model of Miguel A. Wister, et al., includes only basic requirements in the first instance. The next table lists the basic requirements proposed by the prototype. The authors chose four basic requirements that could be useful for daily work in a refugee camp. [89]

Table 3: Basic Requirements of RFID Information System [89]

ID	*Description*
R1	Registration of refugees at the shelter
R2	Registration of food services delivered: breakfast, lunch, and dinner.
R3	Control of arrivals and departures of refugees
R4	Control toiletries delivered

The database for the prototype was modeled with UML using the entity-relationship diagram. The diagram is illustrated in the next figure and shows how the basic entities are related to each other. The main entities are *users ("personas"), food consumption ("comida"), toiletries ("kit")*, and *arrival/departure ("salida")*. Database entries are stored and read via the RFID bracelet. Every refugee receives a bracelet after the first registration. The bracelet has to be held over a stationary RFID reader. After reading the RFID tag via the reader, the employee has to choose the services that will be consumed. Afterward, the data will be stored in the database and can be read every time by the employee. A history table provides this data. [89]

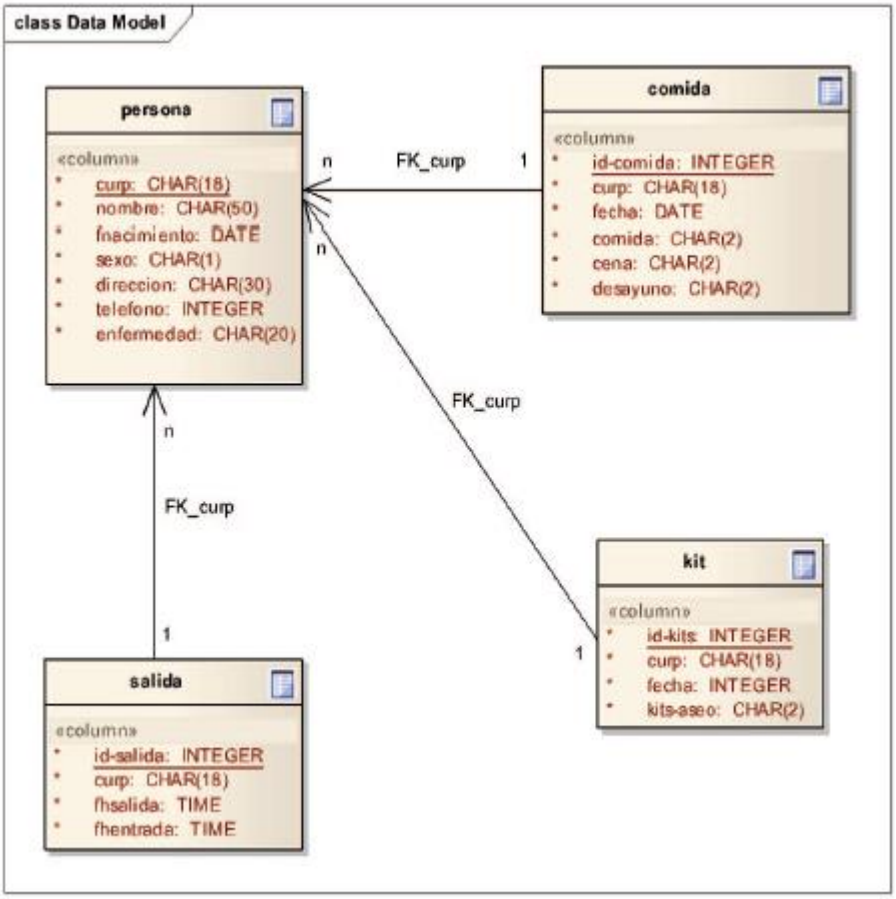


Figure 26: RFID Information System ER Model [89]

The experiment with the given prototype highlighted the need for more services. A more comprehensive system is missing for managing refugees and users more efficiently. The authors plan to next implement the control of medical care and other services. The way the RFID bracelet reads and writes with the RFID reader can sometimes provoke technical issues. If the reader does not recognize the RFID tag correctly, the system is not working. Hence, exception and error handling have to be implemented. Furthermore, the authors will include the application of NFC technology to use their prototype over a mobile phone. [89]

3.2.2 Tracking System dCoST-ER

Kurnianingsih et al. proposed a comprehensive disaster response system called *dCoST-ER (Disaster Command and Support Centre for Emergency Response)* [90]. The system includes several services and focuses on the identification and tracking of refugees during natural disasters. The primary motivation for this work was the natural disasters that happened mainly in the Asia Pacific region. After tsunamis, floods, earthquakes, and other disasters, the possibility of losing family members is very high. Masses of people try to reach the next refugee camp or shelter under devastating conditions. In such cases, families get separated very quickly. The proposed concept should provide essential features for the refugees, including a tracking process to find lost family members. The authors emphasized that information is the key to establishing an efficient refugee information system [90]:

> *"Information is the most valuable commodity during emergencies or disasters. Information is the main element in the damage and need assessment process and is the basis for coordination and decision making in emergency disaster response situations."* [90]

Hence, the concept proposes using community-based crowdsourcing to collect and share geographic data about refugees and critical situations. The authors aimed to integrate a high number of volunteers in their application to enhance social awareness, social involvement, and social readiness during disasters. Besides other services, volunteers can send requests and status reports to the dCoST-ER system. The proposed system must be as responsive as possible due to the chaotic situation and extreme conditions during natural disasters. The system connects stakeholders and resources for organizing, storing, and distributing information in a refugee shelter. The data of the dCoST-ER system is managed with the aid of cloud computing. The use of cloud computing can facilitate the implementation of a new refugee shelter by being accessible to the network. Figure 27 illustrates all model components of the proposed dCoST-ER system. [90]

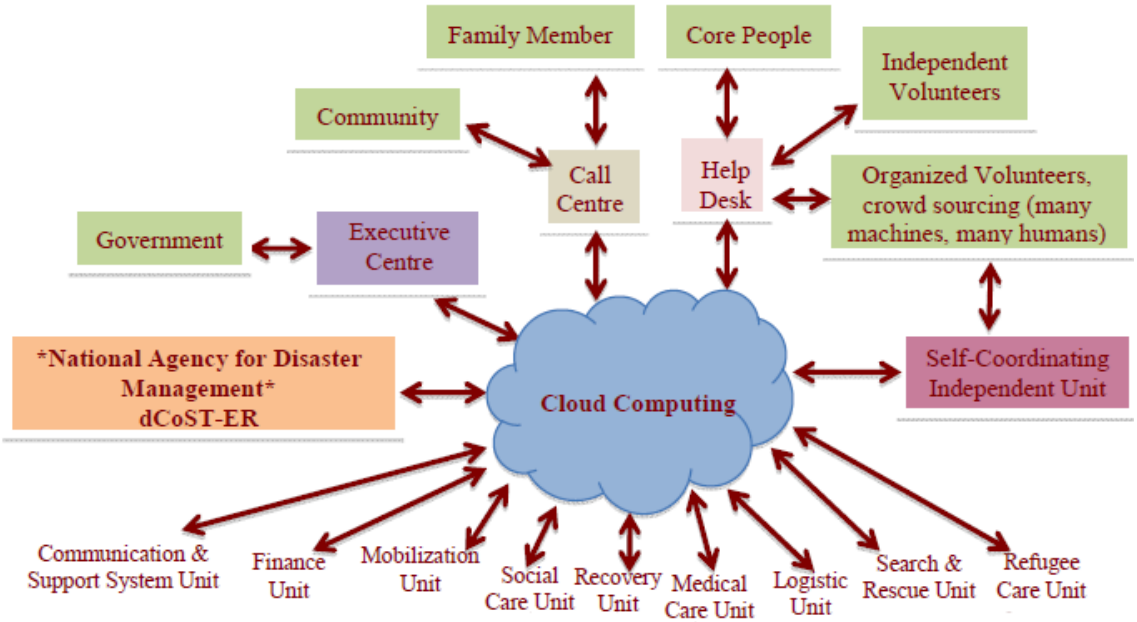


Figure 27: System Model of dCoST-ER [90]

The National Agency is tasked with the coordination and application of the proposed system for Disaster Management or other government agencies. The agencies have to prepare the resources needed for a fast disaster response before the disaster happens, as well as registering and coordinating volunteers, and analyzing the data provided by the dCoST-ER system. The different tasks that were proposed by the authors are listed in Figure 27 [90]:

- The Refugee Care Unit is responsible for refugees that need social treatment.
- Search and Rescue Unit is responsible for finding and rescuing victims during and after a disaster.
- Logistic Unit collects, classifies, and distributes logistic information from the public and government.
- Medical Care Unit is responsible for helping refugees who need medical support.
- Recovery Unit coordinates the reconstruction of the infrastructure after a disaster.
- The Social Care Unit is responsible for the social caring of victims.
- Mobilization Unit coordinates the transportation of refugees.
- Finance Unit collects fundings for disaster management.
- Communication and Support System Unit coordinates the communication within and outside the refugee shelter. It is also responsible for managing all services of the dCoST-ER system.
- Call Centre is the central unit that receives public calls for further information about the disaster or lost family members.
- Help Desk supports volunteers and employees of the refugee shelter.
- Executive Centre is responsible for communication with the government.

The proposed refugee information system is composed of a server-side and client-side component connected over a cloud. The server application will be installed in the cloud. Hence it can be used everywhere with a network connection. Moreover, the server manages the geographical data, road and transportation data, utility data, and other service data, needed in a refugee shelter. One of the primary databases is the demographic database, which includes family and residence data (mostly given in Indonesia). On the other hand, the client-side application will be used by volunteers and employees. The application provides a mobile gadget for working with refugees. For instance, a volunteer can identify a refugee using demographic data with the client-side application and use it as a reference for finding lost family members. Furthermore, the client-side application provides services for relocation, sending aids, and other actions proposed by the dCoST-ER system. [90]

The authors implemented a prototype based on the given requirements. The implementation led to some issues that have to be faced in the future. One problem is that the server is only available over the cloud. After severe disasters, government employees might have no IT infrastructure or network available at the refugee shelter. In such a case, no data can be obtained. Moreover, the authors found some issues when using their mobile technology. The data for the demographic map was not accurate enough. The identification and relocation of family members were also not feasible. Another issue was that refugees are hard to identify in some cases. Some refugees might not have an ID card or lost it during the disaster. In such a case, no identification with the given prototype was possible. [90]

3.2.3 Safety Confirmation System

The Safety Confirmation System of Ishida, et al., is a refugee camp registration and information exchange system that uses the Japanese IC card. The primary motivation of this proposed system was the great East Japan earthquake of 2011. There was no standardized way of registering refugees in a refugee shelter. The authors decided to integrate Japan's national identification card, the IC card, for registering and identifying refugees. The IC card is a widely-used identification card, including the social security number. The next figure illustrates the main components of the Safety Confirmation System. [91]

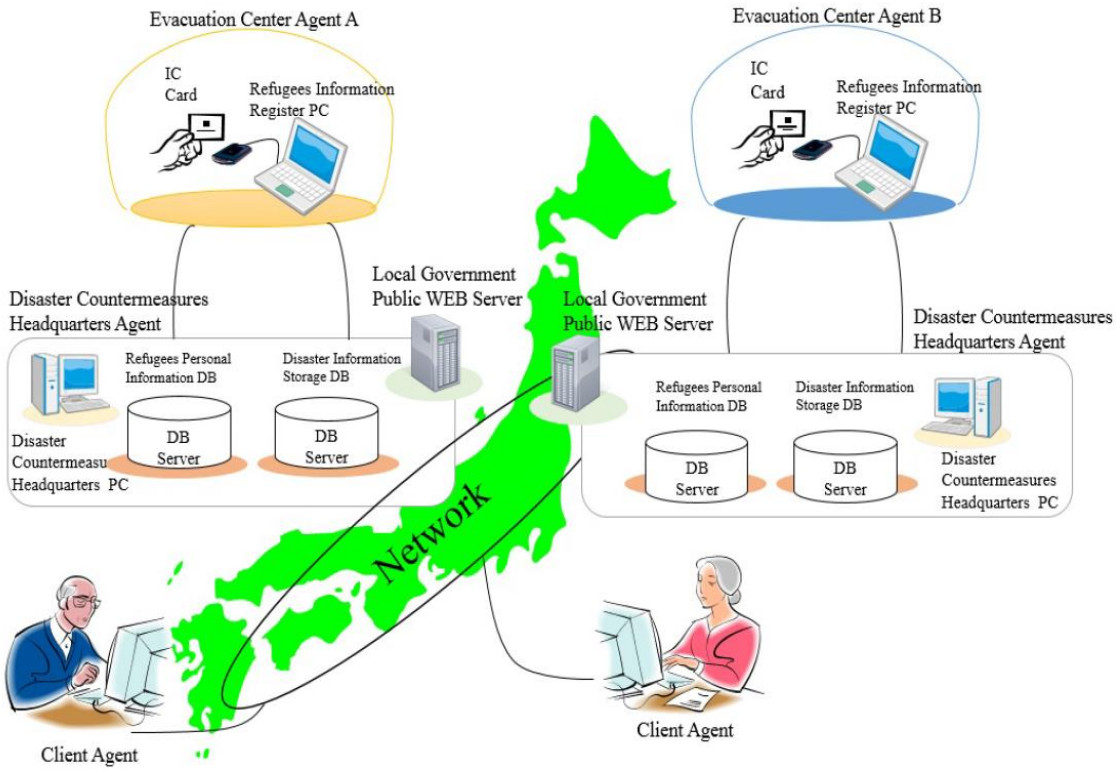


Figure 28: Safety Confirmation System Architecture [91]

The system consists of the *Evacuation Center Agent, Local Government Public WEB Server, Client Agent, Disaster Countermeasures Headquarters Agent*, *Refugees Personal Information Database*, and *Disaster Information Storage Database*.
The process begins with the Evacuation Center Agent. The agent is responsible for the identification and registration of the refugee. In the typical case, the refugee IC card will be read by a card reader. The proposed application can identify personal data and provide two actions ("Admission" and "Exit"). In case an individual has no IC card or lost it, personal data will be written manually with the keyboard. The Local Government Public WEB Server is responsible for storing and exchanging local refugee information from and to every local government center. The server processes database queries requested by the Disaster Countermeasures Headquarters Agent or the Evacuation Center Agent. Moreover, the server converts information into JSON files and stores it into the Disaster Information Storage Database. [91]

Next, the Client Agent has access to refugee data provided by the Local Government Public Web Server. The agent utilizes the information to search for local refugee data, provided as a JSON file.
On the other hand, the Disaster Countermeasures Headquarters Agent is the superuser of the entire application. The agent has access to all refugee data stored in each evacuation center and the Disaster Information Storage Database. Moreover, the agent can change and delete database entries.
In the case of a disaster or emergency, the Refugee Personal Information Database stores only the personal data of the refugees. The local government processes this information with the aid of a unique personal number to the Evacuation Center Agents.
As already mentioned before, the application provides two actions. ("Admission" and "Exit"). The protocolled entries are stored in the Disaster Information Storage Database and can be requested by the Evacuation Center Agent and the Local Government Public WEB Server. [91]

The next figure illustrates two main screenshots of the proposed prototype. The left screenshot shows the main refugee shelter (evacuation center) configuration page. This is the first action that will be made by the Evacuation Center Agent. The agent is also able to add a new evacuation center if it does not already exist. After selecting the correct evacuation center, a new page will be displayed (right screenshot in the figure below). The agent is now able to decide between an entry or exit action. After clicking on one of the two buttons, the data will be stored over the server in the Disaster Information Storage Database. The personal data displayed in the input fields are loaded via the IC card and card reader or written manually by the agent. Moreover, the employee can change the personal data via the button in the lower right corner. The personal data (first name, last name, age, sex, and address) will be stored in the Refugee Personal Information Database. [91]

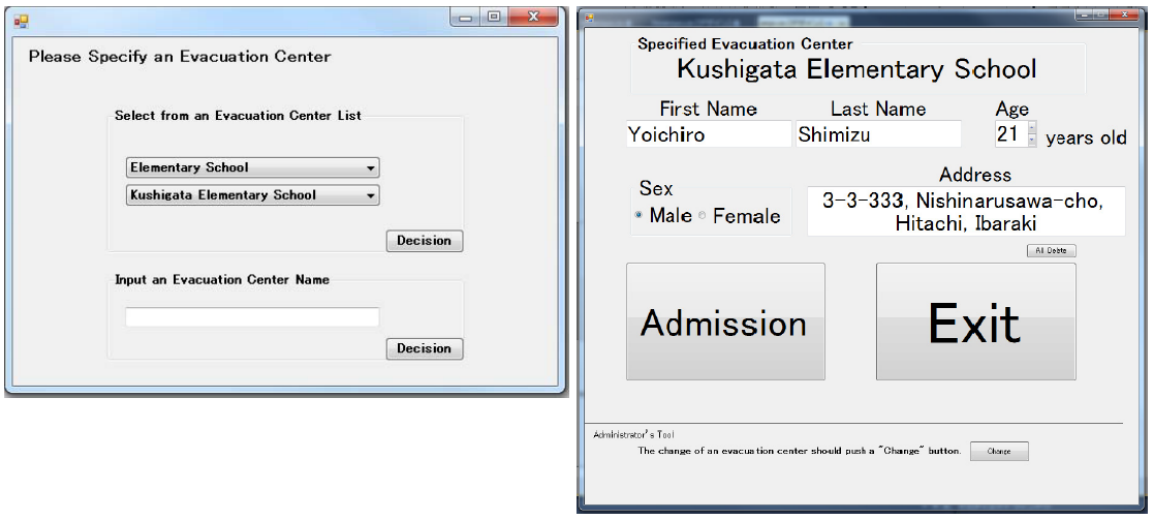


Figure 29: Safety Confirmation System User-Interface [91]

3.3 Results

Sections 3.1 and 3.2 demonstrated some crucial solutions for evaluating the current state of the art in refugee or event management systems. The author defined four main criteria which are essential for a refugee management system in Europe:

- Identification Medium is the most critical tool for a refugee camp. Without an effective identification medium, no structured and organized process is feasible in a refugee camp.

- Support Services, such as the coordination of food distribution, medical supplies, and other services, are essential in a refugee camp. The authorities have to provide goods and food for everyone in a controlled way. For instance, this is important to organize proper food orders depending on changing refugee streams.

- The integration of European Information Systems is significant for the European Union. The political and economic situation demands an efficient determination of asylum application and refugee distribution. This can only be done when the refugee was identified via a European information database.

- Besides food and medical supplies, a secure house unit is indispensable for all refugees. House Unit Management is responsible for house unit assignments.

Table 4 lists all solutions described in the sections before and gives a quick overview of the limitations of each solution. The last three requirements were rated with a green plus symbol (requirement completely covered), a yellow slash (requirement partly covered), and a red cross (requirement not covered).

Table 4: Comparison State of the Art

Source	*Identification Medium*	*Support Services (Food, Medicine, ...)*	*European Information Systems*	*House Unit Management*
Hotspot Italy	Numbered Bracelet	/	+	/
QMM Germany	RFID Card (or Barcode)	/	/	+
Accreditation System Austria	QR Code Card (or Badge)	/	/	x
RFID Information System	RFID Bracelet	/	x	x
dCoST-ER System	National ID (Indonesia)	+	x	x
Safety Confirmation System	IC Card (Japan)	x	x	x

The presented solutions and proposals in Table 4: Comparison State of the Art have one main component in common: they all use an identification medium to ensure a reliable registration and identification process during special conditions. All solutions have a unique identification medium such as a bracelet, badge, or card. Depending on the financial and organizational resources, the identification medium is entirely independent of other systems or integrated with existing authority processes (for instance, the Japanese IC card). The need for an efficient and simple identification medium is given by the chaotic situations that can occur in front of refugee camps or shelters. The European refugee crisis in 2015 demonstrated in several member States what happens when there is no organized or standardized identification process. Masses of people were waiting in front of the camps. They were traumatized from the long journey and the war. The possibility of identifying and relocating families or groups can help the government employees in their work and refugees in finding lost persons. Hence, the selection of the identification medium is crucial for developing a comprehensive refugee management system. The numbered bracelet in Italian Hotspots is too simple because no reliable electronic ID exists. The number must be typed manually by the employees in the refugee camp. The QMM System and the Accreditation System are using badges and cards. Depending on the environment, cards or badges are more durable than bracelets, but they are more expensive.
On the other hand, the probability of losing a card might be higher than having a solid bracelet. The RFID information systems, which proposes the use of an RFID bracelet, is a good example. The proposed bracelet seems to be very durable. Nevertheless, the authors mentioned that their RFID bracelet and the reader are not reliable enough. They propose to use NFC technology. The problem is that such durable bracelets can be costly for the masses of people. Losing such a bracelet should not be a significant financial loss for the local refugee camp. Giving the dCoST-ER System and the Safety Confirmation System, they are using already existing national ID cards. It can be handy to use already integrated identification processes in the refugee camp. The problem is that people might lose their identification cards during natural disasters or wars. This leads to issues during the first identification and registration step in a refugee camp or shelter. The refugee camp organization must develop an alternative identification medium that fits the already existing national ID card. Using an autonomous identification medium has the advantage of always being available for all refugees. There is no need for other documents or data to be registered in the refugee camp system.

The next important point is the application of support services in a refugee camp. Aside from food and medical care, other support services could be NGO or police integration. The Hotspots in Italy are identifying refugees who need medical support with the aid of numbered bracelets. But an electronic protocolling system for food or medicine distribution is missing. The QMM system provides a protocolling database and scanning system for specific actions (serving meals). An integration of NGOs or police officers is missing. The Accreditation system includes security checks done with the mobile phone during the events. That means police officers or security employees can scan the QR code card of the participants if needed. On the other hand, there are no food delivery or medical support services that are essential for a refugee camp.
The RFID Information System includes elementary services such as the protocolling of food and sanitary supplies delivery and consumption. But no medical support or NGO integration exists. The Safety Confirmation System has no service at all.

The next service is significant for the identification of refugees in a European refugee center. The integration of European Information systems or databases is crucial for evaluating where refugees can apply for asylum. The same counts for the identification of criminals or illegal border crossing. The Italian Hotspots include several European information systems that are only applicable to the Italian territory. There is no possibility of applying other national information systems.
The QMM System only implemented an interface for the German BAMF database. There is no international information system integration available.
The Accreditation System has high integration with Austrian authorities over the so-called "License Application." Austrian authorities can check registered participants before the event begins and block their access. Here again, no international information system integration is available.
The other solutions in Table 4 also have no integration with international information systems, only with national communication systems such as the Japanese or the Chinese national ID.

House Unit Management is essential when chaotic situations happen, as in the refugee crisis in 2015. Many persons have to be relocated and moved from one location to the other. The local authorities need an overview of all available house units for new incoming refugees. In their Standard Operation Procedure, the Italian Hotspots include the transportation of refugees from one place to another without electronic support. Besides the QMM systems, all other solutions have no explicit house unit management.

The evaluation of the described solutions and the theoretical background of the sections before form the basis for the requirements identification of a new European refugee camp solution. As already mentioned in the introduction of this doctoral thesis, the author analyzed, with the aid of experts, the situation of European refugee camps during the refugee crisis. No standardized implementation for a European refugee camp information system exists. Indeed, the Italian or Greek Hotspots were an attempt to coordinate refugees on the external borders and to keep them outside of the EU. However, an overall information system solution is still missing. The refugee camp management system should be applied very quickly and efficient in any place. The refugee streams can change very quickly and therefore Hotspots are not adequate in every situation. It should also be possible for local authorities to establish a refugee camp according to a standardized process and management system. The target is to define which requirements are needed for a European refugee camp management system.

- Which services and databases are needed?
- Who are the stakeholders?
- Which information systems have to be integrated?
- What could the application look like?
- What are the ethical and technical issues that can arise?

These questions will be answered in the next sections with qualitative and quantitative surveys, interviews, a low-fidelity prototype, and a high-fidelity prototype.

4 Results

This chapter describes the results that were obtained with the knowledge of the chapters before. That means the theoretical part, state of the art, and several interviews and surveys provide the basics for the proposed European refugee management system application. The chapter is composed of five stages. These stages are aligned with the requirement engineering technique of user-centered design (already described in *Section 2.6.2*). The author decided to employ user-centered design because the requirements depend strongly on the proposals and decisions of the users. In this case, the users are experts in the field of refugee administration or national authorities. The figure below shows the different steps: *Stage I* contains the proposed functional and non-functional requirement areas in the first place. These requirement areas were evaluated with a qualitative survey, composed of several interviews with national authorities and experts. The second stage describes the quantitative survey with European agencies, experts, employees in the refugee management sector, and much more about the acceptance of the given requirement areas. Moreover, *Stage II* gives an insight into the evaluation of ethical issues, which can arise through the proposed requirement areas. The evaluation was done with a quantitative survey in which refugees participated. *Stage III* describes and illustrates the use-cases and mock-ups based on the results and corrections of Stage II. The author decided to add an additional evaluation for the mock-up results described in *Stage IV*. The evaluation was done with a qualitative survey conducted by a set of national experts. The last *Stage V* includes the high-fidelity prototype with the first design draft related to the results of the previous stage.

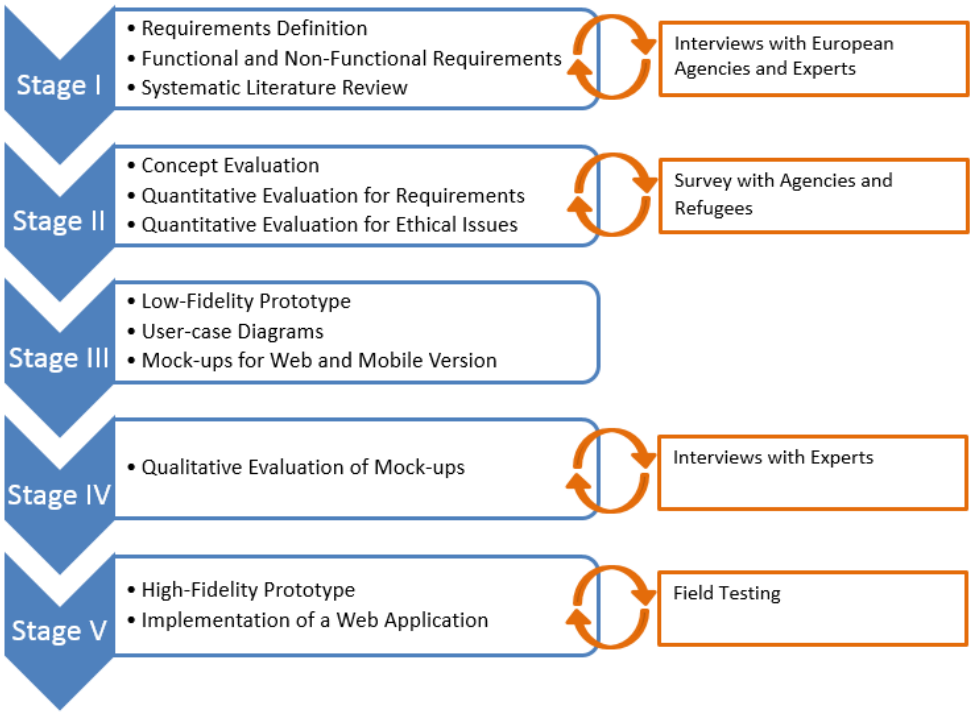


Figure 30: Results Process Overview

4.1 Stage I: Concept

This section describes 24 requirement areas and the system architecture for a new European refugee camp system. These requirement areas were evaluated with knowledge from the theoretical part (*Chapter 0*), state of the art chapter (*Chapter 3*), and qualitative research (conducted with interviews). The requirements areas are separated into two requirement types: functional and non-functional. This work focuses primarily on functional requirements. Aside from one item (ethics), the non-functional requirements were initially described, but not more deeply evaluated. This will be considered for future work.
The proposed European information system includes pre-identification (with the support of a QR code bracelet) and several services for processing refugees in a European refugee camp. The technical support for food distribution, housing assignment, and other services are also included. The interview partners were professionals in the field of migration in Europe and software engineering. These interview partners helped to attain a quick overview of the registration process of refugees in a specific country. Furthermore, European institutions provided a more detailed understanding of refugee data identification and processing within the entire European Union. The interview partners were: the press office of the *ministry of the interior Italy, Austria* and *Germany,* the head office of the *Federal Immigration and Asylum Service Austria*, the department for infrastructure and information technology of the *Federal Immigration and Asylum Service Germany,* the *European Asylum Support Office (EASO)* located in Malta, the research and development officer of the *European Agency for the operational management of large-scale IT systems in the area of freedom, security and justice (eu-LISA)* and the technical project leader and members of an Austrian research and software engineering company specialized in technical refugee support. All interview partners are listed in the next tabled, including the identification code. This code is used for assigning the requirement areas (listed in the following table) to a specific interview partner. [92]

Table 5: Interview Partner Requirement Areas [92]

ID	*Description*	*Position*
P1	Ministry of the interior Italy	Press Office
P2	European Commission	Directorate- General Migration and Home Affairs (Italy)
P3	Ministry of the interior Austria	Press Office
P4	Federal Immigration and Asylum Service Austria	Head Office
P5	Ministry of the interior Germany	Citizen's Service
P6	Federal Immigration and Asylum Service Germany	Department of Infrastructure and IT
P7	EASO	Office Malta
P8	Eu-LISA	Research and Development Officer
P9	Austrian Research and Software Company	Project leader "Refugee Registration"

4.1.1 Functional Requirement Areas

This section describes all functional requirement areas which were evaluated through qualitative research. The table below lists the functional requirement areas including an identification key, a short description, and the source information. Some requirement areas are linked to other requirement areas because they are not entirely independent of each other. The sequence of the proposed requirement areas corresponds to the identification and registration process in a European camp. Also, Figure 31 illustrates the first sketch, including all functional requirement areas. This helps to understand the approximate process sequence. [92]

Table 6: Functional Requirement Areas of Proposed Concept [92]

ID	*Description*	*Source*
R1	Pre-Registration with QR code bracelet	Interview **P9** / Section 3.1 and 3.2
R2	International Refugee Camp Database	Interview **P4**, **P9**
R3	Fingerprint identification and registration (AFIS and Eurodac)	Interview **P2**, **P8** / Section 3.1
R4	Case-worker Information and Document Database	Interview **P4**, **P7** / Section 3.1
R5	Integration of national asylum database	Interview **P5**, **P6** / Section 3.1
R6	Integration of Search Interface for SIS II, VIS and national police database	Interview **P1**, **P2**, **P8** / Section 3.1
R7	Scanning of QR code over the mobile application	Section 3.1
R8	Registration and tracking of used services	Section 3.1
R9	Integration non-Governmental organizations (NGOs)	Interview **P3** / Section 3.1 and 3.2
R10	Mobile application for police	Interview **P4**, **P9**
R11	Transportation management	Interview **P9** / Section 3.1 and 3.2
R12	Refugee home management	Section 3.1, **P9**
R13	User and rights management	Section 3.1
R14	Statistics and reports	Section 3.2

Requirement area R1 was defined with the aid of experts from an Austrian research and software company, other commercial software, and the scientific work of Wister et al. [89]. The general idea of pre-registration is based on the application of numbered bracelets in Italian Hotspots. As shown in the figure below, the pre-registration is the first step in the proposed refugee camp solution. It should be taken into consideration that in the typical case, refugees had to make a very long and exhausting journey to get to this place. [92]

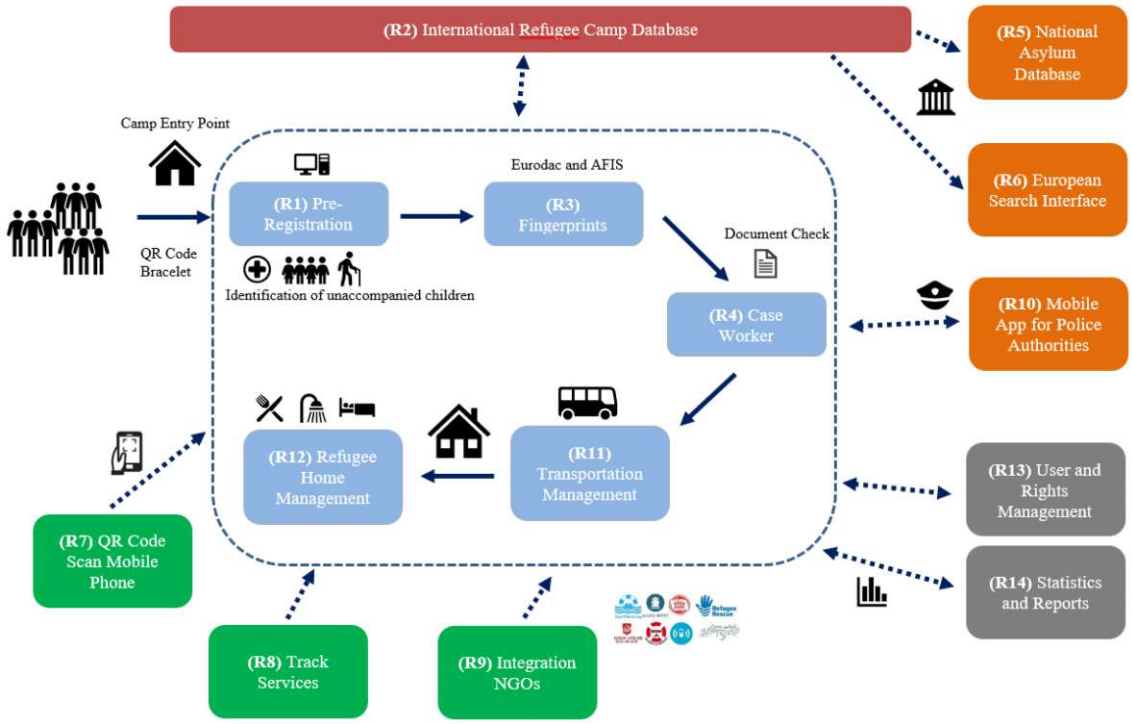


Figure 31: Overview Refugee System Concept [92]

Some are traumatized by war and other acts of violence, and others have lost their family or friends. Hence, the first step has to be done as quickly and as comfortably as possible. Long waiting queues are the worst situation that can happen. In addition to the traumatized persons, some are ill, need medical support, or are unaccompanied minors. It is essential to identify all persons who may need help as soon as possible. Shortening long refugee queues in front of the refugee camp entrance could reduce stress and other problems. Therefore, the pre-registration step provides fast and efficient registration of each refugee. Only the most critical data will be registered; all other details will be done in the second registration step, after the medical screening. A QR code bracelet will be handed out to each person.

Comparing the applied identification mediums in *Section 3.3* led to the conclusion that using a QR code bracelet in a refugee camp is most effective. The use of a paper-based bracelet is cheap and simple to print in any environment with electricity. It could also be possible to print a high number of bracelets in advance. It is essential to use a very stable paper, like the materials used during other events. The QR code should be printed on the bracelet. The advantage is that every mobile phone camera or QR code reader can scan the identification number. The reliability of such readers is very high because they do not need any chip (unlike RFID or NFC bracelets).

Each bracelet has a unique identifier that will be used for all other services and database entries in the refugee camp. The data will be stored in an international refugee database, see *requirement area R2*. The bracelet should be comfortable to wear and, at the same time, be resistant to adverse weather conditions. The idea is to wear it for the entire stay in the refugee camp. A person who had lost the bracelet has to perform the complete registration and identification process again. The old bracelet will be immediately disabled. [92]

To begin with, a government or NGO employee will print out the QR coded bracelet with a new identifier and hand it out to the refugee. Afterward, a picture will be taken. The refugee has to provide personal data such as name, surname, sex, date, and place of birth, nationality, religion, and reason for leaving the country of origin. Cultural mediators and translators should support the employee in communicating with the refugees. Thus, the personal data will be immediately connected to the unique identifier of the bracelet, including the picture. Often, entire families arrive at the refugee camp. In such cases, it makes sense to know which person is related to others. Past experience has shown that children or other family members could be lost quickly in such chaotic situations. Hence, during the registration, the employee will be able to cross-reference a specific person to another. One of the most sensitive situations is when unaccompanied children arrive. Children should be treated very cautiously and be assigned an adult who is responsible for their well-being. In case an unaccompanied child is registered, an employee will support him/her. The employee who is responsible for the registration has to define the responsible person. This will be recorded in the system. Usually, NGOs or police officers already checked the medical condition of the refugees. In some cases, one may need further medical support. In such a case, the refugee will receive a colored bracelet (for instance, a green one). This is important for the medical staff that is on call immediately after the pre-identification step and is trying to find people who may need medical support. [92]

Requirement area R2 is a critical component of the proposed refugee camp information system. Figure 31 illustrates that requirement area R2 relates to the main refugee camp system (dotted rectangle) and other European information systems. R2 defines the application of an international refugee database, called *Refugee Management Database (RMD)*. The requirement was defined through the interviews with the Federal Immigration and Asylum Service Austria and an Austrian research and software company. The data stored with the QR Code bracelet has to be stored somewhere. Hence, each refugee camp can store the QR code data, personal data, service information, tracked control points, European database references, and much more in the international database. The system could help to enhance the interoperability of refugee camps on an international level. The data stored in RMD can also be shared with other Member states. The exchange of data may help authorities to initially detect already-registered refugees. In case an individual provides data that already exists, the registration employee can match the stored picture and check the personal data. If needed, the comparison of fingerprints will be made later, due to the high number of people waiting in front of the refugee camp. Another essential feature is the configuration of data accessibility and visibility. There will be situations where a European Member State has no intention of sharing all data with other countries. RMD shall provide the possibility of configuring stored data as local or global information. Furthermore, national data will provide data access only for specific authorities. Like Eurodac, SIS II, and VIS, the database will be composed of a central and national unit.
The next step is the *requirement area R3*, the acquisition of fingerprints. The requirement is based on the interviews with the Italian Directorate of General Migration and Home Affairs and eu-LISA. Furthermore, several European Commission regulations request the acquisition of fingerprints in refugee camps to define the responsible country for an asylum application. Requirement area R3 is the step immediately after R1 (see Figure 31). The procedure of how fingerprints will be taken will be the same as the procedure in Italian Hotspots (as mentioned in *Section 3.1.1*). [92]

Each refugee camp has its own Eurodac Machine. The data obtained by the machine will be stored and checked in the national AFIS system and Eurodac. In contrast to the standard procedure, the proposed concept will also save a reference to the national AFIS database entry and the Eurodac entry to the already stored refugee database entry in RMD. To keep the data consistent and avoid privacy regulation issues, only the external reference ID of the corresponding European Information System will be saved. In case no entry was found neither in the AFIS and the Eurodac system, a new entry will be stored. This step is vital for the Dublin III regulation. The data stored in the Eurodac system is used in every European country to determine the responsible asylum application country. The Dublin III regulation (as already mentioned in *Section 2.1.4*) defines that the country where the first entry was registered is responsible for the asylum application. As mentioned before, the fingerprinting step will be done after the pre-registration and medical screening. This is essential to avoid long queues. [92]

Requirement area R4 describes the investigation check after the fingerprint registration. The interviews with the Federal Immigration and Asylum Service Austria and EASO contributed essential information for this requirement. Additionally, Norway developed a similar software application for its asylum service employees. Figure 31 shows that the Case-Worker Information and Document database (R4) is the step after the acquisition of the fingerprints. In case an individual was never registered in the European Union, a case-worker has to check the given data (mostly in the form of documents) for validity. Past experience showed that some refugees try to provide false information to be granted asylum in a specific country. The case-worker has to distinguish two scenarios: an individual brought no documents or forged documents. For the first case, the case-worker will perform a quick interrogation with the refugees. Each case-worker has access to the case-worker information system provided by the proposed concept. This information system includes all relevant information about a country: applied religions, political situation, culture, language, and much more. The information about the relationship between groups is essential for determining if someone tells the truth. Moreover, a geographical illustration of the distribution of political groups or religions might help to find the correct data efficiently. Hence, when a person claims a specific nationality, the case-worker checks the information about the country and asks basic questions. Depending on how the interviewee responds and reacts to the questions, a decision about the further procedure will be taken. Wrong information could lead to redistribution to the country of origin (if applicable according to human rights). In case documents were carried by the refugees, police officers or specialists check the documents for validity. This is done by querying the documents' IDs with the European information system SLDT (Stolen and Lost Travel Document database). A quick link or interface provided by the proposed information system will provide quick access to the database. [92]

The theoretical introduction to the European Border Management Information Systems in *Section 2.3* already highlighted the high number of different information systems and databases used in the European Union. Therefore, it is not feasible to replace all these systems with the proposed application. Instead, the proposed system demands the integration of these systems. The information about *requirement area R5* is based on the interviews with the Ministry of the interior Germany and the Federal Immigration and Asylum Service Germany. As mentioned in the last requirement areas, the international refugee database (RMD) will refer to any system required, by storing a given external ID for each QR code identification entry. [92]

Requirement area R5 describes the integration of the national asylum or police database. Each European Member State stores its asylum data in a national information database. In some cases, not every entry will be shared with the European Union. Instead, it will be stored in the national database. In some cases, the authorities search in the national databases first. Hence, a government employee will be able to search in these information systems using the proposed application. [92]

Besides the national databases, the government employee will also search for information in other European databases. Other important systems used in the refugee camp are the SIS II and the VIS system (*requirement area R6*). The regulations of the European Commission and interviews with the Ministry of the interior Italy, the Directorate- General Migration and Home Affairs (Italy), and eu-LISA contributed important information for this requirement area. As mentioned in *Section 2.2*, SIS II is used for retaining data about stolen objects or vehicles and wanted or missed persons in the European Union. VIS is responsible for the data exchange of VISA data between the European Member States. Requirement area R6 proposes the integration of these two systems. However, it has to be considered that the European Commission already proposed a standardized European Search Portal (ESP). This search portal (see *Section 2.4*) integrates the search for Eurodac, SIS II VIS, the SLTD database, and much more in one application. In case the implementation and deployment of ESP are completed, the proposed concept has only to provide access to the new ESP application, instead of integrating each European information system individually. [92]

Requirement area R7 proposes the utilization of mobile phones to scan QR codes within the refugee camp. The refugee camp employee has a personal computer with QR code scanner hardware in a permanent workstation. Usually, the pre-registration employee will sit on a table and scan the QR codes with a QR code scanner. However, depending on the local situation and environment, a mobile application might be an efficient extension. Using a mobile phone to scan the QR codes of the refugees can enhance the work for the employees. The mobile version of the proposed application has to be as intuitive as possible to minimize complexity. The mobile application will provide the essential features from the main application, like a simple version of the pre-registration. The user will be able to take a picture with the mobile phone, store the most critical data (for instance, selection between international protection and asylum application) and scan the QR code. More specific tasks could be carried out afterward on a terminal, such as the assignment to other family members. [92]

The next *requirement area R8* specifies additional features for the mobile application. Employees in the refugee camp should be able to scan the QR code in crucial checkpoints. Due to the enormous organizational effort for planning the correct amount of sanitary products, foods, medical supplies, beds, and much more, the consumption of the most important services will be protocolled with the QR code scan. Some refugee camps need to control the consumption of food and how often a person is permitted to use the canteen. The mobile application will support the supply team to keep an overview of the consumption or restrict access in specific situations. It is essential that all persons can eat, use sanitary products, and receive sufficient medicine. Hence, waste has to be controlled. For instance, some refugee camps will limit the number of daily meals per person to avoid uncontrolled consumption. [92]

One will not be able to eat more than needed, but at the same time, others will have enough to eat. The limit can be configured via the proposed application. The mobile application (but also the standard desktop application) will provide different service options. For instance, the employee can select "Food" on the mobile phone, then scan the QR code of the person that wants to eat. After scanning the QR code, the mobile app will immediately return the confirmation and store an entry in the database. [92]

The interview with the Ministry of the interior Austria led to the conclusion that non-governmental employees should also use the software application. The past demonstrated that NGOs are closely integrated into the refugee camp process. Hence, *requirement area R9* defines the integration of NGOs. Other commercial software and the work of Ishida et al. [91] confirmed this requirement area too. NGO employees will also be granted access to the application, primarily to the mobile application. They can scan QR codes for meal distribution, medical emergencies, sanitary supplies, bed assignments, transportation, and much more. However, at the same time, some services have to be restricted to comply with the GDPR and European Commission regulations. Not every person is permitted to use the European Information Systems or perform new registrations. [92]

Requirement area R10 extends the application with the mobile phone, giving access to police officers. The interviews with the Federal Immigration and Asylum Service Austria and an Austrian research and software company emphasized the option to integrated border controls or police checks into the application. In specific situations, a police officer is permitted to scan the QR code of a person and access the most important information immediately. This could help to keep the security within or outside the refugee camp. The police officers will be able to see the last activities such as location and data of pre-registration, border control checks, if someone is missed or wanted, and so on. The mobile application will also include a map to display the last activities as geographical information. [92]

Another important feature is the transportation service between different housings and the refugee camp. *Requirement area R11* defines that an employee can create a transportation request from one location to another. Moreover, it is possible to determine how many seats are given. This is essential to organize transportations for many people more accurately. The interviews with an Austrian research and software company and the papers of Wister et al. [89] and Ishida et al. [91] contributed essential knowledge for this requirement area. The employee that is in charge of the transportation management will usually be a bus driver. The bus driver should create a transportation request on the spot. After creating the transportation request with the mobile application, the bus driver will scan each passenger's QR code. In case a family wants to check-in for the bus, the app will check if enough seats are available for the entire family. Separating family members should be avoided. If someone decides to exit the bus before it has started, the bus driver scans the QR code again. The mobile application automatically deletes this entry from the transportation request. This is essential to keep the transportation overview of all persons and minimize the possibility of losing someone. When the bus arrives at the desired destination, the bus driver can confirm the bus transportation as completed. The information will be stored in the refugee camp database (RMD) and retrievable using the application. Thus, employees can follow-up where and when a person was transported. [92]

The next *requirement area R12* describes the management of the housing units for refugees. Depending on the geographical location and conditions, several housing units exist near or far from the refugee camp. The proposed application will provide the functionality to manage the complete housing coordination. That means an employee has an overview of all available housing units assigned for the refugee camp. Moreover, the employee will be able to select a specific housing unit for a single person or group. The application provides information such as the number of available beds, which ethnic groups, nationalities, or religions exist, and much more. Due to the social or religious problems that can arise in a housing unit when bringing specific groups together, it is crucial to have the information available. Families are categorized as groups and will be assigned together to the same housing unit. Special care has to be taken for unaccompanied minors. Furthermore, some housing units may request specific restrictions such as facilities only for adults or only for children. All of these conditions should be considered when assigning persons to specific housing units. Like all other services that will be referenced to the unique QR code database entry, the assignment of beds will also be done in the same way. [92]

Requirement area R13 defines the application of a user and rights management service that includes all features to create, edit, delete, and assign users and rights. The refugee camp system provides several features that are not accessible to everyone. For instance, the search requests in a national police database or the central Eurodac system is only permitted for specific employees and authorities. Some services have exceptional access rules depending on privacy regulations and government policies. Therefore, the user and rights management enables the restriction and access to specific service via defined rights or permissions. Each user is assigned to a particular group of users that has a specific set of rights. One of these user groups could be the NGO group. The refugee camp system administrator will be the only user that can modify users and rights. [92]

The last *requirement area R14* proposes the generation and illustration of statistical diagrams and data. To maintain an overview of the entire refugee camp process, are statistical reports essential tools. Moreover, representative data helps to generate forecasts for specific activities. For instance, the food and medical care orders can be monitored via the statistical report about the daily, monthly, or yearly consumption of food and be planned more efficiently. This can reduce costs and avoid gaps in food delivery. Furthermore, a statistical review about the incoming and outgoing refugees per month can illustrate in which seasons more or fewer persons are to be expected. This helps to prepare or adapt the personal and financial resources for the refugee camp. The user will be able to generate new diagrams at any time. [92]

4.1.2 Non-Functional Requirement Areas

This section describes the ten non-functional requirements of the proposed European refugee camp system. The definition of non-functional requirements was already described in *Section 2.6.1*. Table 7 lists all non-functional requirements: *accessibility*, *availability*, *security*, *backup*, *scalability*, *interoperability*, *usability*, *maintainability, ethics,* and *legal boundaries*. The non-functional requirement areas were defined by the qualitative research of Lamber et al. [92] and systematic literature review.

Table 7: Non-Functional Requirement Areas [92]

ID	*Description*
N1	Accessibility
N2	Availability
N3	Security
N4	Backup
N5	Scalability
N6	Interoperability
N7	Usability
N8	Maintainability
N9	Ethics
N10	Legal Boundaries

The non-functional requirement a*ccessibility N1* defines the proposed refugee system as accessible for all types of users. The system is navigable via a web interface and has to be available for all persons, including persons with disabilities. [92]

Availability N2 requires access to the application 24 hours a day. It should always be available in every place with an internet connection. Hence, it is essential to provide a stable internet connection in the refugee camp. The search through national or international databases is only possible with an internet connection. [92]

Due to the storage of very sensitive data from third-country-nationals and European citizens, it is essential to guarantee high access *security N3* for the databases and the application. Only allowed users should be able to use the application and request data from international databases. [92]

A *backup (N4)* of the entire database has to be executed autonomously in specific time intervals. Additionally, the administrator should be able to trigger a backup manually. In the worst case, the refugee camp application could shut down unexpectedly or have problems with the internet connection. Furthermore, the application will process and persist much of its data, including government information and references, to other systems. Backups help to reset the entire database to a working state. [92]

Past experience demonstrated that a forecast of refugee streams is not accurate in every case. Depending on political, economic, and weather conditions, a refugee stream can change very quickly. One day thousands of people may arrive at the refugee camp, while on another day only a few arrive. So, *scalability N5* enables the increase or decrease of database resources and services depending on the number of employees using the application or the data that has to be processed within the system or external databases. [92]

Interoperability N6 defines the characteristic of enhancing the collaboration and exchange of data between national and international authorities and the users within the proposed application. The European Member States that are using the refugee camp application should request and provide data to any other country. [92]

The conditions in the refugee camp can be very stressful and complex. Therefore, the user interface of the web application and the mobile app should be very intuitive. The functionality and services have to be very well readable, understandable, and clickable. The entire user interface has to be well structured and *usable N7*. [92]

The entire system has to be *maintainable (N8) t*o react to possible issues with the software or hardware. That means the software ensures a high-quality standard in the documentation and implementation of the code. At the same time, the hardware infrastructure—such as the server, deployment, and delivery management—should be easily configurable and adaptable at any time. [92]

The non-functional requirement *ethics N9* is also very important for this refugee registration system. Every stakeholder, including the refugees, should accept the identification and registration process of the proposed system. Hence, the system should consider the impact of ethical issues and reduce them as much as possible by providing services and functionality in a human-friendly and non-discriminating way.

Legal Boundaries N10 considers the European Commission directives and regulations. Thus, all data access activities to personal data have to be protocolled, due to the GDPR. Furthermore, other law enforcement regulations such as the LED have to be considered. This means personal data should be anonymized in specific situations.

4.1.3 Refugee Management System Architecture

This section gives a short overview and summary of the refugee management system components and how they are linked. The proposed European refugee camp information system in this doctoral thesis is titled *Refugee Management System (RMS)*. As mentioned before, in *Section 4.1.1*, all 14 functional requirement areas represent the main features of the proposed system. These requirements correspond to a specific component of RMS, which can be seen in the next figure. The figure illustrates the composition of the first services in RMS and the relation to the *Refugee Management Database (RMD)* and other services. Generally, the entire system is composed of external and internal systems, such as RMS. RMS is linked to RMD in both directions, which means RMS can read and write data to RMD. On the other side, RMD has references to other external systems such as VIS, SIS II, Eurodac, the national police database, and much more. Depending on the implementation progress of the *European Search Portal (ESP)*, RMD will either reference each European information system or only to the ESP interface. The proposed system does not provide the possibility to write to external systems. Only reading data was specified.
RMS is composed of the *Registration*, *Identification*, *Housing Management*, *Case-Worker Database*, and *Transportation Management* unit. These components cover the most crucial part of the already described requirement areas. The registration unit is in charge of reading and storing refugee data from and into the RMD. The identification unit includes the features of scanning QR codes or processing fingerprint information that were registered on a local system. Moreover, the identification unit checks the user login and the applied user rights for specific services. [92]

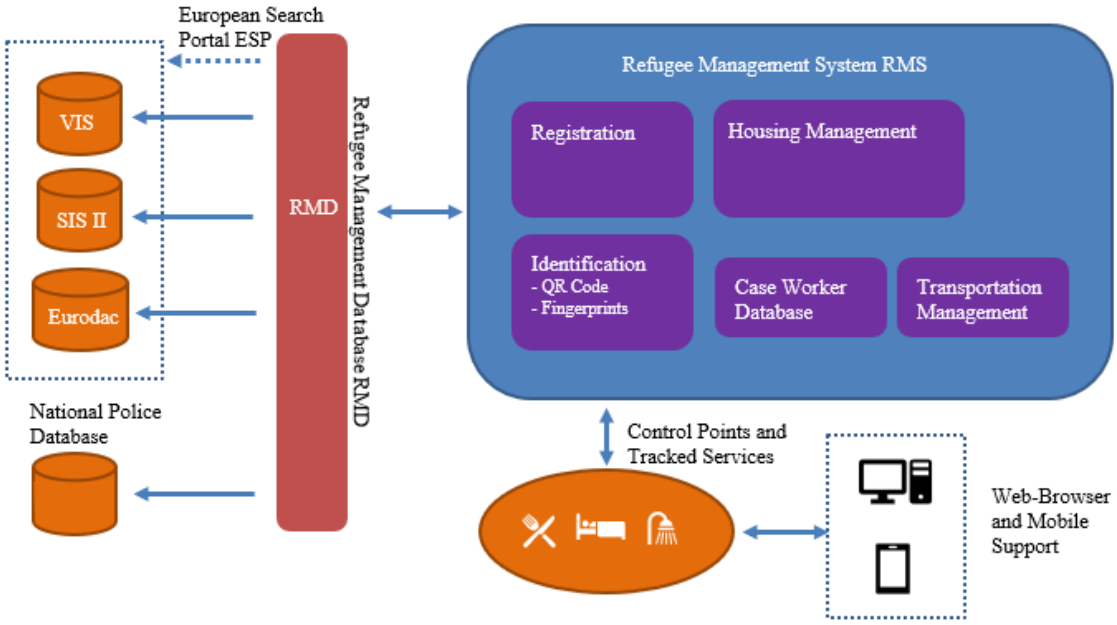


Figure 32: Refugee Management System Components [92]

As seen in the figure above, the other RMS components are categorized into separated domains. Therefore, the case-worker database, transportation management, and the housing management unit are optional features for a refugee camp. Not every camp has the personnel resources to provide the case-worker check (requirement area R4), executing transportations, or managing the housing allocation of refugees. Furthermore, the figure illustrates the connection between the RMS to external control points and services. That means that an employee with a mobile or working station can request and send data with RMS. [92]

For instance, an employee scans the QR code of a refugee with the mobile phone in front of the food distribution unit. The mobile application requests the scanned QR code from RMS. The identification unit of RMS decodes the QR code and requests the decoded data via the registration unit. The registration unit provides the functionality of reading and writing the data with the decoded identifier. RMS includes a unique identifier with properties and external reference keys. If an entry was found with the given identifier, RMS provides the information needed by the registration and identification unit. In this case, the picture and primary personal data of the refugee are needed. Also, the employee needs the information about whether the scanned person has reached a configured meal limit. Afterward, all requested data will be processed back to the mobile application. The employee receives the information about whether the refugee has been permitted to go to the dining unit or not. The picture and the personal data also allow the possibility to check if the bracelet corresponds to the scanned person. [92]

The database infrastructure will be decentralized. That means each European country will have its own national refugee management database. The data is only visible for the country and restricted for other countries. In case a European Member State wants to share the local refugee management data that was collected in a refugee camp, it has to transmit the data to the public data center. In the best case, this data center is located in a central place, for instance, Brussels. [92]

Every Member State can request data from this central component. Therefore, depending on the data access privileges, the decentralized data centers are indirectly connected. This is the same mechanism as provided by eu-LISA with VIS, SIS II, and Eurodac. The exchange of refugee camp data might enhance the collaboration between the European Member States and facilitate the identification and registration of refugees on national borders. [92]

4.2 Stage II: Concept Evaluation

The second stage of the user-centered process includes two quantitative surveys about the requirement areas from *Section 4.1.1*. Besides the *N9 Ethics*, the evaluation of the non-functional requirements will be considered for future work. To obtain valid results for the non-functional requirements of *Section 4.1.2,* a more practical assessment has to be done (for instance, the application in a real field scenario).
Nevertheless, the purpose of the first quantitative survey is to underpin the applicability and acceptance of the proposed requirement areas with the aid of authorities, NGOs, experts, scientists, and many others. During the development of the requirement areas, some scientists and experts emphasized the need for considering ethical issues. The application of information technologies in the domain of refugee management can produce ethical issues for refugees and employees. Hence, the second quantitative survey evaluates the ethical issues that can arise and what can be done to reduce their impact on refugees.

4.2.1 Quantitative Survey Requirement Areas

As mentioned before, the quantitative survey about the requirement areas should demonstrate the overall acceptance or rejection rate of all proposed features given by a more significant community. The results should affirm the application of the requirement areas and propose some suggestions and enhancements to several services. The quantitative evaluation was done with the aid of an online tool (*UmfrageOnline*[25]). This was an efficient way to reach as many persons as possible in different countries and institutions. The purpose of the survey was to gather valuable answers from a specific set of participants. Hence, this was only possible with participants with know-how in the field of migration and European information systems. The survey was sent to various authorities and institutions in the European Union, NGOs, government employees, scientists, and experts in the field of refugee migration. Some of the European institutions were: eu-LISA, EASO central office in Malta, contact offices of the European Migration Network (EMN[26]), European Commission, European ministries of interior, Austrian communities, NGOs such as Caritas, and the European Research Academy of Bolzano (Eurac[27]). Every participant could decide which requirement area is more or less appropriate and write additional comments. Participation in the online survey was anonymous. In total, 102 persons participated in the survey and submitted 1321 answers. [93]

[25] https://www.umfrageonline.com
[26] https://www.emn.at
[27] http://www.eurac.edu

The given answers gave a more profound background for deriving assumptions about ethical, technical, and organizational issues that can arise when applying the proposed European refugee management system (RMD). Moreover, the result demonstrated the allocation of acceptance rate distribution between different groups and possible reasons for that. The survey provided a short introduction to the proposed refugee management system and described all requirement areas briefly. The first set of requirement areas included R1-R6, the second part included R7-R14. After a short introduction into the topic, every participant had to provide basic information about their sex, age, and country of origin (see the figure below). This information was used to find any rating constellations depending on the sex, age, and country. [93]

Figure 33: Quantitative Survey Requirements Personal Information

The next question was crucial because the job or employment category helped classify given answers into specific groups and derive some assumptions. The participants had the option to decide between the "Government Sector," "Non-Governmental Organization," "Scientist," "Student," and "other." The comparison between the government sector and the NGO sector provided interesting assumptions about the given results. [93]

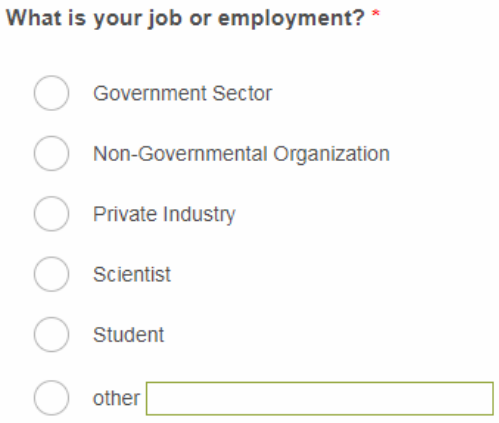


Figure 34: Quantitative Survey Requirements Employment

The first part of the requirement areas (R1-R6), which was defined with the category "Identification and Registration," was the next section in the survey. This was followed by the section "Further Refugee Camp Services," which included R7-R14. Every requirement area was listed and briefly described. The next figure illustrates the 5 rating options for each requirement area (R1-R6): "Strongly Agree," "Agree," "Disagree," "Strongly Disagree," and "I do not know." The last option did not influence the evaluation and was only offered for participants who had no opinion or not enough knowledge to rate the requirement area. [93]

The first option is the highest rating that could be given, and the fourth option the worst. The author decided to provide only positive or negative answers. The evaluation of the ratings was enhanced by calculating the arithmetic mean and the standard deviation of each requirement area rating. The same classification and calculation mechanism hold for R7-R14. [93]

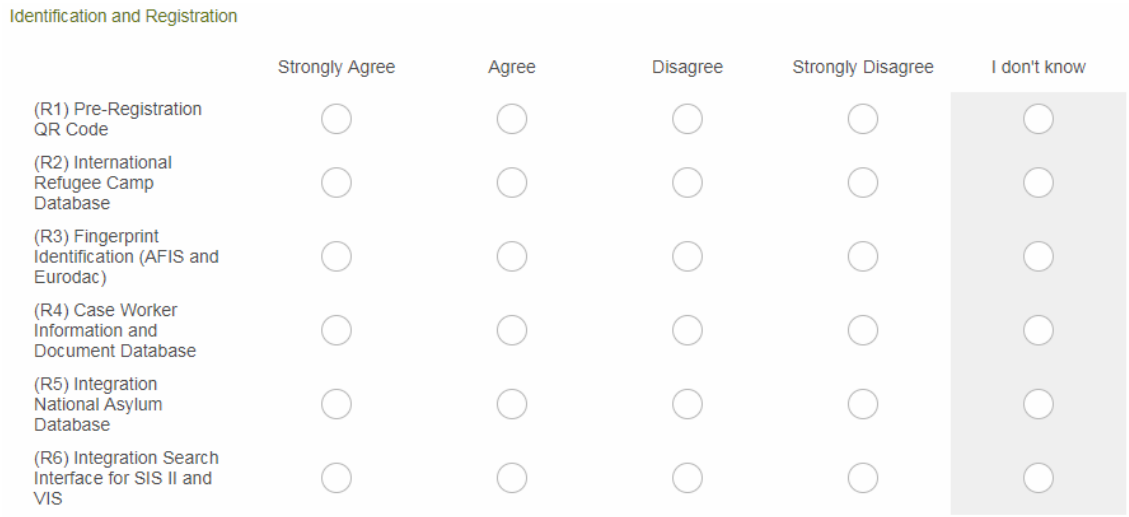


Figure 35: Quantitative Survey Requirements Example R1-R6

As mentioned before, 102 persons participated in the online survey. The following details were indicated [93]:

- 49 persons were women (48%) and 53 men (52%).
- The age was indicated between 21 and 59.
- The given countries of origin were: Austria, Germany, Italy, Malta, Spain, Finland, France, Belgium, and the USA. Most participants are from Austria with 26%, followed by Italy with 12%.

Filtering the answers of the participants with the given personal data, led to no definite conclusions. The author was not able to find any significant differences between the responses with the provided personal data. Instead, the allocation of the employment sector was much more interesting. Figure 36 illustrates the distribution of the employment sectors: 30% indicated their employment in the government sector (29 participants), followed by the private industry with 23% (22 participants), scientists with 22% (21 participants), NGOs with 20% (19 participants), students with 3% (3 participants) and other employment with 2% (2 participants). The results given by the participants with the employment "Student" and "Other" did not influence the evaluation, due to the minimal number. [93]

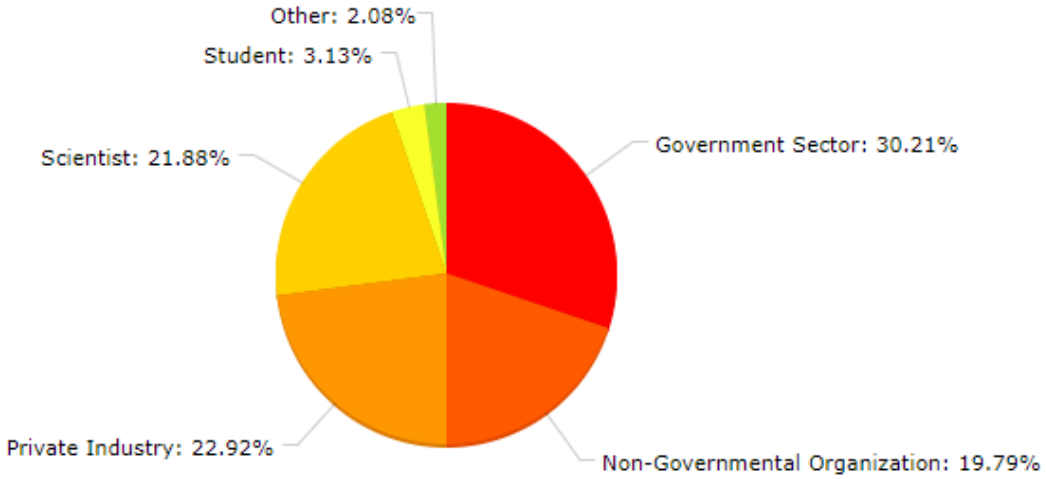


Figure 36: Quantitative Survey Requirements Employment Results [93]

The next figure shows the results of the rating distribution of requirement area R1 to R6 given by 74 participants. Not all participants were able to answer all questions. As seen in the figure, the arithmetic mean and standard variance are given at the end of the table. Moreover, they were illustrated graphically to have a better overview of the distribution. The arithmetic mean shows the total acceptance for all rows and the standard variance distribution of the answers. A smaller standard variance means a more definitive result. On the other hand, a higher standard variance may lead to inaccurate conclusions. Furthermore, the total of all answers (including the percentage factor) is given for every rating option. The results show that the overall acceptance for all requirement areas was given. Every requirement area has a standard variance between 1 and a maximum of 2.5. The arithmetic mean (illustrated as an orange line) is never higher than 2. This is a very positive result for all requirement areas. As seen in the figure, the best-rated requirement area is R4 (case-worker information system) with an arithmetic mean of 1.64. The integration of the European Search Interface R6 is the second-best rated with 1.66. On the other hand, the worst-rated requirement area is R2 (international refugee database) with 1.82. Requirement areas that work with very sensitive and international data have the highest standard variance. One of them is R3 (fingerprint identification), with a standard variance of 0.82. The pre-registration R1 with QR code also has a high standard variance with 0.77, followed by R2 with 0.75. In the author's opinion, the reason for that high variance reflects the increase of public awareness about personal data exchange and the possible consequences of ethical issues. [93]

Participants: 74

	Strongly Agree (1)		Agree (2)		Disagree (3)		Strongly Disagree (4)		I don't know (0)		
	Σ	%	Σ	%	Σ	%	Σ	%	Σ	Ø	±
(R1) Pre-Registration QR Code	27x	36,49	32x	43,24	9x	12,16	2x	2,70	4x	1,80	0,77
(R2) International Refugee Camp Da...	23x	31,08	37x	50,00	5x	6,76	3x	4,05	6x	1,82	0,75
(R3) Fingerprint Identification (AFIS...	33x	44,59	25x	33,78	10x	13,51	2x	2,70	4x	1,73	0,82
(R4) Case Worker Information and D...	32x	43,24	31x	41,89	5x	6,76	1x	1,35	5x	1,64	0,69
(R5) Integration National Asylum Da...	21x	28,38	42x	56,76	5x	6,76	-	-	6x	1,76	0,58
(R6) Integration Search Interface fo...	26x	35,14	35x	47,30	2x	2,70	1x	1,35	10x	1,66	0,62

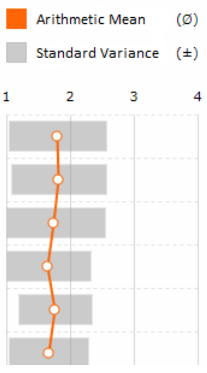


Figure 37: Quantitative Survey Requirements R1-R6 in Total Results [93]

Using QR code bracelets and taking fingerprints can lead to several ethical or political issues. Moreover, the political differences and privacy regulations (GDPR) might hamper the application of an international database (R2) between the different Member States. Nevertheless, the government highly recommends the use of fingerprint identification. The actual European policies require a stable and unique identification medium. Therefore, it is not feasible to dispense with the application of fingerprint identification based on ethical issues. Moreover, the application of a QR code bracelet is indispensable for an efficient and secure registration process in a refugee camp with numerous people. To highlight the gap between the government's and NGO's needs, the author filtered the rating answers in two groups: participants at a more organizational, governmental and business level (government sector and private industry), and participants focusing more on human needs and ethical issues (mostly NGO sector and scientists). [93]

Figure 38 illustrates the answers filtered by the most significant employment sectors (the results of the "Student" and "Other" group were ignored). As mentioned before, the acceptance rate of all requirement areas can be divided into a more positive and more negative group. [93]

Figure 38: Quantitative Survey Requirements R1-R6 Sectors Results [93]

As seen in Figure 38, the acceptance rate of the government sector and the participants of the private industry is much higher and more accurate (a low standard variance) than the answers of the NGO sector and scientists. Indeed, the overall acceptance is given for every constellation; no requirement area was denied completely. In the author's opinion, the reason for such a gap is that the government sector and private industry have a higher focus on the operability and applicability of the requirement areas. Government employees usually know the need and advantages of the given features. On the other hand, NGOs and scientists merely consider social and ethical issues. Giving every person a bracelet for the registration procedure or taking fingerprints might cause someone to feel like an object. The worst ratings were given by the NGO sector, especially for the registration and identification requirement areas. Requirement area R1 and R2 have an arithmetic mean of more than 2. Some participants strongly disagreed with these requirement areas. Hence, the ethical and moral issues that can arise in such a European refugee camp information system have to be taken into account. Such an application that works with humans should consider the needs and the well-being of the refugees and the employees using the application. [93]

Next, the second section of the survey included the description and rating of all other requirement areas (R7-R14) and was filled out by 71 participants. The next figure illustrates all the answers given by the participants without any filter. The arithmetic mean of two requirement areas (R8 and R10) is very high, contrasted with all other requirement areas. Despite that, all requirement areas were in total rated positively. The arithmetic mean of all answers is between 1.49 and 2.25. R8 (Protocolling used Services) has an arithmetic mean of 2.05 and a standard variance of 0.79. The numbers might lead to the conclusion that this requirement area engenders the feeling of being surveilled and controlled in the refugee camp. The scan of the QR code before going to eat or receiving a medical supply might increase the possibility of ethical issues. However, on the other hand, having an overview of all consumed products and services enhances the planning and coordination of supplies. Past experience demonstrated that refugee streams could change every day. Hence, it is essential to prepare all resources as efficiently as possible. Requirement R10 (mobile app for the police) is the worst-rated requirement area, with an arithmetic mean of 2.25 and a standard variance of 1.04. Many people might see the idea of giving police officers the possibility of scanning and controlling persons any time as a potentially problematic situation. The conception of this feature should include the consideration of human rights. Aside from R10, the best-rated requirement areas are R13 with an arithmetic mean of 1.49, R14 with 1.56, and the R12 with 1.61. It can be assumed that these requirement areas are more valuable for all participants. Moreover, services such as Statistics, User Management, and Home Administration have a lower impact on ethical issues than the other requirement areas. [93]

Participants: 71

	Strongly Agree (1)		Agree (2)		Disagree (3)		Srongly Disagree (4)		I don't know (0)		
	Σ	%	Σ	%	Σ	%	Σ	%	Σ	Ø	±
(R7) QR Code Scan over Mobile Phon...	24x	33,80	33x	46,48	8x	11,27	1x	1,41	5x	1,79	0,71
(R8) Protocolling used Services	16x	22,54	31x	43,66	15x	21,13	2x	2,82	7x	2,05	0,79
(R9) Integration of NGOs	31x	43,66	28x	39,44	7x	9,86	-	-	5x	1,64	0,67
(R10) Mobile App for Police	17x	24,29	25x	35,71	11x	15,71	11x	15,71	6x	2,25	1,04
(R11) Transportation Management	27x	38,03	34x	47,89	4x	5,63	1x	1,41	5x	1,68	0,66
(R12) Refugee Home Management	32x	45,07	33x	46,48	3x	4,23	1x	1,41	2x	1,61	0,65
(R13) User and Rights Management	37x	52,11	29x	40,85	2x	2,82	-	-	3x	1,49	0,56
(R14) Statistics and Reports	35x	49,30	28x	39,44	5x	7,04	-	-	3x	1,56	0,63

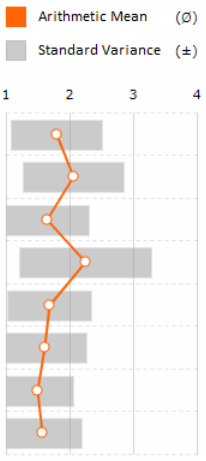


Figure 39: Quantitative Survey Requirements R7-R14 Results [93]

The requirement area R10 was the most contested feature. The high standard variance shows that the rating of this requirement area was not clear. Therefore, the author decided to filter the answers into two groups: the participants who agreed to this feature and the participants who disagreed.

The next figure illustrates the selection filtered with all participants who have chosen "strongly agree" for requirement area R10. All other requirement areas from R7 to R14 were agreed upon, mostly by the government sector (50%). The private industry, with 31%, also gave very positive feedback. As mentioned before, it can be assumed that the government and private sector have a high focus on the organizational and technical view of the requirement areas. [93]

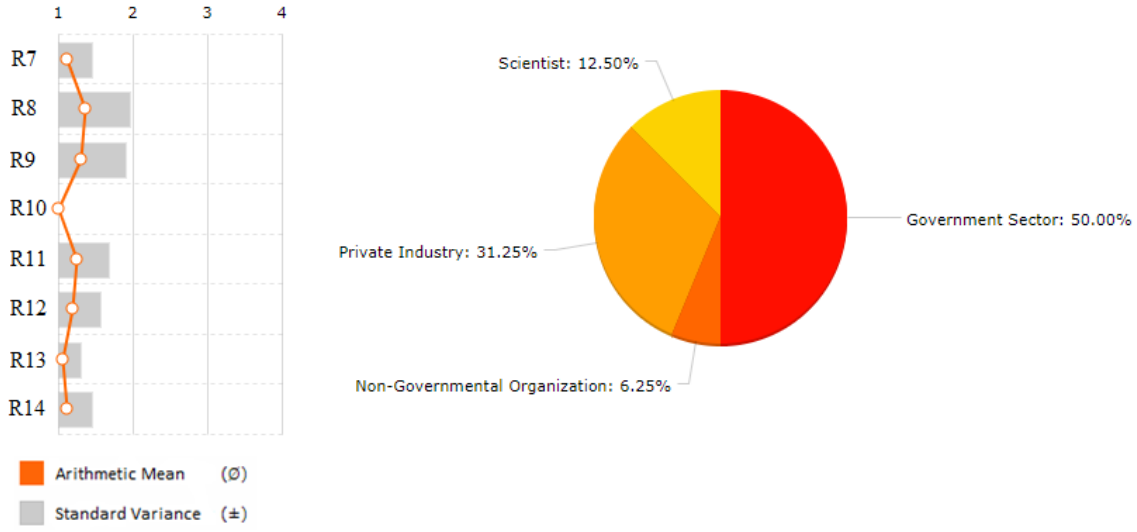


Figure 40: Quantitative Survey Requirements R10 Best Rating Results [93]

On the other hand, the next figure shows the most negative answers for requirement area R10. Figure 40 illustrates all answers that were filtered with the participants who rated R10 with "strongly disagree." The graph shows the discrepancy between the government sector and the NGOs. The NGOs have the highest percentage with 54% and the government sector the lowest with 9%. Interestingly, the rate of the private industry is almost identical to approximately 30%. The same can be said for the scientists, but the value is, in both cases, insignificant. [93]

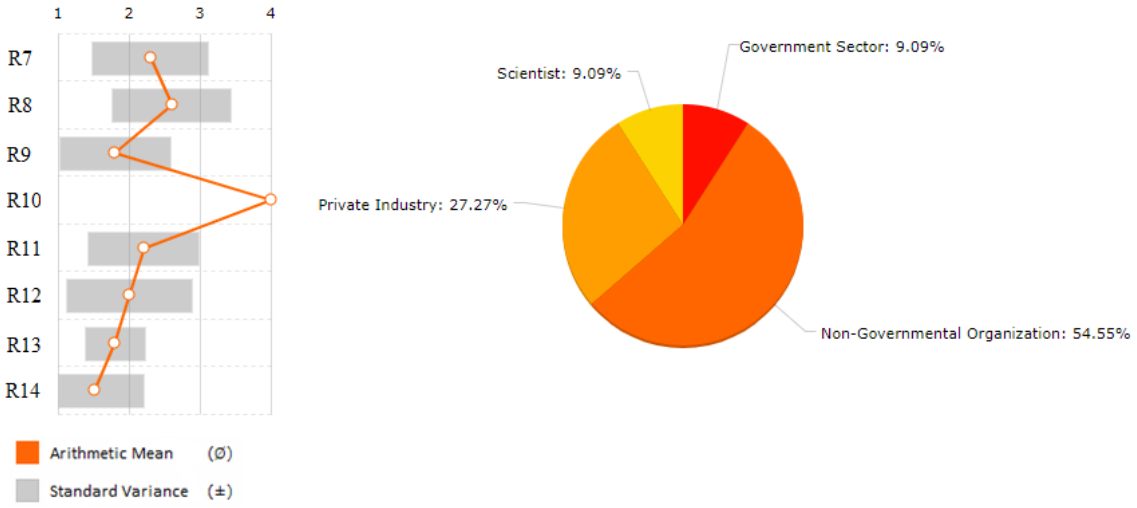


Figure 41: Quantitative Survey Requirements R10 Worst Rating Results [93]

The quantitative survey results led to some adaptation and conclusions for some of the proposed requirement areas. Besides the ratings, participants were able to write comments and to share their opinion. The results and feedback of R1 to R6 demonstrated that the scanning of the QR code bracelet or taking fingerprints led to ethical concerns. More transparency and information has to be provided to the refugees to reduce the ethical issues or the misunderstanding of the purpose of the identification medium; otherwise refugees may have the feeling of being just an object. Taking fingerprints is also very critical. Not every person wants to provide their fingerprints. [93]

The refugees must know why they are obligated to give their private data to the government employees. Hence, the author analyzed the ethical issues which can arise through the refugee management system and described it in *Section 4.2.2*.
The international refugee database R2 will be reduced to a local and national level. It is very large-scale undertaking to provide an international database for the European Member States. The organizational and political limitations are not in the scope of this doctoral thesis. Therefore, the RMD will only store local refugee camp data in the first instance and use the references of the European information systems. In case the database is needed on an international level, the RMD can be upgraded afterward.
Based on some of the ratings and comments of the government and NGO sector, requirement R4 will also be adapted. The investigation and interrogation of an individual will not be done after the fingerprinting step, as illustrated in Figure 32. Instead, it will be done right after a person was assigned to a specific home unit and transported to this location. Some participants argued that some refugees might be too traumatized after the long journey and should be interrogated in a more stable and calm environment. The next figure shows the process, based on Figure 32 and the new recommendations. [93]

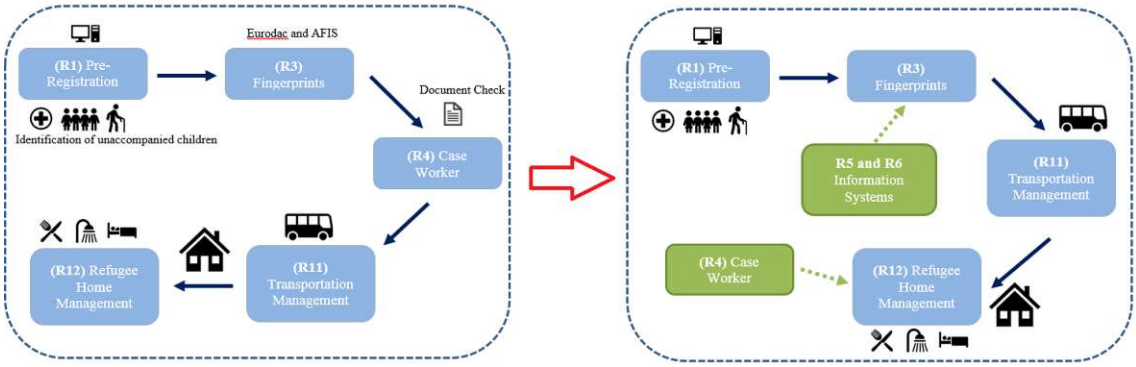


Figure 42: Quantitative Survey Requirements Process Recommendation Results [93]

As seen in the figure above, the green case-worker step R4 was moved within the refugee home management step. Moreover, the query and check of the other European and national information systems (included in R5 and R6) will be done within fingerprint step R3 and not later.
Regarding the other requirement areas, scanning the QR code with a mobile phone (R7) remains unchanged. R8 will be revised; no one should feel like a surveilled object. Hence, more transparency and information has to be given. On the other hand, the need for efficient resource coordination has to be taken into account and can only be provided by the protocolling of specific services.
The requirement areas R9, R11, R12, R13, and R14, do not need any adaptations. However, requirement area R10 is very critical. Depending on the situation in the Member State, this requirement has to be eliminated entirely or at least limited. The access could be restricted to a small group of police officers. A geographical limitation could also be useful, for instance, allowing the use of the app only within the refugee camp and not outside. The application of this requirement area relies strictly on the security situation in the country and its needs. In the years where terror attacks happened very frequently, the requirement area was more important than today. [93]

4.2.2 Quantitative Survey Ethical Issues

This section describes the ethical issues that can arise when applying the proposed European refugee management system (RMS), how the refugees and NGOs feel in specific situations, and how to adjust the procedure to reduce the issues. This evaluation considers the non-functional requirement R9 (see *Table 7*). RMS processes very sensitive data. Moreover, giving refugees identification bracelets or taking fingerprints can be linked to several ethical issues. During the conception phase, some scientists and experts criticized that the proposed refugee camp registration procedure might evoke different feelings for the refugees. The participants in the quantitative survey of *Section 4.2.1* mentioned that some persons might feel "like an object" or uncomfortable. Notably, the use of a QR code bracelet led to some ethical concerns. The refugee camp situation can enforce the problem of *Identity* and *Otherness* (Zygmunt Bauman), which was already described in *Section 2.8*. In the author's opinion, all services that provide information and registration processes can have some ethical implications.
That means the identification with QR code bracelets, the fingerprint acquisition, the scanning with the QR code via the mobile app, and the mobile police application are requirement areas that can negatively influence the perception of the identity and increase the feeling of belonging to another group. The situation when receiving a bracelet can evoke the feeling of being different, the other. Moreover, the feeling of being just a number or a code could be enforced. This might reduce the self-confidence of the refugees and their perception of identity. In the case of the fingerprint acquisition, one might feel uncomfortable when providing personal data about their own body ("loss of face"). Databases, including private data, could also create ethical issues (international refugee database or the case-worker information and document database). During the interrogation step of the case-worker, someone innocent might feel like a criminal. The subjective feeling depends strongly on the manner in which the case-worker interrogates the refugees. Moreover, when storing personal data, private data rights must be taken into account (see *Section 2.5*). As mentioned in the sections before, privacy rights regulations are nowadays more critical. Disclosing personal data might cause some people to feel embarrassed or denigrated through discrimination, profiling, and surveillance ("loss of privacy"). The next table lists all the requirements that were identified concerning ethical issues. [74]

Table 8: Requirement Areas Which Might Evoke Ethical Issues [74]

ID	*Description*
R1	Pre-Registration with QR code bracelet
R2	International Refugee Database
R3	Fingerprint identification and registration (AFIS and Eurodac)
R4	Case-Worker Information and Document Database
R7	Scanning of QR code via a mobile application
R8	Registration and tracking of used services
R10	Mobile application for police

Nevertheless, one requirement area is crucial in the first place and has to be applied as adequately as possible: requirement area R1. Many refugees arrive at the refugee camp after a very long journey and are already traumatized. Hence, the first contact with the camp and the system must be adequate and not demoralizing. Hence, the author decided to create a quantitative survey for refugees and NGOs to understand the needs in such a situation. [74]

The survey should provide essential information about the acceptance of the QR code bracelet in specific situations. The study should help to understand ethical issues that can arise when applying such an information system, how the refugees and NGOs feel in particular cases, and how to adapt the procedure to reduce the issues. The survey was provided in an online form with *UmfrageOnline*. As in *Section 4.2.1*, the participants had to provide basic information such as age, sex, and country. The survey is composed of three main sections, beginning with the main introduction [74]:

"You (as a refugee) arrive at a European refugee camp after a long journey. The governmental employee asks you for personal information and gives you a numbered bracelet for the identification process within the camp."

Next, the author defined four different feelings that could fit the situation for a refugee when receiving an identification medium in front of a refugee camp. The definition of emotions is based on *Section 2.8* about ethics and software engineering. The defined feelings are listed in the figure below: "It doesn't bother me," "Loss of face," "Loss of privacy," "Feeling like an object," and "Other. The first one should be clear; "Loss of face" describes the situation if someone has to disclose body information, e.g. giving fingerprints, even though he/she does not want it. "Loss of privacy" is the situation when someone has to disclose private information to other authorities. "Feeling like an object" relates to how someone perceives his/her own identity. An example where one might feel insecure or like an object is being given a bracelet and being categorized into a specific group. [74]

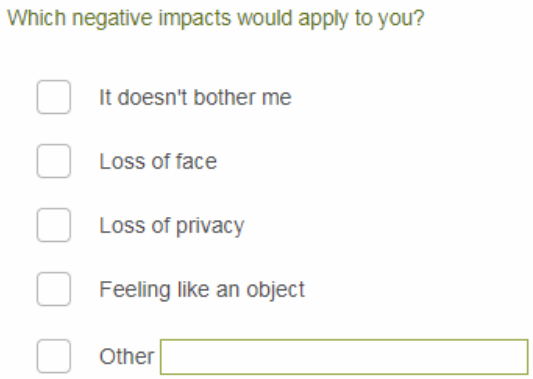


Figure 43: Quantitative Survey Ethics Feelings [74]

Then, the selection of the feelings was followed by the question: "Would you accept the bracelet?" The introductory part of the survey should check the acceptance rate in the first place without the involvement of any other details. The survey continued with providing more information to the situation that occurs to the refugee. [74]

After being given more details, the participants were asked again if they would accept the bracelet or not. The first section (Section I) focuses on the situation when considering a more dramatic scene and social commitment [74]:

"Now, let us rethink the situation: You arrive at a European refugee camp after a long journey. Hundreds of people are already waiting in front of the refugee camp. Some of them are ill, tired, or unaccompanied minors. Therefore, government employees need an identification tool to be able to keep an overview of the situation. Some need medical support, some have lost their family... it is chaotic."

So, every participant had to re-evaluate if they would accept the bracelet or not. Would someone take something that he/she does not want, in favor of others? Section II investigates the results considering the situation when someone would be compensated [74]:

"The ID bracelet is used for getting food, medicines, or other supplies. It would enhance the stay in the refugee camp for you and the employees."

The last section (Section III) focuses on how someone would act when having a free choice [74]:

"You could decide between a numbered bracelet or a numbered piece of paper. Let us assume, you know that the bracelet could be more convenient for you."

Despite that, the participants had to answer to the last question [74]:

Would it make a difference for you when using a bracelet with QR code instead of a numbered bracelet?

The participants could select between "It would be worse," "It would be better," or "No difference." The results should show if there is any negative opinion of QR codes in contrast with numbered bracelets. [74]

The author contacted different refugee home centers in Austria, Italy, Germany, and Switzerland. In the end, 66 refugees and NGO employees participated in the survey. In total, 587 answers were given by participants of the USA, Europe, India, and other migration countries such as Syria, Iraq, Afghanistan, and Libya. The indicated age was between 21 and 58 years. 61% men (40) and 39% women (26) participated in the survey. The next figure shows the selection rate of all feelings. 57% of the participants chose "Feeling like an object" (37), 36% "Loss of privacy" (24), 35% "It doesn't bother me" (23), 29% "Loss of face" (20) and 6% "Other" (4). The last option did not influence the evaluation of the results. The figure demonstrates that "Feeling like an object" was the most selected feeling if some were to be given an identification bracelet in front of a refugee camp. This could relate to the perception of their own identity. The bracelet might provoke the feeling of being only a number or object for the entire registration process. Everyone seeks personality and individuality, and such a bracelet could hamper this feeling. One might feel like the "Other," in contrast with the European citizen or government employee. The bracelet could enforce this feeling. Nevertheless, 29% chose "It doesn't bother me." In the following question, whether the participant would accept the bracelet, 52% answered with "yes." [74]

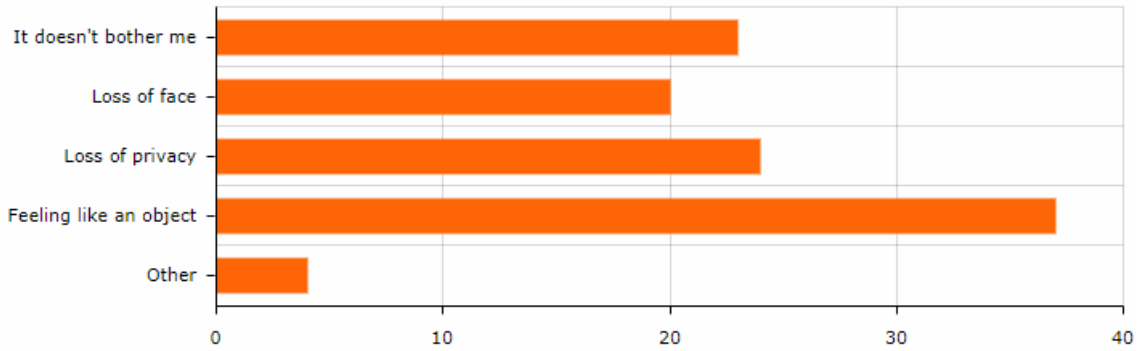


Figure 44: Quantitative Survey Ethics Feelings Results [74]

The given answer for Section I to III of the accepting group is not significant, because they already accepted the bracelet. Hence, the author filtered the following responses with the declining part of the participants (the 48%) and analyzed the results in more detail. [74]

The figure below shows the results given by the declining part of the participants for Section I to III. As can be seen, the results demonstrate a significant increase from Section I to III. The first section illustrated the influence of social commitment in such a situation. Giving the participant a more detailed description of the case led to an acceptance rate of 34% of the declining part. That means that the participants who declined the bracelet are now willing to wear it for the good of the community. Moreover, some participants mentioned that it would be great to have an efficient identification medium to keep an overview of other family members. For some refugees, it is better to be "over-controlled" than losing a child in chaotic and dramatic situations. [74]

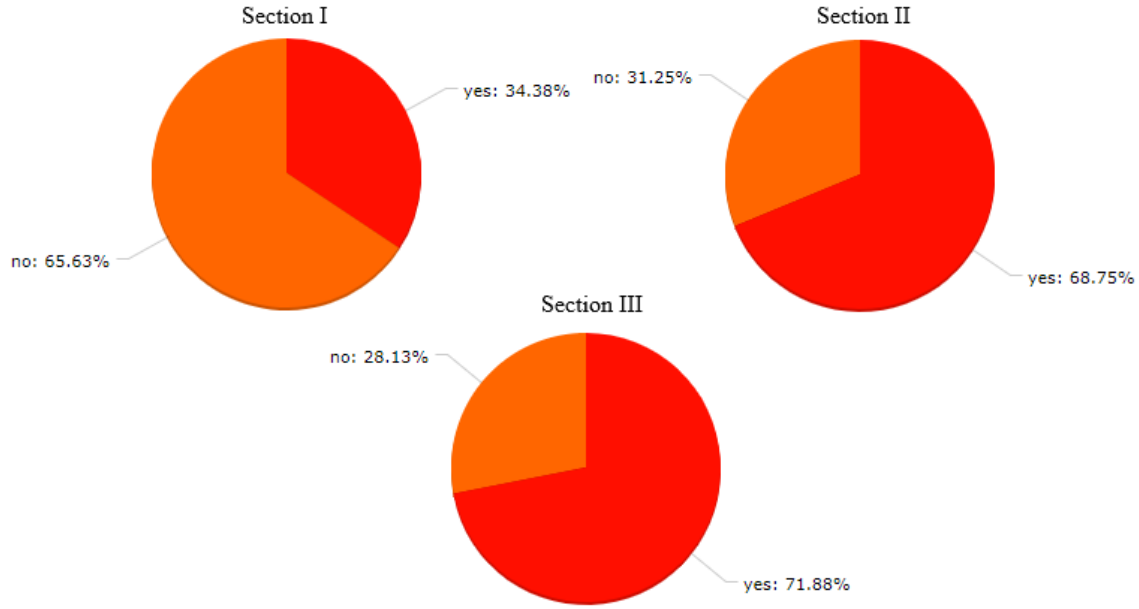


Figure 45: Quantitative Survey Ethics Section I to III Results [74]

Nevertheless, 66% still declined the bracelet. It is evident that in chaotic situations, people might only think of themselves or their families. The results of Section II illustrated an even better rate of 68%. Section II represents the situation when someone would be compensated for wearing the bracelet. It can be concluded that giving more information and transparency could reduce insecurity and fear in front of the refugee camp. In case someone knows why he/she has to wear the bracelet and what the advantages are, he/she will be more willing to wear it. The Otherness effect might be reduced with this information. It demonstrates that the acceptance of wearing such a bracelet in a chaotic situation depends strongly on the perception of their own identity. Furthermore, the most acceptable condition is when someone has the free choice of selecting the identification medium. Section III resulted in an acceptance rate of 71%. This could be because the participant has a free option and can emphasize his/her own decision and individuality. The participant is granted more power than before. Hence insecurity could be decreased.

The results of the last question, about the opinion if someone would feel more or less comfortable with QR code bracelet instead of with a numbered bracelet, are illustrated in the next figure. These results are not filtered by the declining part, and show the overall decision of all participants. For 56%, wearing a QR code bracelet (37) instead of a numbered bracelet makes no difference. 22% would prefer a QR code bracelet, and 22% would prefer the numbered bracelet (15). With these results, it can be concluded that the used technology on the identification medium makes no significant change for the acceptance rate. Hence, applying a QR code bracelet should not make the situation worse than using any other bracelets. As mentioned in *Section 3.1.1*, a numbered bracelet was already used for identification in Italian Hotspots. [74]

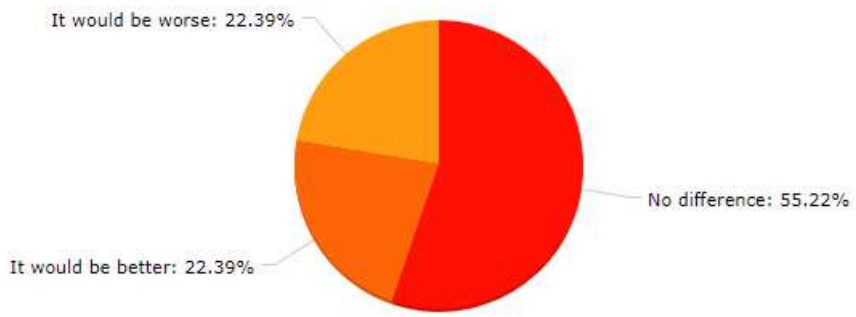


Figure 46: Quantitative Survey Ethics QR Code Results [53]

Despite all these suggestions, if refugees are not treated as humans by the employees and European citizens, they still will feel like the Other. In such a case, no transparency or information will ever help make the refugee camp more comfortable.

Nevertheless, the results showed that having more information about the situation in the refugee camp and the problems that can arise led to better acceptance of identification and registration technologies. These survey results will change the application of requirement area R1 (pre-registration with QR code bracelet). The bracelet will be provided in different colors, but it has to be considered that green bracelets are already used for a person with the need for medical support. If someone declines to wear a bracelet, he/she will be given a piece of paper with a printed QR code on it or a small ID card. The practicability of such an identification medium has to be evaluated. Nevertheless, the entire process will be optimized for the use of a QR code bracelet. Moreover, it is crucial to train employees accurately and prepare for ethical or organizational issues. [74]

When people arrive at the refugee camp, some will be traumatized and might react negatively to any identification medium. Hence, the employees should respond adequately in such cases and calm down the situation with information and patience.
Moreover, according to the GDPR and the other executive regulations described in *Section 2.5*, the employees have to inform the refugees about their data privacy rights applied in the refugee management system. Due to the ethical issues that can arise when disclosing personal information to others and the GDPR, privacy data regulations must be taken into account for the proposed system (for instance, anonymization). [74]

4.3 Stage III: Low-Fidelity Prototype

The third stage of the user-centered requirements process includes the essential use-case diagrams of the entire system and graphical mock-ups. The use-case diagrams and mock-ups were defined with the information obtained in the two previous stages.

4.3.1 Use-Case Diagrams

This section describes the use-cases of the proposed refugee management system RMS. Due to the high amount of use-cases, not every single use-case scenario is described. First, an overall illustration of the already described requirement areas is given by the next figure. Background information on use-cases diagrams was previously described in *Section 2.6.2*.

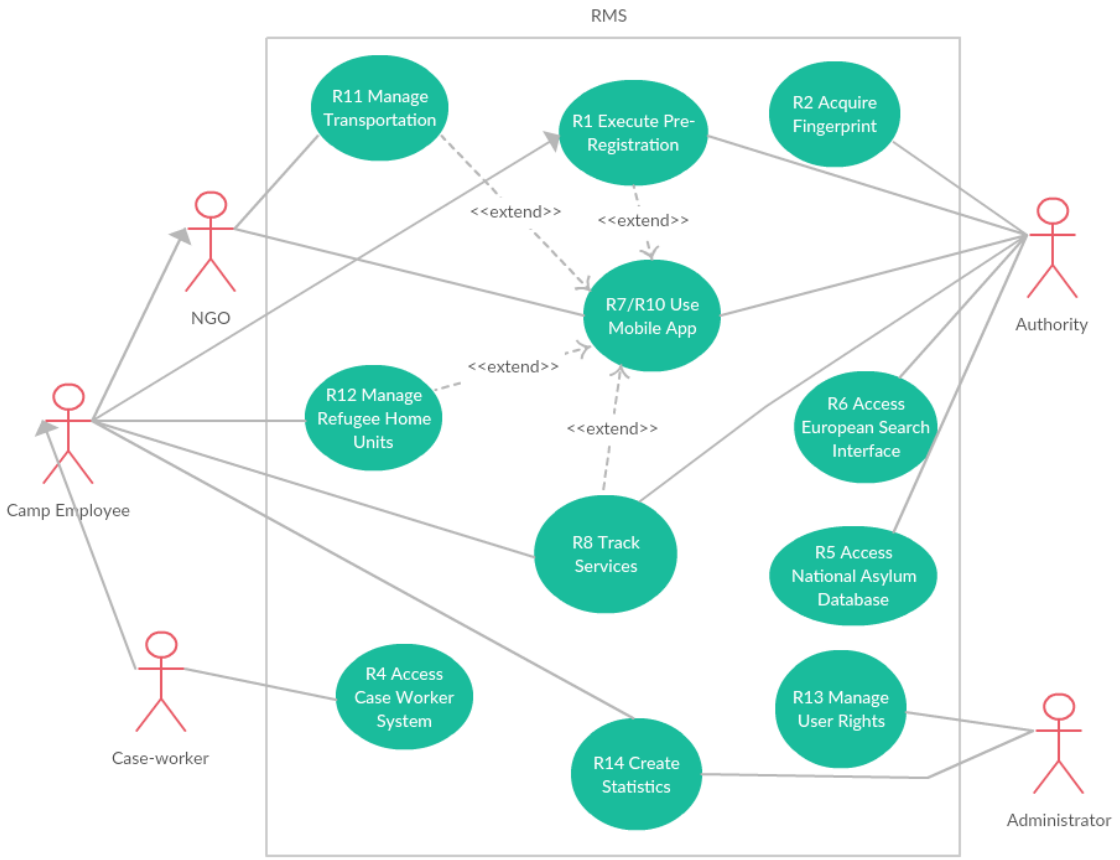


Figure 47: Use-case Diagram RMS Overview

The figure shows all requirement areas which are assignable to specific roles. Five role types were classified to differentiate the responsibilities and main tasks of the users: *camp employee*, *NGO, case-worker*, *authority,* and *administrator*. The camp employee is the standard user of the RMS application. The camp employee has access to all services of the NGO user. Hence, the camp employee and NGO user can access the mobile app and manage transportations. The mobile app partly supports the pre-registration, transportation management, the tracking of services, and the home unit assignment. The interaction between these use-cases is defined by the word "extend." Hence, the extending use-cases are also available without the mobile application. The camp employee can also execute the pre-registration, track services, and use statistics for further analysis. The case-worker has a unique role that allows accessing the case-worker information database. This database should only be available for well-trained staff who are responsible for the interrogation of refugees about their country of origin (in case of discrepancies). Nevertheless, the case-worker role has the same position as the camp employee. The authority role has access to the government information systems. Not every employee has permission to access such sensitive data. Hence, only government authorities can acquire fingerprints, access the Eurodac and the national AFIS system, retrieve data via the European Search Interface, or access the national asylum database. Moreover, it makes sense to provide the authority role with the permission to execute the pre-registration, access the mobile app, and track services. Lastly, the administrator role is permitted to give all read and write permissions to all users. Additionally, the administrator can generate and provide specific diagrams and statistics for the primary user. For security reasons, the administrator should not have access to all other use-cases.

The next use-case diagram defines all direct interactions between refugees and the system. Other roles such as NGO, camp employee, and authority are also included. The figure below describes all QR code scan scenarios. Hence, all interactions require a QR code bracelet and QR code scanner (mobile phone, webcam, or QR code reader), except for the deactivation of a bracelet. This last interaction can be done via the application without a QR code. The primary interaction is *Scan QR Code,* which includes several actions: pre-registration, entry/exit home protocol, control scans, bus assignments, limit checks, daily meal protocol, and bracelet deactivation. The refugee is indirectly involved in the QR code scans: an employee scans the refugee's QR code bracelet. The given interactions in the figure below are all executable via the mobile application. The QR code bracelet lifecycle begins with the first scan after the pre-registration. The camp employee is in charge of the pre-registration and the activation of new QR code bracelets. A new QR code ID will be stored in the local refugee management database (RMD) and associated with the bracelet. More data is also linked to this entry (more details in the next use-case diagram). The NGO role and the camp employee are in charge of controlling the essential services for refugees by scanning their bracelets before the meal distribution or bus assignment. Moreover, these two roles can record when a refugee enters or exits a home unit. Some authorities need this requirement for security and assurance reasons. Keeping track of meal consumption is essential to keep an overview of the food resources. Daily limits are also useful to control the maximum consumption and can be checked by the camp employee. The last interaction of the camp employee is the deactivation of the bracelets. The employee deactivates the bracelet by scanning the QR code or searching the QR code ID in the application.

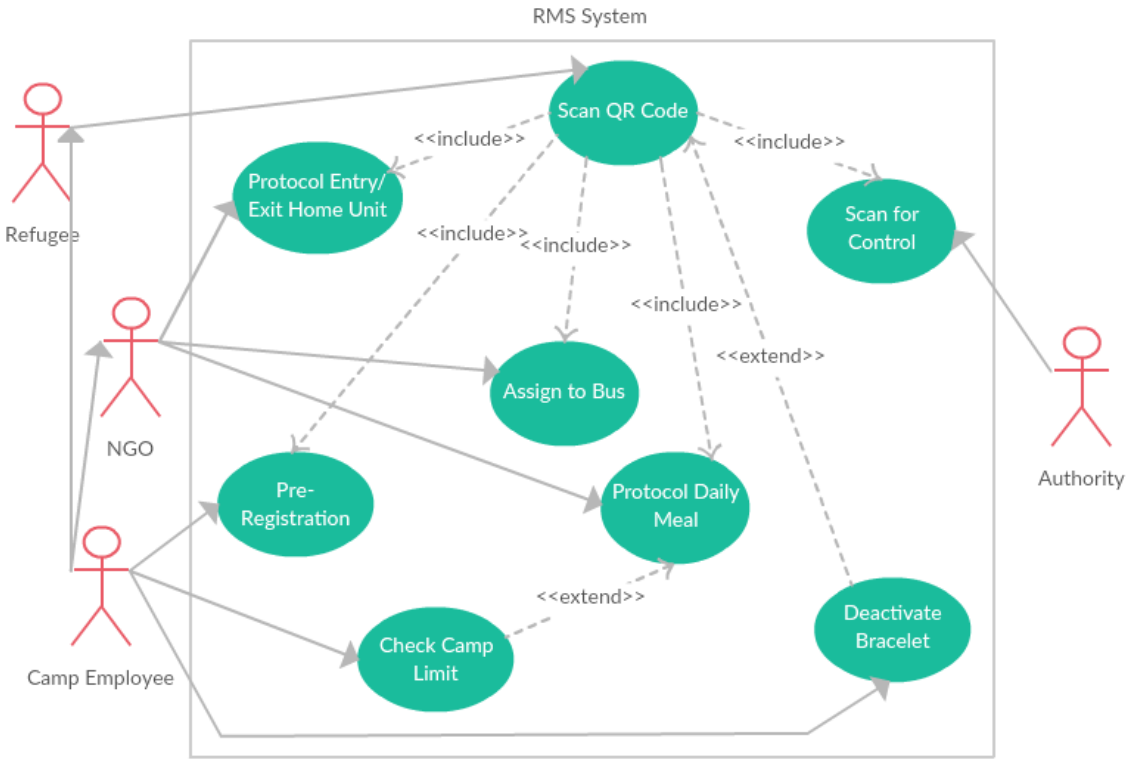


Figure 48: Use-case Diagram RMS Scan Services

Authorities are permitted to scan a QR code bracelet to keep an overview of the refugee camp inhabitants. In some cases, such as security issues or the loss of a family member, the possibility to check the personal information via the QR code is very useful.

The next use-case diagram (Figure 49) illustrates the main components of the pre-registration action. It includes the possibility of adding/editing a refugee's personal data, adding a picture for identification, scanning the ID document, and defining a responsible authority for an unaccompanied minor. These actions are done during the pre-registration step. As in the use-case before, the camp employee and the refugee role are involved. The pre-registration is essential for the entire RMS process and should only be executed by trained camp employees.

The Case-worker Information and Document Database, defined by requirement area R4, is illustrated in Figure 50. The role case-worker has access to the information database and can view vital information about a refugee's cultural background. When an ID document is missing, a case-worker must interrogate the refugee. In some cases, the police might have the suspicion that an ID document was falsified. Hence, the case-worker has to prove if the individual tells the truth. The use-case begins with the selection of a specific country. The information database provides standard information after selecting the country: the national flag, geographic information, main cities, spoken languages, religions, and ethnic groups. Additional information, such as political conflicts with other countries, is also listed. Furthermore, the user can preview official ID document templates for the comparison with a suspected document. This helps to identify particular characteristics in the document, which might reveal a possible forgery.

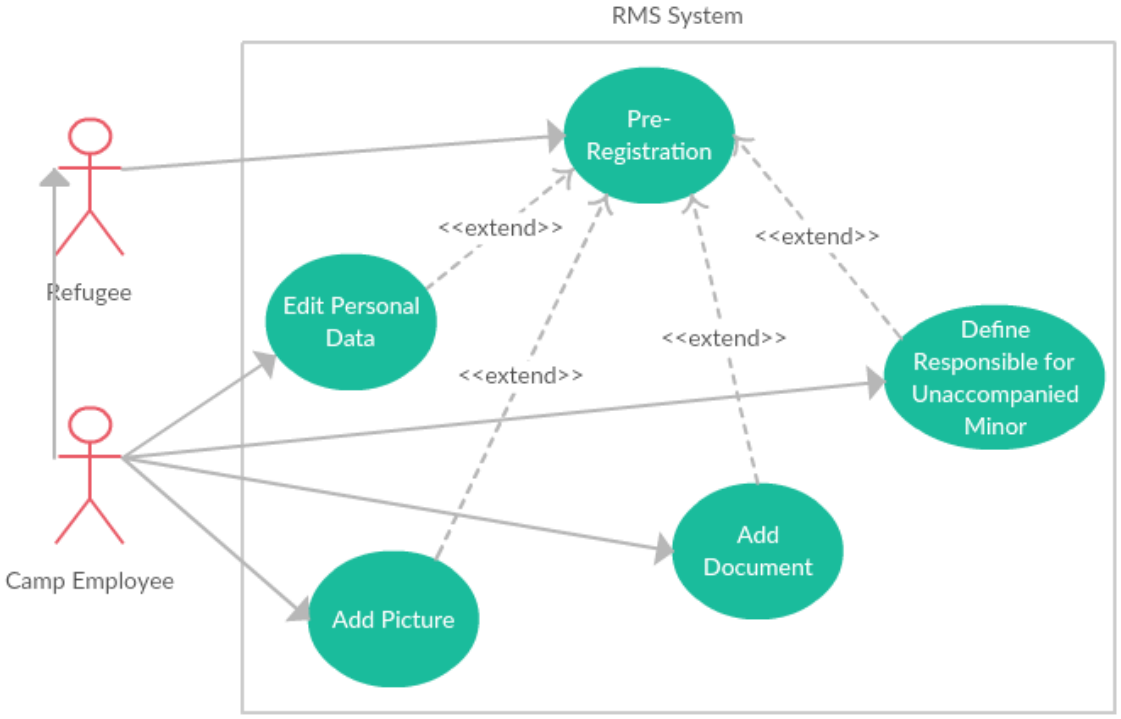


Figure 49: Use-case Diagram RMS Pre-Registration

This information can be in written form or illustrated by further document pictures with marked sections. If the user needs more detailed information about geographic relations within the country, it is possible to view a graphical map of the selected country.

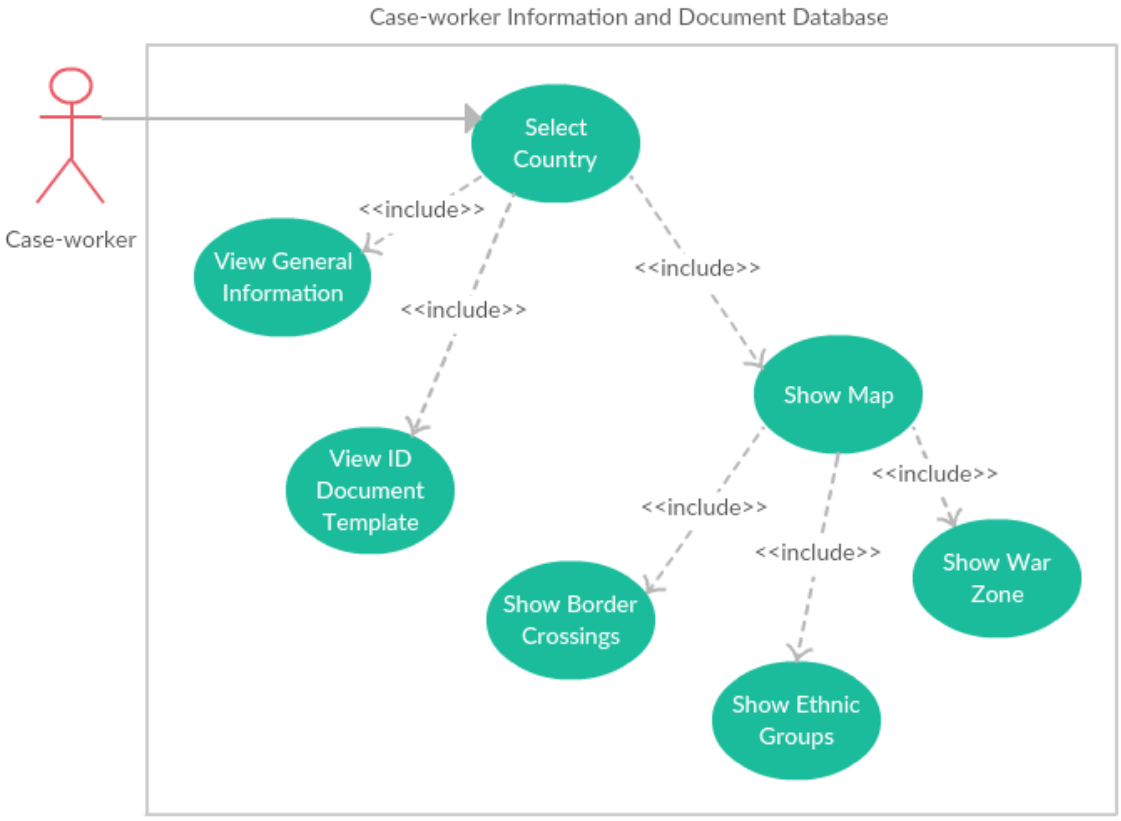


Figure 50: Use-case Diagram RMS Case-worker Information and Document Database

This map provides various information, such as the locations of official and unofficial border crossings, the allocation of ethnic groups in the country, and current war zones (if present). For instance, if a person mentions belonging to a specific ethnic group, but a different group populates the given address, then the case-worker can conclude that the information is correct or not. Moreover, the application provides details about currently known forgery methods that have often been applied in a specific country.

Next, the *Refugee Home Management System* (requirement area R12) provides essential functionality for the assignment of home units to refugees. The camp employee can search through all available persons that are stored in the refugee camp database. The information about whether a refugee is already assigned to a home unit is stored in the camp database. The search interface provides several filter possibilities: filter by a country, a religion, an ethnic group, persons with special medical needs, sex, and unaccompanied minors. If the persons were found, the employee could assign the entry to a specific home unit. The home units are listed in the application, including the information about the number of available beds. Moreover, the user can filter the home units list by a full-text search. In case the user needs more detailed information, the application provides a list of all persons living in a specific home unit. Sometimes it is crucial to distinguish between different ethnic groups or religious affiliations to ensure the safety of the refugee home unit inhabitants.

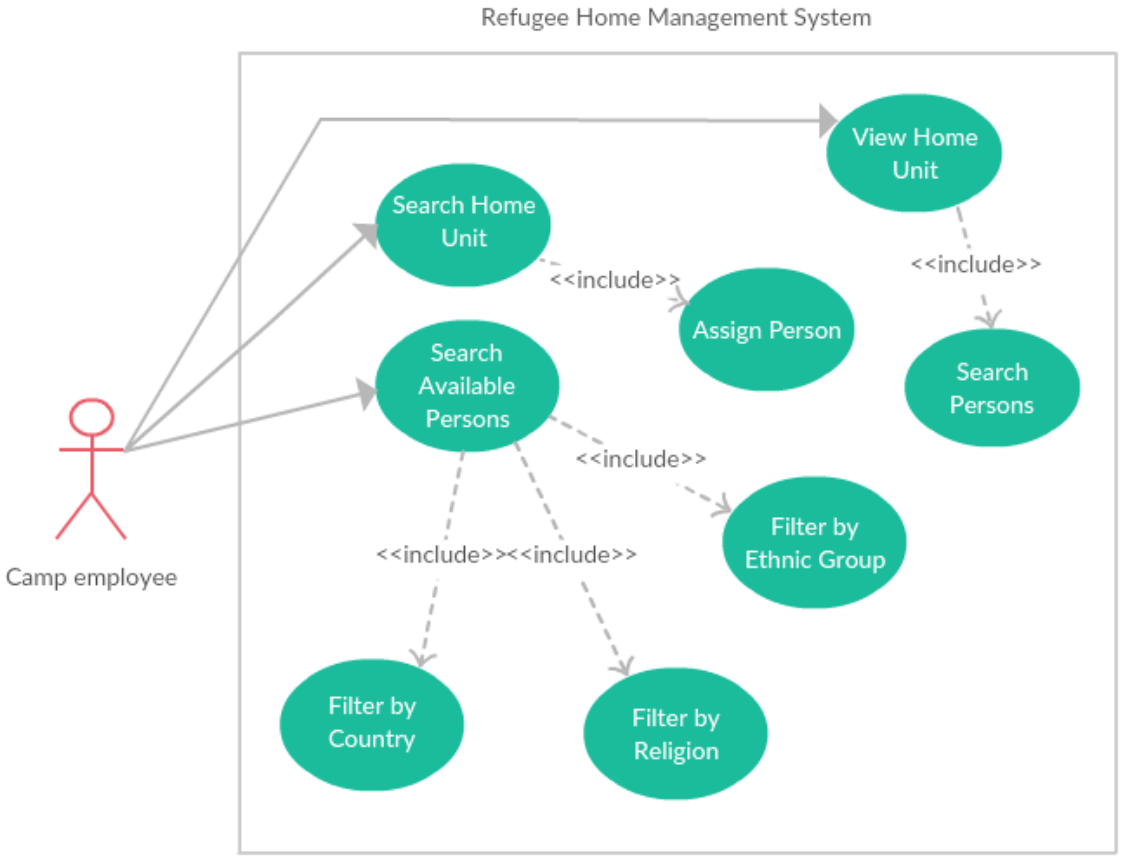


Figure 51: Use-case Diagram RMS Refugee Home Management System

User and Rights Management enables the configuration of the entire Refugee Management System. The administrator is permitted to manage all users, service providers, and camp limits. The permissions are already configured and must not be changed. The administrator can search for a specific person. A person can be added or edited. The surname, name, e-mail address, and phone number are the necessary information of each user. Moreover, every person must be assigned to a specific service provider (for instance, NGO1) and a particular permission group. Some users want to be informed when a camp limit was reached. This option can also be activated.

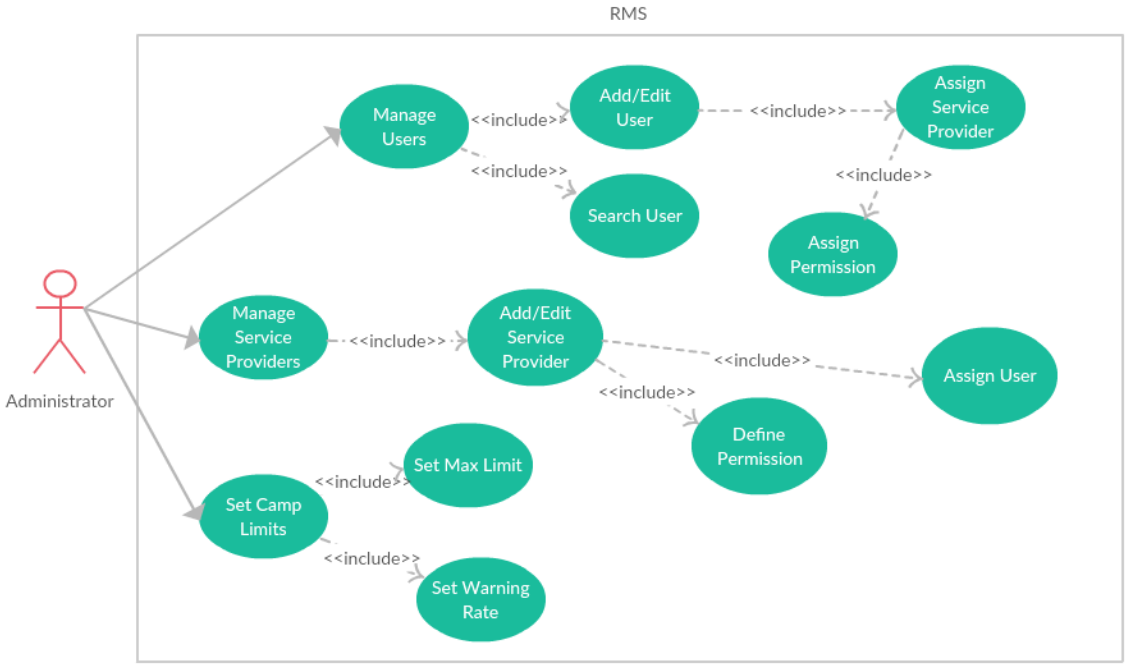


Figure 52: Use-case Diagram RMS User and Rights Management

The application will be used by different service providers, such as local police units, NGOs, and other government institutions. Hence, the administrator can add and edit service providers. Each service provider has a specific group of users, which can be added and removed. Specific permission groups can also be configured for a particular service provider. For instance, the NGO "Caritas" has the permission group "NGO," which has several pre-configured permissions such as "assign bed," "create transport," and so on. These permission groups are also available for the assignment of users.
Different daily limits can be set, depending on the configuration of the local refugee system. The RMS system uses three daily limits as an example: *Incoming Refugees*, *Asylum Requests,* and *Meal per Person*. The administrator can set the maximal number of a limit. For instance, four meals are allowed per person per day. Furthermore, the Incoming Refugee and the Asylum Request filter provide a percentage limit for sending warnings to configured users (via e-mail or SMS).

The last described use-case scenario illustrates the interactions between roles and the RMS system according to requirement area R14 (statistics and reports). Every refugee camp needs a comprehensive overview of all activities made in the refugee camp. This is important to be able to plan the correct amount of food or supplies. Hence, the administrator and the camp employee role have permission to generate and view specific statistics. Two main interactions exist: *View Bracelet List* and *View Scan Protocol*.

The user can search for a specific bracelet with different filter possibilities (bracelet ID, status, date intervals, camp user scan, and more). Unlike the camp employee, the administrator can import new bracelet IDs for the local RMS system. This enables better control of the scan of different QR code bracelets. Hence, the illegal use of a faked bracelet is not possible, as long it is not pre-configured in the RMS system.
Furthermore, the user can view a camp overview page containing a useful data scan table. The table should display essential scan numbers about the last days. Moreover, the user can view statistics that demonstrate the current daily limits and their maximal capacity.

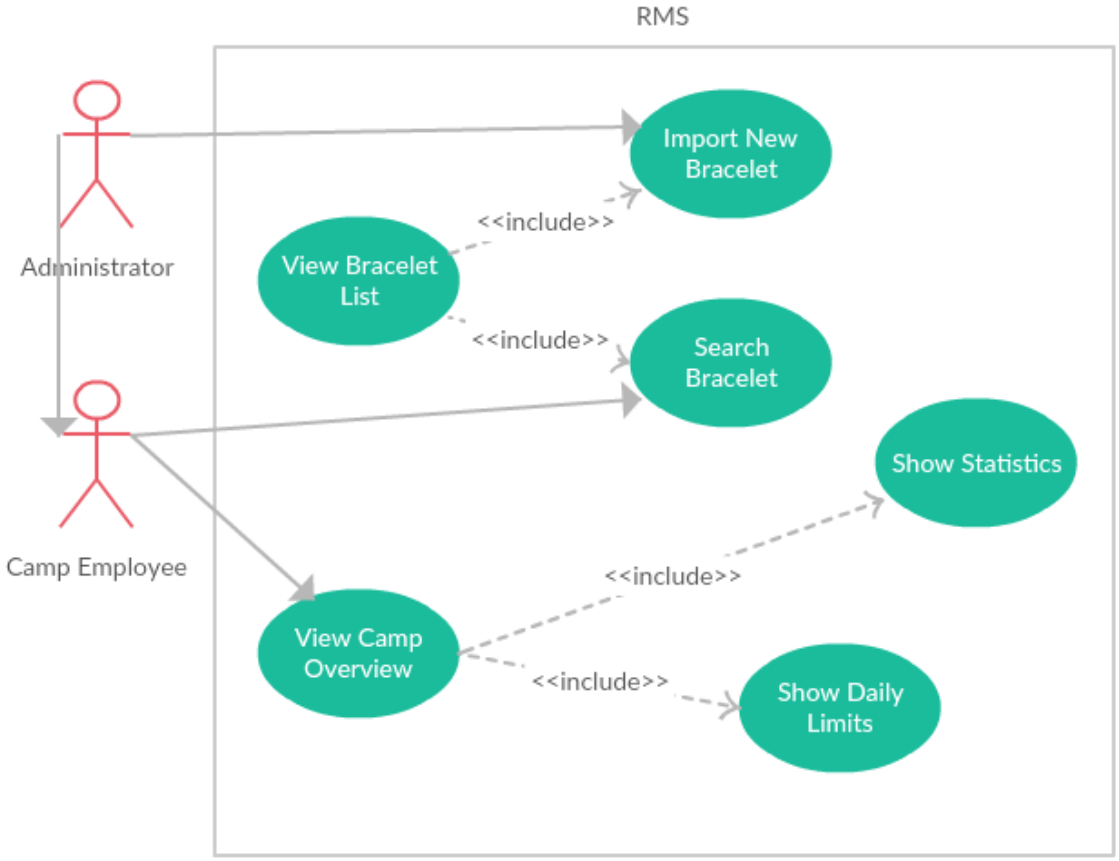


Figure 53: Use-case Diagram RMS Statistics and Reports

4.3.2 Mock-ups Web browser

This section presents the defined mock-ups for the RMS system as a low-fidelity prototype. Every mock-up is also described as a use-case diagram in *Section 4.3.1*. Due to lack of time, not every single use-case of RMS is illustrated as a mock-up (some are illustrated in Appendix).

The first mock-up demonstrates the main application with all provided capabilities that are selectable via the main user interface. Figure 54 displays the three main components of RMS: the *Top Header*, the *Navigation Menu,* and *Content*. The Top Header contains the current user information and the possibility of logout. The user is already logged-in in this scenario.

On the left, the Navigation Menu provides all functionality for working within a European refugee camp: *Scan*, *Person Administration*, *National Asylum DB*, *AFIS System*, *EU Search Portal*, *Case-Worker Database, Housing Unit*, *Reports,* and *Settings*. When clicking on one of the menu items, the corresponding content will be displayed within the center component. Some menu entries are collapsible and contain further sub-menu items. For instance, clicking on *Scan* enlarges the entire navigation menu and displays further scan actions, such as *Transport*, *Daily Meal*, and so forth. Hence, the user interface is simple and easy to use. The user has all the information in view and can quickly switch from one set of content to another. The menu entries are visible according to the permission set by the administrator. Hence, not every user is allowed to click on *Case-Worker Database* or *Housing Unit*. After successful log-in, RMS shows a welcome screen with an optional government logo.

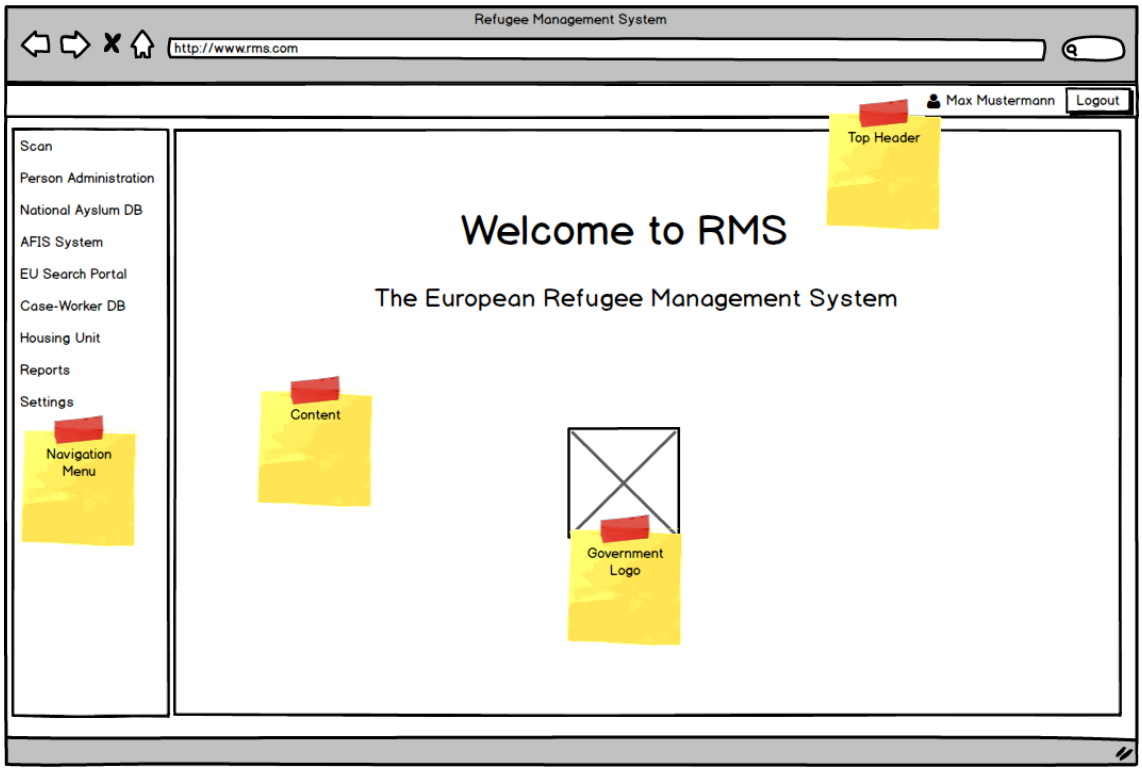


Figure 54: Mock-up RMS Main User-Interface

The next mock-up (R1) illustrates the scenario when a user clicks on the sub-menu entry *Pre-Registration*. On the left, all sub-menu entries of the menu entry *Scan* are listed. The chosen sub-menu entry is highlighted. When clicking on a menu entry, the content will be displayed in the center with a corresponding title (in this case, "Pre-Registration"). In the case of *Pre-Registration,* the content is composed of several sections: *Personal Information, Unaccompanied Minor, Special Information, Family Affiliation,* and *Identification.* The first section contains all relevant data such as *Surname*, *Name*, *Sex*, *Date of Birth*, *Place of Birth*, *Place of Residence*, *Nationality,* and *Religion*. This is the same personal data as requested in the "Foglio Notizie" of an Italian Hotspot (see *Section 3.1.1*). Different input types exist: traditional text input fields, dropdown fields with a given set of values, date pickers, and checkboxes.

The *Unaccompanied Minor* section is significant and should be selected if a minor arrives alone without parents or custodians. The user has to check the checkbox and add a responsible authority. When clicking on the *Person-Add* button on the right-hand side, a dialog window with a search interface appears. The interface provides all free persons for an Unaccompanied Minor assignment. The name of the selected person will appear in the section. The user is also able to delete the connection to the responsible person via the trash icon.
The section *Special Information* contains essential information such as the *Need for medical support.* It is crucial to define the reason for leaving the home country, for the entire registration procedure. In this case, the user can select between *Asylum*, *Refugee*, and *Work*. A checked *Asylum* checkbox means that the individual wants to apply for asylum in the current country. A checked *Refugee* checkbox means that the individual seeks international protection. On the other hand, a checked *Work* checkbox describes a standard scenario for applying for work authorization. The section can be modified at any time should more data be required (for instance, diabetes, pregnancy, and so on).

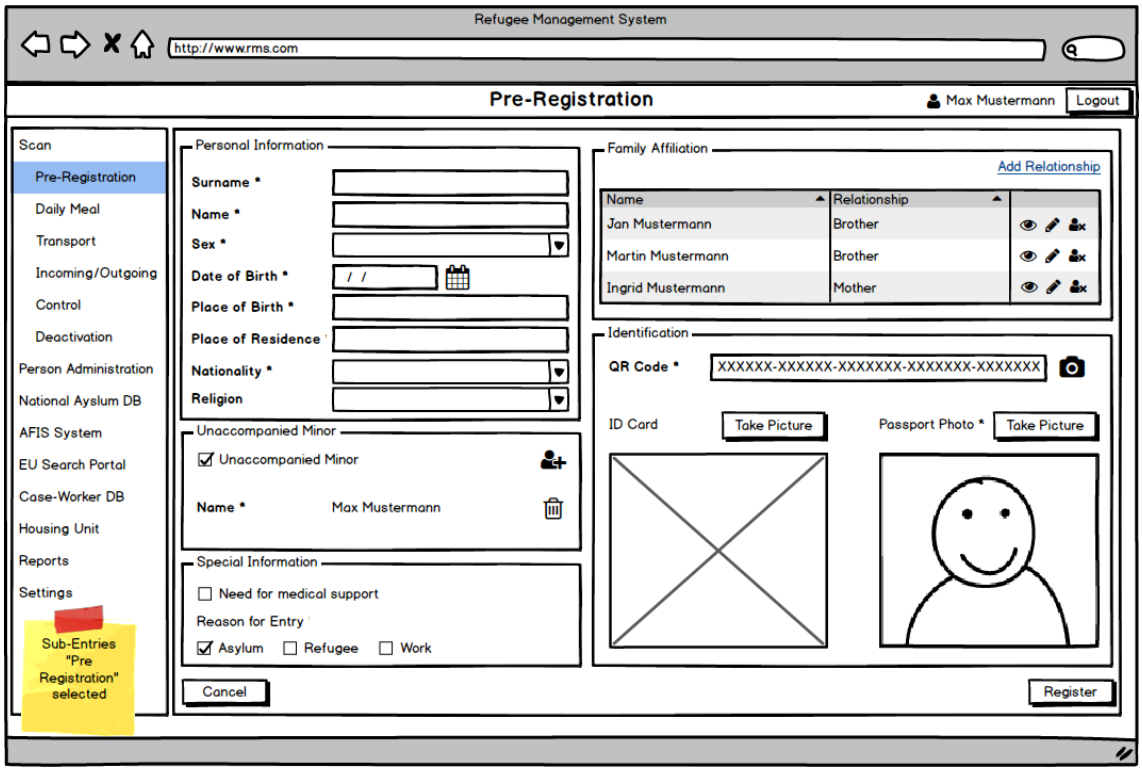


Figure 55: Mock-up RMS Pre-Registration

Family Affiliation is displayed on the right-hand side of the content and includes a list of all known family members. This helps to keep track of families within the refugee camp. By clicking on the link *Add Relationship,* a dialog window appears that contains a search interface of all known refugees in the RMD database. After selecting a specific person, the user can choose a given set of relationship types (brother, sister, mother, etc.). Every relationship can be deleted afterward via the *person-remove icon*. The user can also view or edit the person details of each family member by clicking on the *eye* icon or *pencil* icon. The last section *Identification* contains the relevant identification data about the QR code bracelet and the person. After scanning the QR code bracelet with a connected QR code reader or via a webcam (click on the camera icon), a unique QR code will be displayed in the input field *QR Code*.

In case a refugee has an identification document, the document can be photographed with the webcam (or if needed scanned by a scanner). The document picture will be displayed on the left-hand side of the *Identification* section. The user must take a photograph of the refugee via a webcam. The user can conclude the pre-registration process by clicking on the button *Register* when all required fields were filled out. The button *Cancel* below left provides the possibility to cancel the entire pre-registration step.

The next mock-up (R8) illustrates the user interface for the scan of a daily meal, control, or deactivation. The three actions differ only in the title and the additional information section. Therefore, one example is sufficient to understand the proposed user interface for all three actions. The user interface of all scan actions has the same structure: every action has a *Scan*, *Picture*, *Additional Information,* and *Status* section.

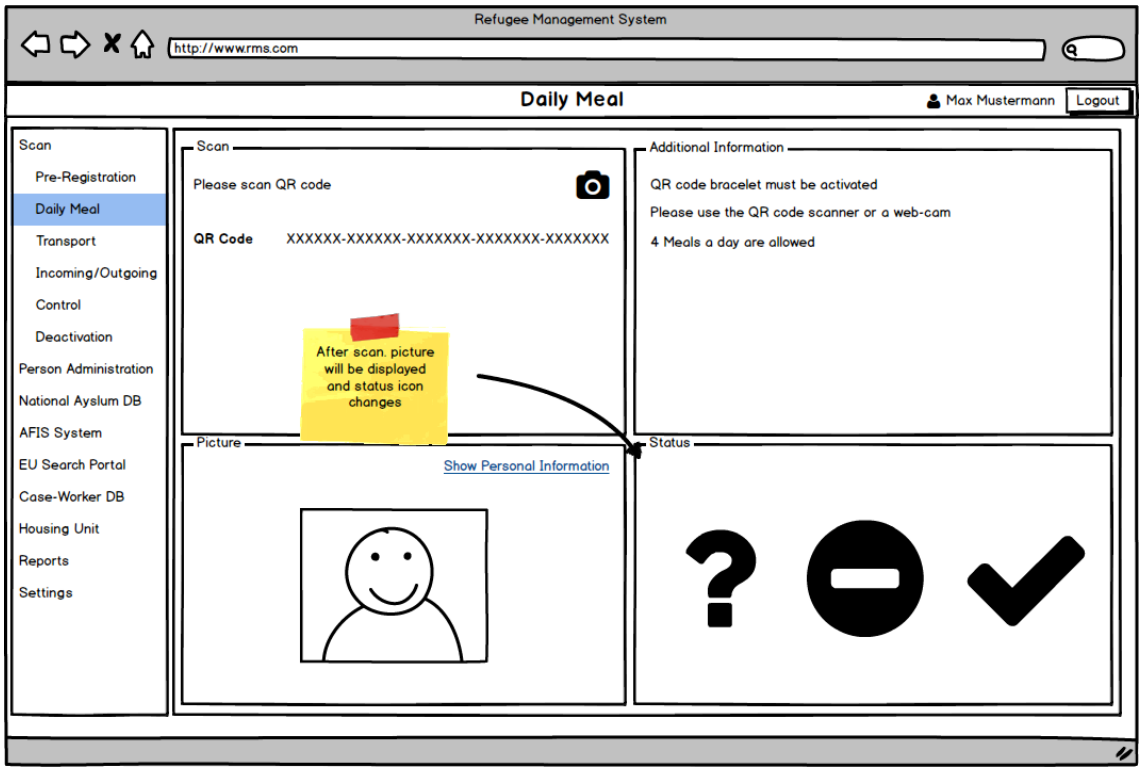


Figure 56: Mock-up RMS Daily Meal Scan

The actions *Daily Meal*, *Control,* and *Deactivation,* are the simplest ones. After clicking on one of these menu entries, the user must only scan the QR code with a QR code scanner or the webcam (by clicking on the camera icon). Immediately after a successful QR code scan, the QR code number will be displayed in the input field *QR code*. Moreover, the picture of the individual will be loaded and displayed on the left-hand side in the *Picture* section. Additionally, the link *Show Personal Information* opens a new tab, including the *Person* view (also accessible via the *Person Administration* menu entry). The status shows if the scan action was accepted by the system or not. Before the scan, the status displays a question mark. Depending on the system result, the status shows a prohibition sign or a check sign. The additional information on the top right can differ between the actions. In this case, the user will be notified that for the current refugee camp, four meals a day and per person is allowed.

The user interface for the *Transport scan* (R8/R11) provides further functionality. Figure 57 includes an additional section *Bus.* The user can create a new transport via the link. After clicking on it, a new dialog window appears, including two input fields *License Plate* and *Number of Seats*. After filling out the input fields and confirming the dialog window, the given value is displayed in the *Bus* section. The link *Show Passenger List* opens a new dialog window, including the list of all already scanned passengers. Any other transportation information can be added to the mock-up (for instance, transportation name, start, destination, due date). Depending on the circumstances in the refugee camp, new fields will be added. These mock-ups should demonstrate the standard case. Nevertheless, the created transport will be displayed as long as a new transport was created. That means the user can scan one passenger after another without changing the window. The other sections in the mock-up are the same and have the same behavior as the *Daily Meal* menu entry.

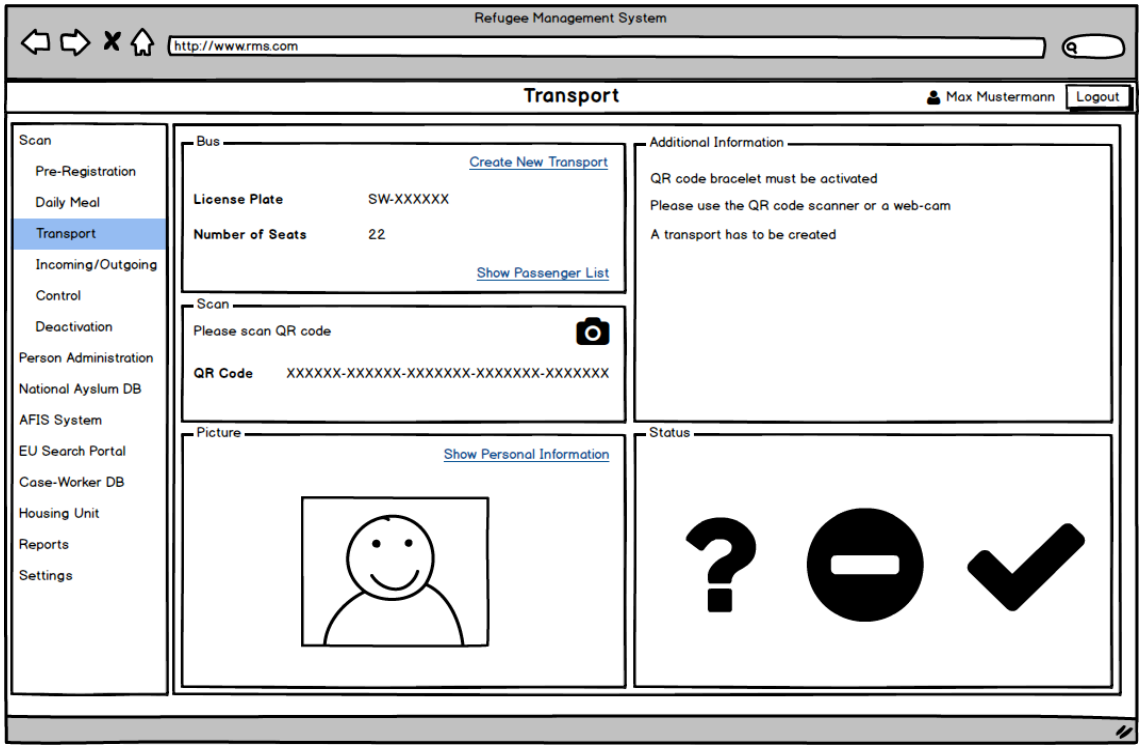


Figure 57: Mock-up RMS Transport Scan

The last mock-up (R8/R12) of the scan procedures is illustrated in Figure 58. This scanning procedure is used to protocol refugees when entering or leaving a specific housing unit. For instance, this could help to identify missing people. The user interface of the *Incoming/Outgoing* scan includes a *Housing Unit* section. The user has to select the corresponding housing unit listed in a drop-down table and choose between *Incoming* and *Outgoing*.

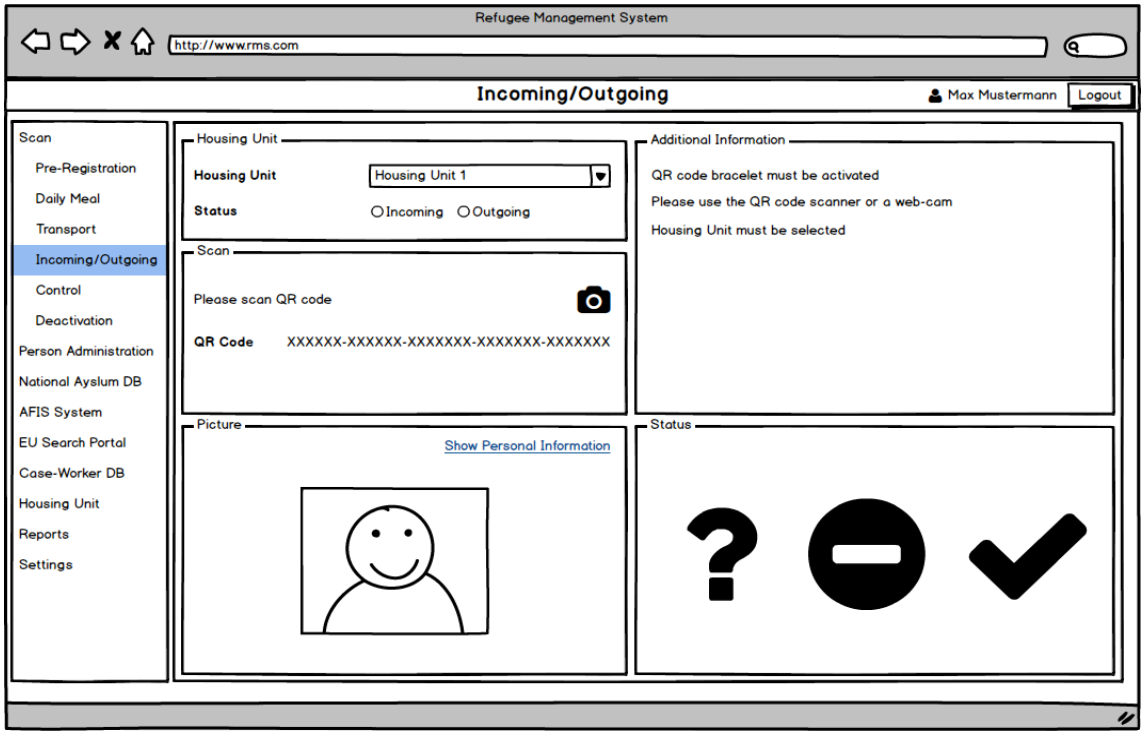


Figure 58: Mock-up RMS Incoming/Outgoing Scan

The next mock-up illustrates the *Housing Unit Administration* user interface (R12), which is accessible via the *Housing Unit* menu entry. This user interface includes three sections: *Housing Unit*, *Filter,* and *List*. The *Housing Unit* section includes the selection of a pre-configured housing unit in the current country. After choosing a housing unit, all relevant data about this center will be displayed. The field *Address* displays the current address information of the housing unit. *Available Beds* displays how many beds or places are still free (in this case, 25 of maximal 100 beds). The remaining fields display the e-mail address, phone number, and name of the person in charge of the housing unit. The link *Show Inhabitants List* opens a new dialog window, including a table with all already added persons in the housing unit. The link *Show Location in Map* opens a new dialog window that includes a map with the current location. The user can filter and search already registered persons on the right-hand side of the content view. The *Filter* section provides already known input fields for finding a specific person. The primary fields such as *Surname*, *Name*, *Sex*, *Date of Birth*, *Place of Birth*, *Place of Residence*, *Nationality,* and *Religion* already exist in the *Person Administration* view. Additionally, this view includes the checkbox *Include Inhabitants*. By selecting this checkbox, the search query also searches persons who already were added to the selected housing unit. In some cases, when an inhabitant has left or changed the housing unit, a user wants to remove the person association in the system. Moreover, the resulting list will be displayed in the section *List*, by clicking on the button *Search*.

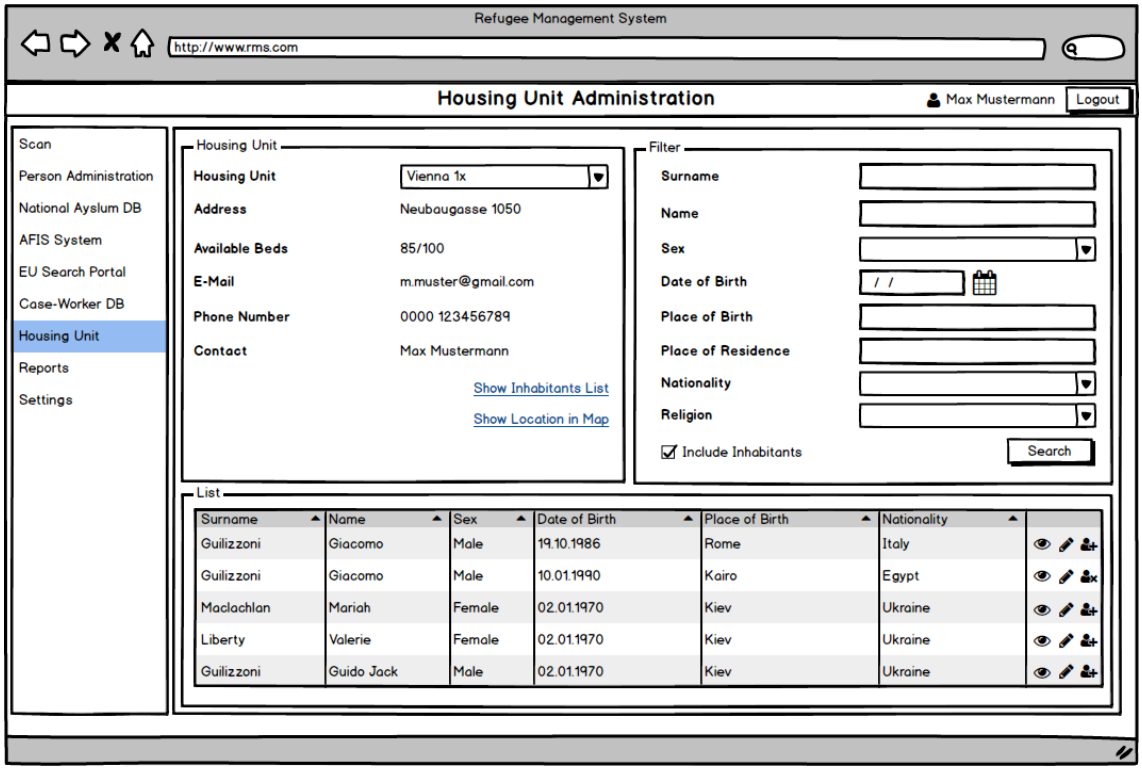


Figure 59: Mock-up RMS Housing Unit Administration

The list is the same as in the Person Administration view (see Appendix). It includes personal information and an additional column *Action*. The user can add or remove (if the checkbox *Include Inhabitants* was checked) a person from the housing unit by clicking the corresponding button. Moreover, it is possible to view or edit each person on the list by clicking on the pencil button.

The last menu entry *Settings* contains three user interfaces (R13): *User*, *Service Provider,* and *Daily Limits*. The user interface *Service Provider* (R9/R13) contains two sections (see the next figure): *List* and *Edit Service Provider*. The *List* section contains all existing service providers and displays them via a tree-list. Every service provider group can include another sub-group. A new service provider can be added by selecting an existing service provider group and clicking on the *plus* button. Instead, a click on the *trash* button deletes a service provider and all its containing sub-groups and users. The right section in the user interface will be displayed when a service provider was selected in the list (*View* mode), when a new service provider was added (*Add* mode) or when a service provider was edited (*Edit* mode). The mock-up in the figure above illustrates the *Edit* mode. Every display mode contains the same controls. The input fields *Name* and *Description* are mandatory. The name must be unique within a service provider group. Every service provider can configure the selection of a given set of rights.

The *Available Rights* tab contains a list of all rights and enables the selection and de-selection of each right for the selected service provider. The permission groups can be configured depending on the selected rights. The rights table contains a checkbox for activation and de-activation, a *Name,* and *Description* column.

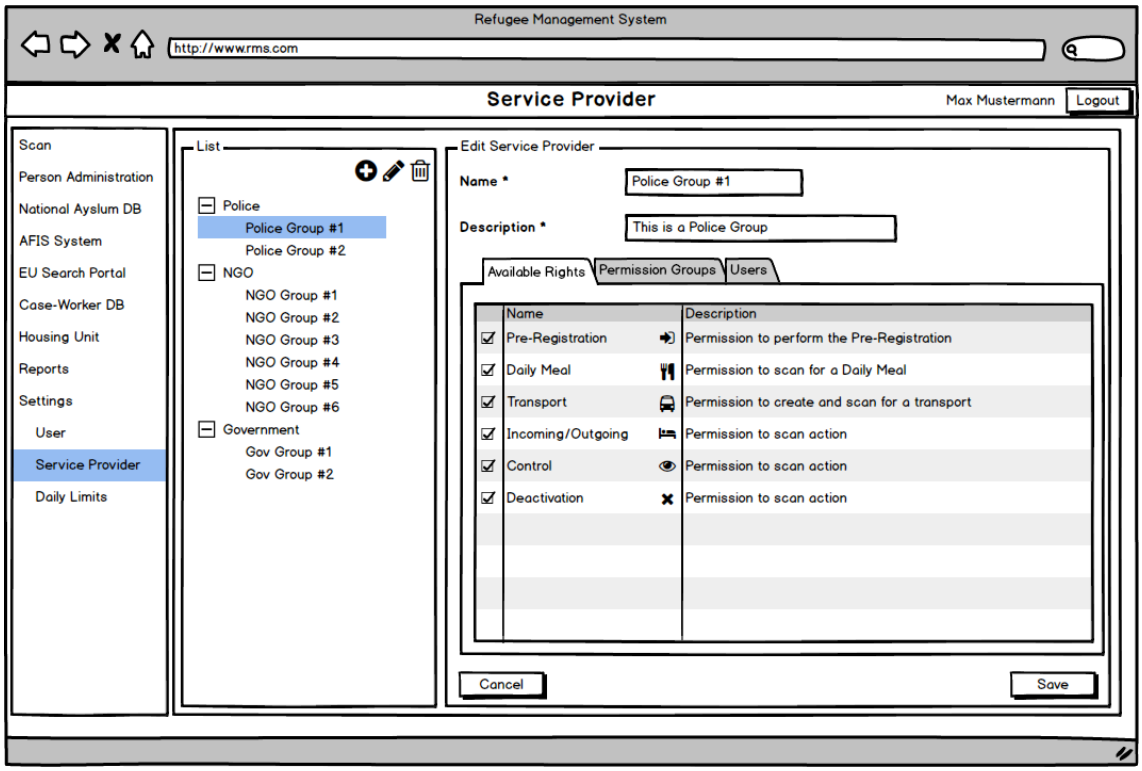


Figure 60: Mock-up RMS Settings Service Provider

If selected, every right has a unique icon that will be displayed in the permission group. In the current RMS version, six rights are defined: *Pre-Registration* (the user can register new refugees and scan their QR code bracelet), *Daily Meal* (the user can scan the QR code bracelet before the daily meal), *Transport* (the user can create new transports and assign persons), *Incoming/Outgoing* (the user can scan the QR code bracelets of incoming and outgoing persons), *Control* (the user can scan a QR code bracelet for security reasons), and *Deactivation* (the user can deactivate QR code bracelets). If needed, more rights can be added.

The last described mock-up illustrates the *Daily Limits* user interface (R14). It contains three daily limit settings:
The maximal number of registrations a day (*Registrations* section). The user can set the maximal number of registrations in the *Daily Limit* input field. Moreover, the user can define the maximal range for an SMS or e-mail notification by providing a percentage value in the *Warning Notification Limit* input field. In this case, when 96 registration of 120 (80%) were made in the current day, the notification service will trigger all notifications (SMS or e-mail) to the users. The administrator can activate or deactivate the SMS and e-mail notifications for every user in the *User* view (see Figure 113).

The next limit is the maximal number of asylum applications a day (*Asylum Requests* section). This section has the same input fields as the *Registration* section. The asylum request number increases when the refugee camp employee checks the *Asylum Request* checkbox in the *Pre-Registration* view (see Figure 55).

The third limit is the maximum number of daily meals per person (*Daily Meal* section). The user can define the maximal number of daily meals by filling out the *Daily Limit* input field. The refugee camp employee will be shown an error message during the QR code scan if the scanned person wants to receive the daily meal after already being scanned four times. This helps to keep track of the overall food consumption in the refugee camp.

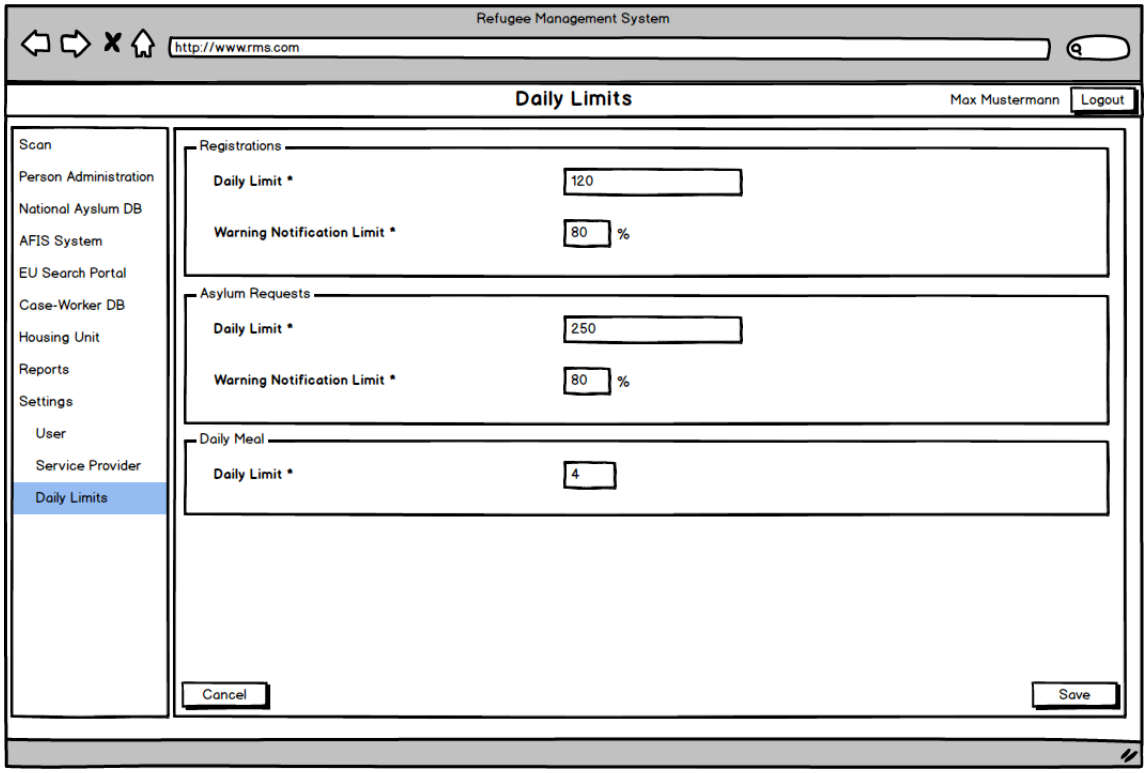


Figure 61: Mock-up RMS Settings Daily Limits

4.3.3 Mock-ups Mobile Phone

This section describes the mock-ups for the mobile application. Besides that, it has to be considered that the web browser version should be implemented with a responsive design. That means RMS application can dynamically adapt its content when the browser window is enlarged or miniaturized. Hence, users can access the standard application on their mobile phones without the need for a separate mobile app. Nevertheless, a mobile application is still defined in this thesis.

The mobile app includes a small set of basic RMS services (R7). The user can perform all scan actions using the app. Not every feature of the standard RMS application is included. The next figure shows three mock-ups.
The first illustrates the overview of the user interface after a successful login. The user can choose between the six scan menu entries: *Pre-Registration*, *Daily Meal*, *Incoming*/*Outgoing*, *Transport*, *Control,* and *Deactivation*. When the user taps the *Pre-Registration* option, the mobile app opens the QR code scan display. The user must scan a new QR code bracelet.

After the employee successfully scans a QR code that was not previously activated, the mobile app displays the basic *Pre-Registration* view. The view contains only the standard input fields *Surname*, *Name*, *Sex*, *Birthdate*, *Place of Birth*, *Place of Residence,* and *Nationality*. All fields are required because names can be identical and only be differentiated with the other input fields. Moreover, the user must specify the reason for the visit: *Asylum*, *Refugee*, and/or *Work*. All other elements of the standard *Pre-Registration* mock-up (see Figure 55) have to be updated afterward in the Person Administration view using a personal computer (see the next figure).

Moreover, the user must take a picture of the person. This can be done via the *Take Picture* icon. The picture will be displayed on the same spot as the icon. The picture can be updated by tapping on it again. The user should only use the mobile phone to scan and process persons very quickly and where no personal computer is available. For instance, if the number of people gathering in front of the center increases significantly, multiple pre-registrations can be performed by different employees using the mobile app.

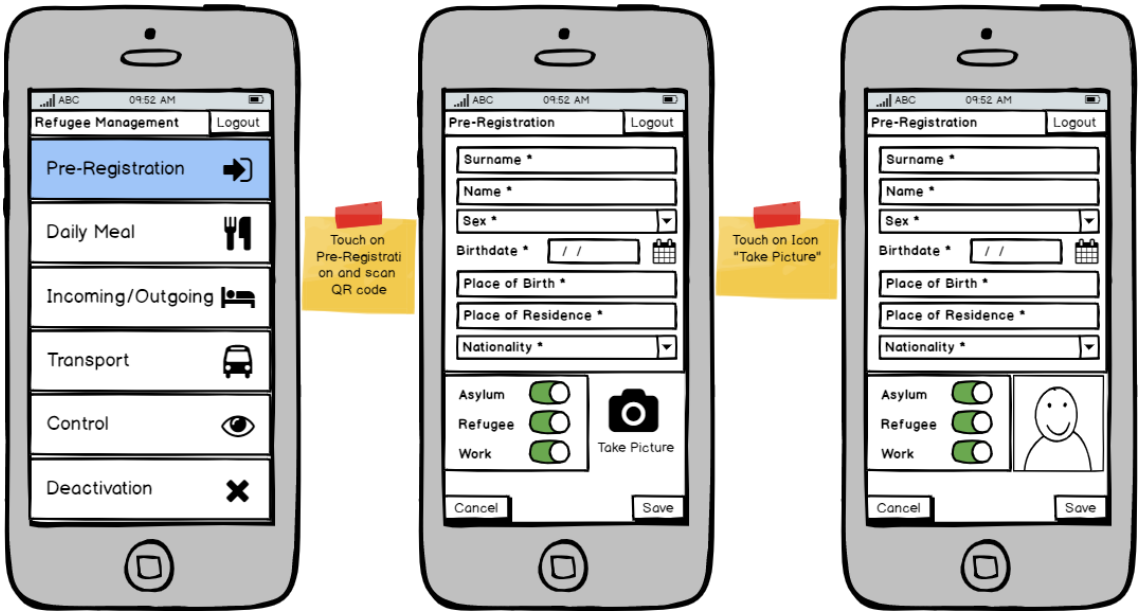


Figure 62: Mock-up RMS Mobile Pre-Registration

The refugee camp employees have to decide whether the use of the mobile phone is needed. The problem is that every pre-registration with the mobile phone concludes with a higher effort managing the *Personal Administration* view.

The next mock-up in Figure 63 illustrates the Daily Meal user interface. A QR code scan display appears immediately when the user taps on the *Daily Meal* menu item. The refugee camp employee scans the QR code bracelet. Immediately following the successful scan, the interface displays the identification picture, a personal data section, and the status of the scan transaction. The picture helps to identify if the person that wears the bracelet is the corresponding owner. The *Personal Information* section can be expanded and contains the most relevant information: *Surname*, *Name*, *Sex*, *Birthday*, *Place of Birth*, *Place of Residence,* and *Nationality*. The status is displayed in the same way as in the web browser version of RMS.

Figure 63 contains all three steps: the menu overview, the daily meal view with an unexpanded *Personal Information* section, and the *Daily Meal* view with expanded *Personal Information* section. The *Back* button allows the user to return to the main menu view.

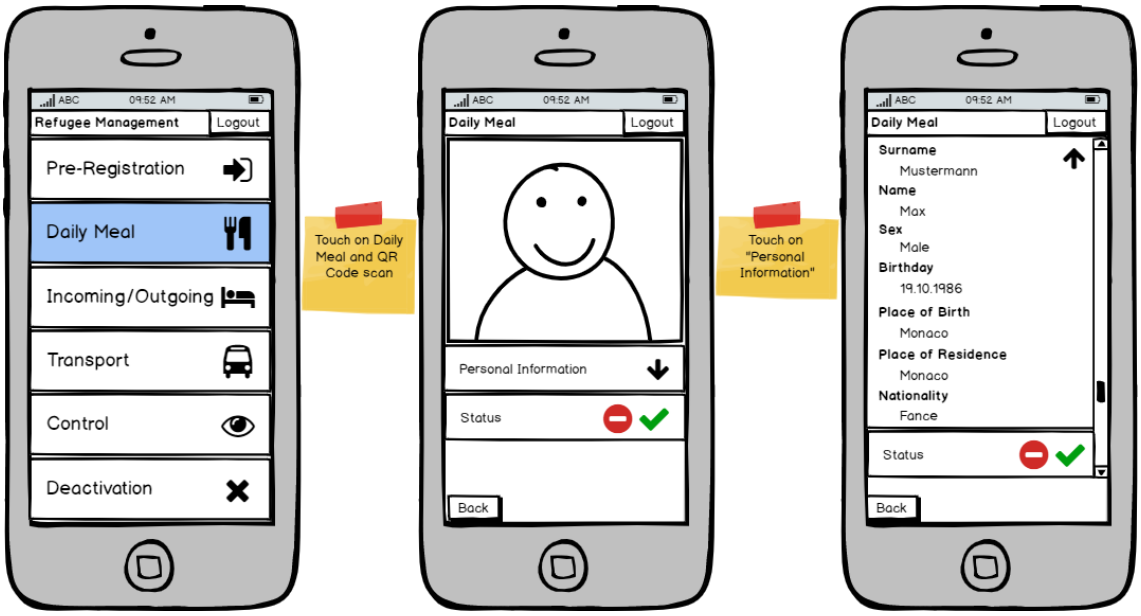


Figure 63: Mock-up RMS Mobile Daily Meal

The next mock-up illustrates the *Incoming/Outgoing* scan option. In this case, the user taps on the menu entry *Incoming/Outgoing* and is shown a new user interface containing the dropdown selection of the corresponding housing unit and a toggle button for an incoming or outgoing scan. If the *Incoming* toggle button is activated, it means the person wants to access the housing unit. If the toggle button is deactivated, it means the person wants to leave the building or area. After tapping the scan button, the user must scan the QR code, and the response view appears. It is the same as described for *Daily Meal*.

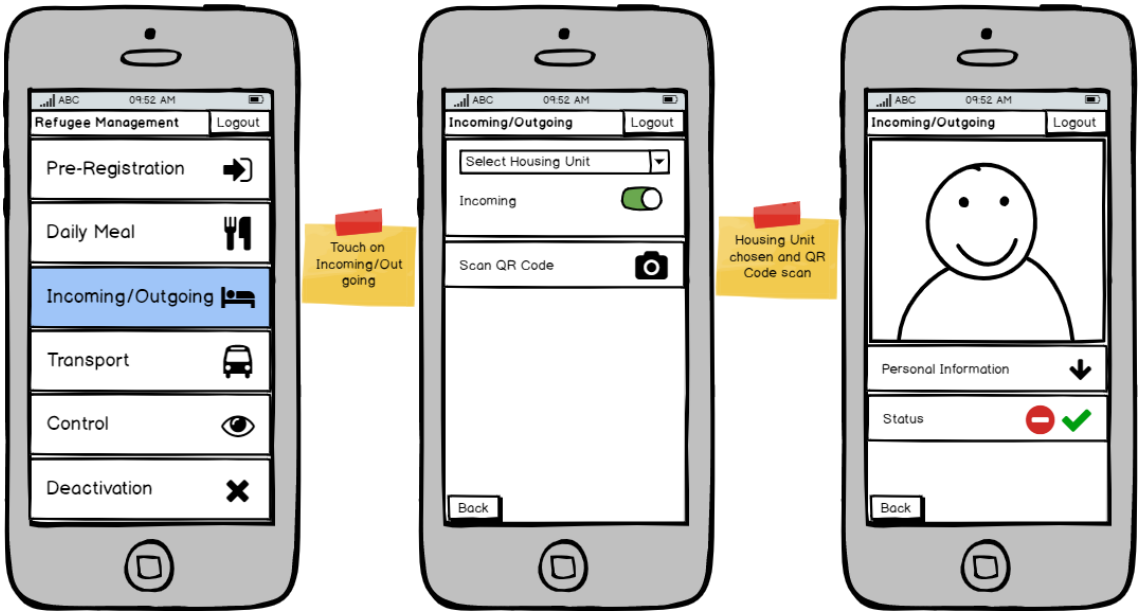


Figure 64: Mock-up RMS Mobile Incoming/Outgoing

Figure 65 contains the mock-up for the transport scan action. The user taps on the *Transport* menu entry and is shown the *Transport* view providing the current vehicle information. It is the same information as in the web browser version of RMS. The difference here is that the user is not able to create a new transport. This is because creating a new transport via the mobile phone may confuse the refugee camp employees. Only one active transport instance is available and should be deleted or created by the current user in charge. Hence, this view has only read-only input fields (*License Plate* and *Number of Seats*). Nevertheless, the user must tap on the scan button and is shown the result view after a successful QR code scan.

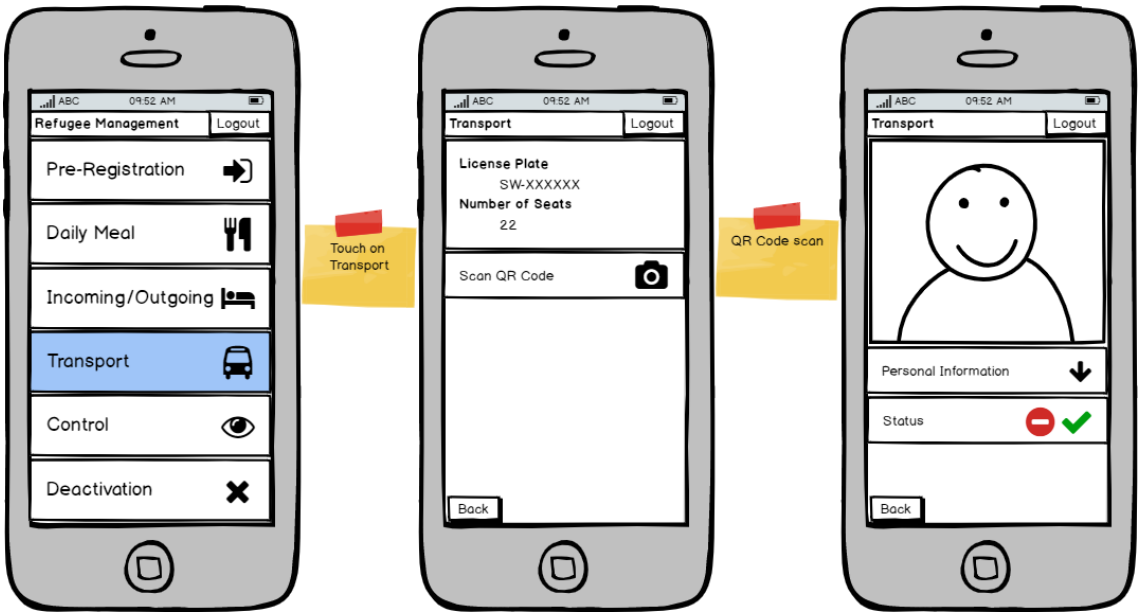


Figure 65: Mock-up RMS Mobile Transport

4.4 Stage IV: Mock-up Evaluation

This section contains the evaluation of the produced mock-ups of *Section 4.3.2*. The author held interviews with a set of experts in user interface design and refugee management systems. The interview partners were project leaders, user interface designers, and software developers of four Austrian software and research companies (in total, five interview partners). The next table lists the five interview partners for the mock-up evaluation step.

Table 9: Interview Partner Mock-up Evaluation

ID	*Description*	*Position*
P9	Austrian Research and Software Company	Project leader "Refugee Registration"
P10	Austrian Research and Software Company	GUI Designer "Refugee Registration"
P11	Technology Company for Austrian Social Insurances	Software Developer
P12	Austrian Consulting Company	Senior Consultant and Mock-up Designer
P13	Austrian IT Company	Senior Consultant for Operational Processes

The author showed each interview partner all mock-ups of *Section 4.3.2*. The interview partner gave valuable information about the implementation and practicability of the proposed user interfaces. The author decided to keep the number of interview partners low due to the high discrepancies that occur when people try to describe if a user interface is well-designed or not. The author conducted the interviews in oral form by showing the designed user interfaces. The interview partners commented on each user interface according to their practical and scientific experience. Afterward, the suggestions were summarized and applied in the mock-ups. This section describes the results of the interviews and the adaptation of some mock-ups. The final mock-up set serves as a basic structure for the high-fidelity prototype described in the next stage section.

4.4.1 Pre-Registration View Updates

The interviews with all interview partners (P9-P13) revealed some modifications for the *Pre-Registration* View. The next figure illustrates the updated view. The external applications *National Asylum DB*, *ESP* (European Search Portal), and *AFIS* (Automated Fingerprint Information System) can be accessed via the links in the *Personal Information* section. The links open a new tab that is convenient for comparing the local data and external information. Furthermore, only the *Surname* and *Name* are required. This is important because not everyone wants to give all personal information to the refugee camp employee during the pre-registration step. Someone might not know his/her birthday or place of birth.

The interviews with the refugee camp system experts (P9 and P10) led to the conclusion that the lack of information could be very high during the registration. For this reason, the birthday will no longer be edited by a date picker but with three separate input fields. The *remove* icon in the *Unaccompanied Minor* section was replaced with the same icon as in *Family Affiliation* (due to better usability).

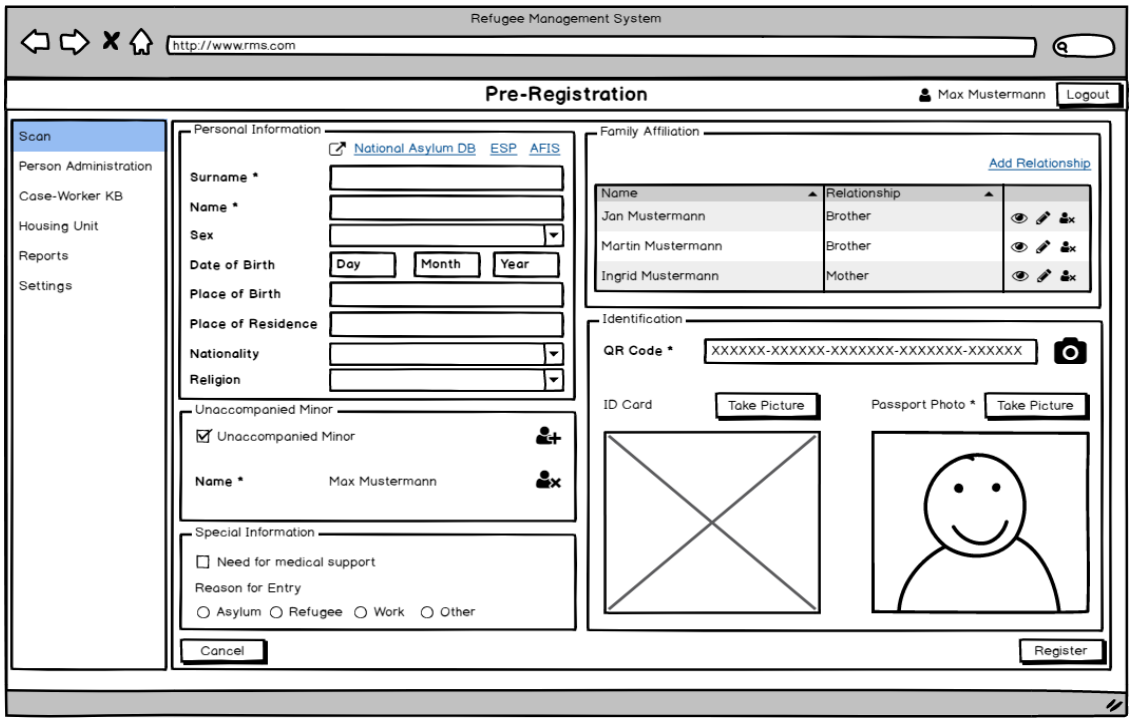


Figure 66: Mock-up RMS Pre-Registration V.2

The checkboxes in the *Special Information* section were replace with radio buttons. A person wants to apply for either asylum, request international protection, or request permission to work. A combination of the reasons for entry makes no sense. A fourth reason was also added: *Other*. This is helpful when someone does not want to specify the reason at that moment. A success or failure notification will be shown when the user clicks on "Register." In case the registration was successful, all input fields and settings will be erased in the view. Hence, the employee can register the next person immediately. Nevertheless, it has to be considered that personal information such as sex or nationality is a crucial detail for assigning a corresponding housing unit. Not every group can be put together into one room, according to their nationality or religion. Some groups might have intense political or cultural conflicts with each other.

4.4.2 Common Updates

The next figure shows the updated home screen interface after a user has successfully logged in. The interviews with P10 and P12 led to the conclusion that a welcome screen is not essential and can be dropped (Figure 54 shows the old version with the welcome-screen). Instead, the user will be immediately redirected to the *Scan Overview* screen, because the scanning of QR codes will be the main task of every employee in the refugee camp. Moreover, a click on the menu item *Scan* will also show the *Scan Overview*.

This overview is a new content containing large icons with labels of each possible scan action. Hence, the user can click very quickly and intuitively on one of the needed icons. The menu navigation changed: for instance, a click on Scan displays the Scan Overview and selects the menu entry, as illustrated in Figure 67.

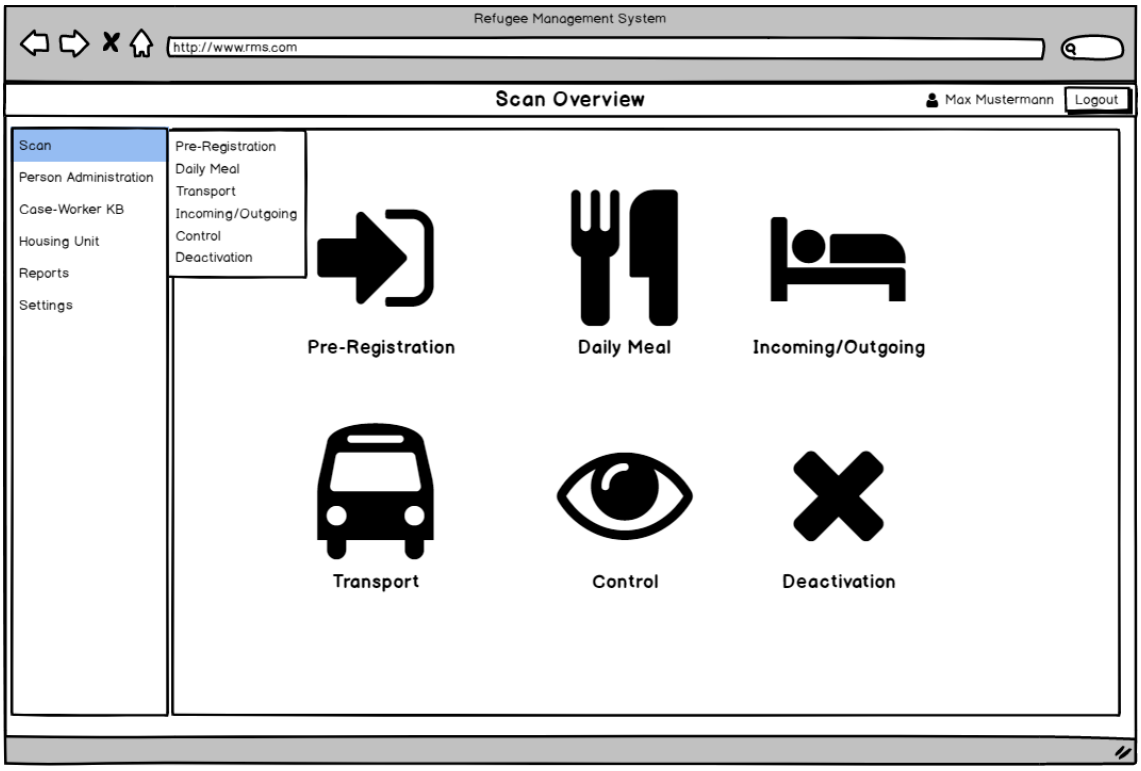


Figure 67: Mock-up RMS Main User Interface V.2

A drop-down selection appears when hovering over the main menu entry. The drop-down selection includes the already described sub-menu entries. The navigation menu will not be expanded anymore due to usability reasons. The menu content also changed: the menu entries *National Asylum DB*, *AFIS System,* and *EU Search Portal* were removed. These three features are only accessible by a small set of users. The access to the external application is essential when editing personal information in the *Person Administration menu*. Therefore, they are included in the *Person Administration* view. If possible, the National Asylum DB will be included in the view as a button (*Sync with National DB* button). The other two external applications are too comprehensive to include in the RMS application and will be removed externally in a new tab. The advantage is that the user can compare values more efficiently between the local and external data. Including the two applications as an iframe within the RMS application could cause visibility problems. The menu entry *Case-Worker DB* received a new name: *Case-Worker KB* (Knowledge-Base). The term “database” confused some interview partners. They suggested using the definition “Knowledge-Base” to emphasize the purpose of this view.

4.4.3 Scan View Updates

The scan view of *Daily Meal*, *Transport*, *Incoming/Outgoing, Control*, and *Deactivation* will show an error message when an error occurs (information obtained by P9, P10, and P13). This is illustrated in the next mock-up. The figure shows the updated *Transport Scan,* including the error message ("Passenger already added!") and more information regarding the seat occupation. The input field *Seats* also shows the current occupancy of the bus. The new field *Departure Date* helps the user to identify the correct transportation instance. In some cases, a vehicle makes more than one transportation a day, so it helps to read the current departure date.

Figure 68: Mock-up RMS Transport Scan V.2

Furthermore, the Deactivation Scan view (see the next figure) contains a text area for adding the reason for deactivation. A dropdown with pre-configured options can also be helpful for government authorities. The interviews revealed that some authorities need information about why a bracelet was deactivated. This helps create reports about how many persons left the refugee camp due to a successful asylum request. The following options will be added: *Asylum application requested*, *Person lost/missing*, *Person back to origin*, *Person relocated to another country*, and *Other*. The text area is only enabled and required when the user chooses the option *Other.*

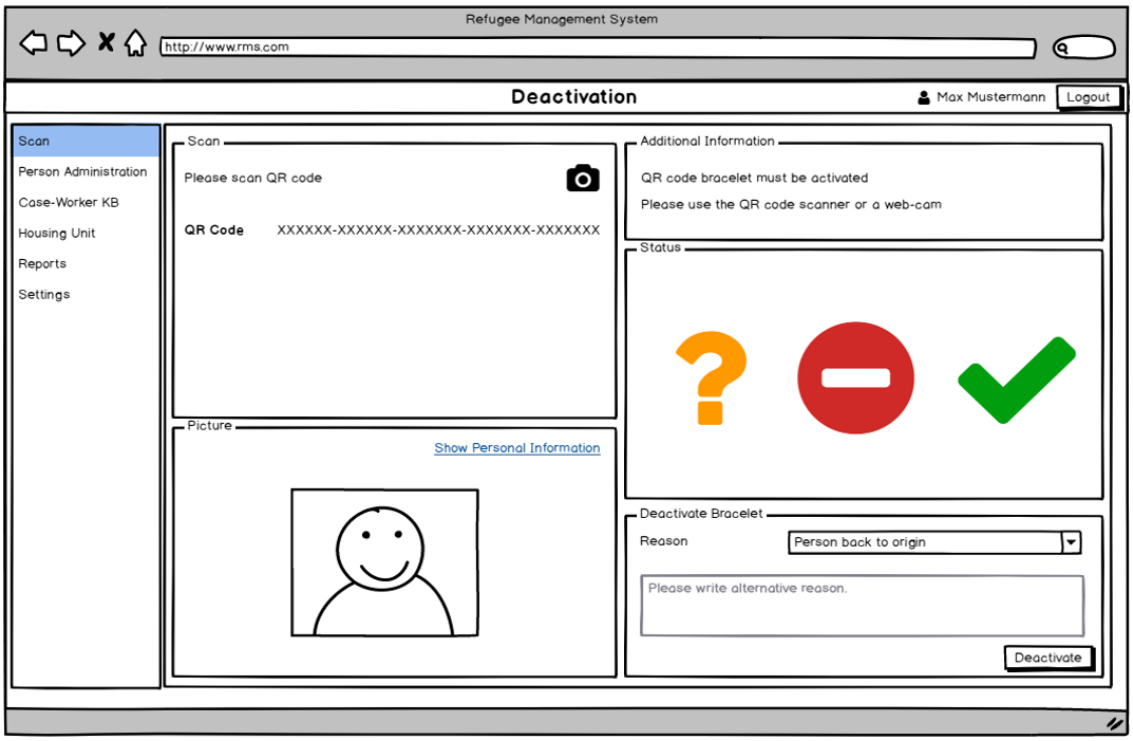


Figure 69: Mock-up Deactivation Scan V.2

4.4.4 Housing Unit View Updates

All interview partners proposed some adaptations for the *Housing Unit View*. The figure below illustrates a new structure with additional sections: *Housing Unit* and *Selection*. In this new concept, the user begins by searching and selecting persons of a specific country or religion. These two properties are fundamental because the refugee camp employee must consider any cultural issues between particular ethnic groups. The filter options were reduced because the user only wants to find a sleeping place for a group of persons or one person. A result list with a *group* and *single human* icons appear after clicking on the button *Search.* Every group icon provides a number that represents the size of a family. The user can see more details when hovering with the mouse over the icon. A tooltip containing the list of the persons with personal information appears.
The interview partner mentioned that a fast and intuitive user interface is needed for managing the housing unit distribution. Hence, the user should be able to drag and drop the icons to the *Housing Unit* section on a specific housing unit. This action adds the persons on the right-hand side in the *Selection* section. The *Housing Unit* section contains all housing units without drop-down selection.

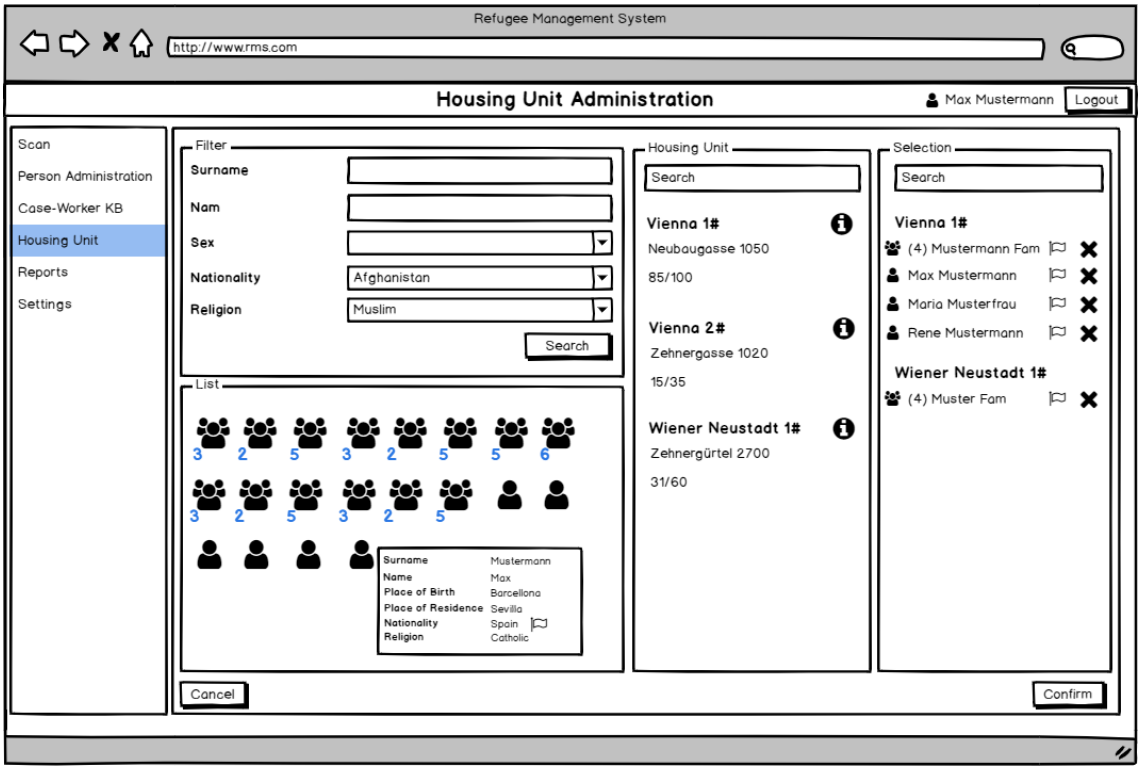


Figure 70: Mock-up Housing Unit V.2

Every house name is listed in bold format. The address and the current capacity are also recorded. The user has to click on the *information* icon to show more information such as the current inhabitants list and contact details. The information icon opens a dialog. The *Search* input field in the *Housing Unit* and *Selection* section filters the current values in the sections. The *Selection* section includes all selected persons and groups. Every item can be removed via the *cross* icon. The country of origin flag is always displayed to the right of the name. The button *Cancel* cancels the current selection, and the button *Confirm* applies the current selection.

4.4.5 Mobile App Updates

This last section of the mock-up evaluation contains the adaptations of the mobile application. The information was given by the interview partner P9, P10, and P13. The next figure illustrates the updated pre-registration view. The mandatory input fields were reduced to two: *Surname* and *Name*. Moreover, the reason for entry is now selectable via a radio button group, including a new entry *Other*. These are the same adaptations as the *Pre-Registration* view for the web application mode. An interview partner mentioned that a pre-registration via the mobile application should be flagged as “Entry not complete”. The problem is that persons that were registered very quickly via the mobile phone have to be found afterward, and the missing data must be filled in.

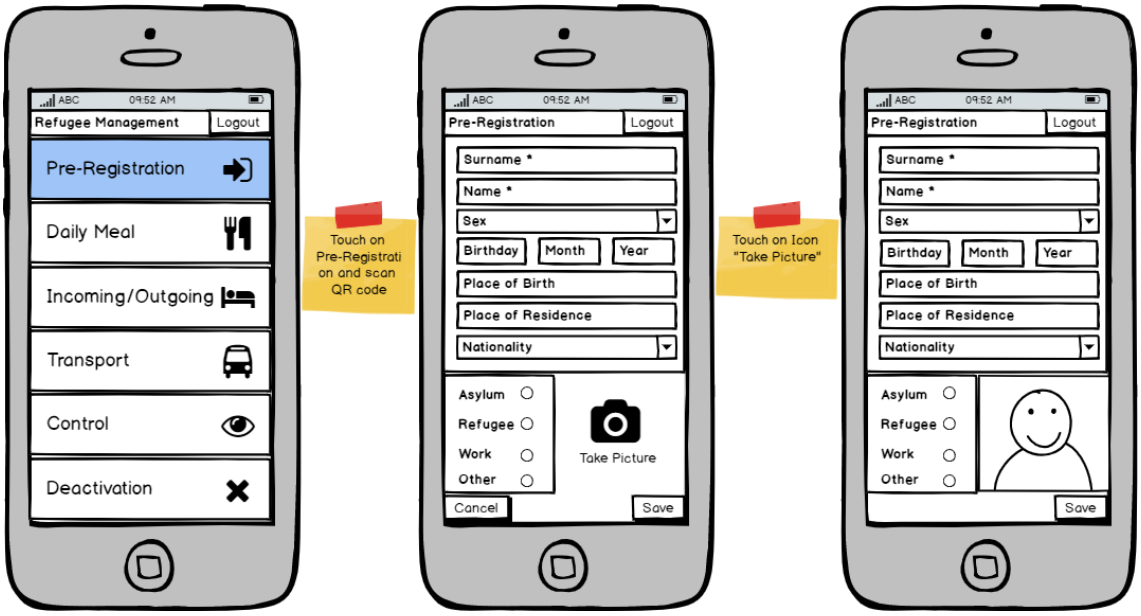


Figure 71: Mock-up RMS Mobile Pre-Registration V.2

Figure 72 shows the updated *Incoming/Outgoing* mobile view. As seen in the picture, the toggle button is replaced with two radio buttons, *Incoming* and *Outgoing*. Furthermore, all scan actions have an additional info message in the *Status* section. The user needs information about why something went wrong.

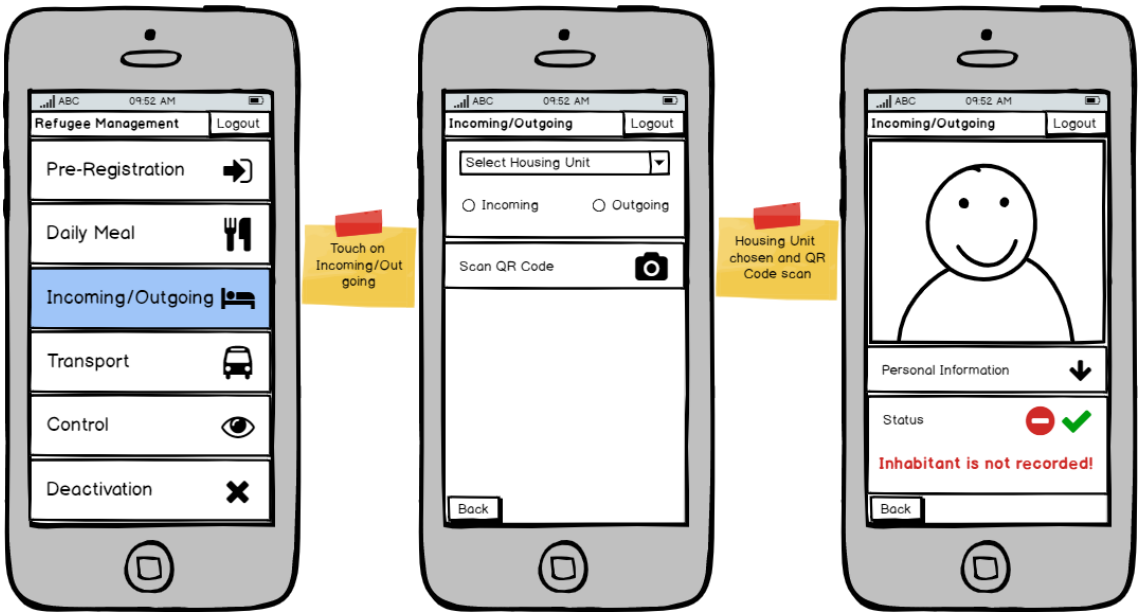


Figure 72: Mock-up RMS Mobile Incoming/Outgoing V.2

4.5 Stage V: High-Fidelity Prototype

This section presents the high-fidelity prototype that was designed and implemented based on *Section 4.4*. The user interface of the application was implemented following the guidelines of the mock-ups. Nevertheless, some adaptations and changes were made due to implementation or design obstacles.
The prototype should apply to any refugee registration center in Europe, but due to a lack of time and resources, some features were not finished. Such a comprehensive application with the features specified in this thesis requires a lot of time and resources. The author decided to pick the essential features which do not need any involvement of a government authority. The implementation of the missing components will be taken into consideration for future work (some figures are listed in the Appendix). Some features, such as the integration of external systems, have to be done in a real-world scenario. The mobile application was partly implemented with the aid of responsive design. That means that the content appearance dynamically adapts to the width when minimizing and maximizing the browser. The implementation of the mobile application (as mentioned in the mock-ups of *Section 4.4.5*) will also be considered for future work.

Furthermore, the application of GDPR was not taken into account in the first instance. The use of GDPR and LED in refugee camps can be very confusing. The LED is applicable in the law enforcement context, whenever a police officer (or other competent authorities) processes personal data for law enforcement purposes. The scope of the LED and the GDPR can be very blurred in the area of migration. For example, in the Member States, where an illegal entry is a criminal offense, police officers could process personal data of the person who entered the country illegally within the scope of the LED. However, once the person applies for asylum, the GDPR must be taken into account. Hence, the author decided to implement functionality such as the anonymization of personal data and manage access according to GDPR for future work.
The system was implemented with *Python*[28], *JavaScript*[29], and *JQuery*[30] and is composed of a backend and frontend module. Every requirement area can be activated and deactivated. As mentioned in *Section 4.1.3*, not every refugee camp needs all features. The high-fidelity-prototype currently uses a local *PostgreSQL*[31] database for storing and loading data. *NodeJs*[32] is used to deploy and start the application. Moreover, the prototype supports the use of QR codes with a QR code scanner or a webcam.

4.5.1 Introduction

The application is called *Refugee Management System (RMS)* and is accessible via a web browser with an internet connection. The user, which was already registered by an administrator, can access the application via the login window.

[28] https://www.python.org
[29] https://www.javascript.com
[30] https://jquery.com
[31] https://www.postgresql.org
[32] https://nodejs.org/en

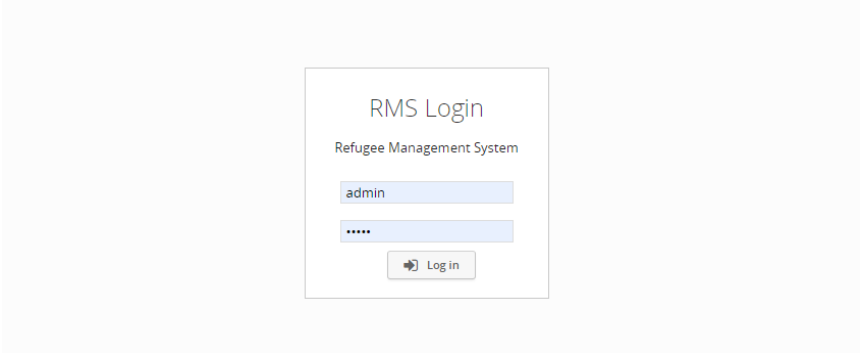


Figure 73: Prototype Login Window

The user has to type the correct username and password. After a successful login, the startup page will be opened. All capabilities are loaded depending on the permission level of the current user. The next screenshot illustrates the application: the header, the menu, and on the right-hand side the content area. Every page is based on the mock-ups of the previous sections. The top header contains the title of the current content area, a user settings button, the picture and the name of the current user, and the *Log out* button. The menu contains all features; the *Scan*, *Reports,* and *Settings* entries have additional sub-menu entries. For instance, when selecting the menu entry *Reports*, a sub-panel appears containing *Overview* and *Bracelet List*. The first content area that is displayed to the user, is the *Scan Overview*. This is essential because these features define the main tasks in a refugee camp.

The entire application works with QR code bracelets. These QR codes have to be imported before using them for one of the scan features. Pre-Registration is not possible when the QR code was not yet imported into the application. The import can be done via a *Windows Excel File,* including the official QR codes for the refugee camp. This file can be uploaded via the *Reports* > *Bracelet List* menu entry.

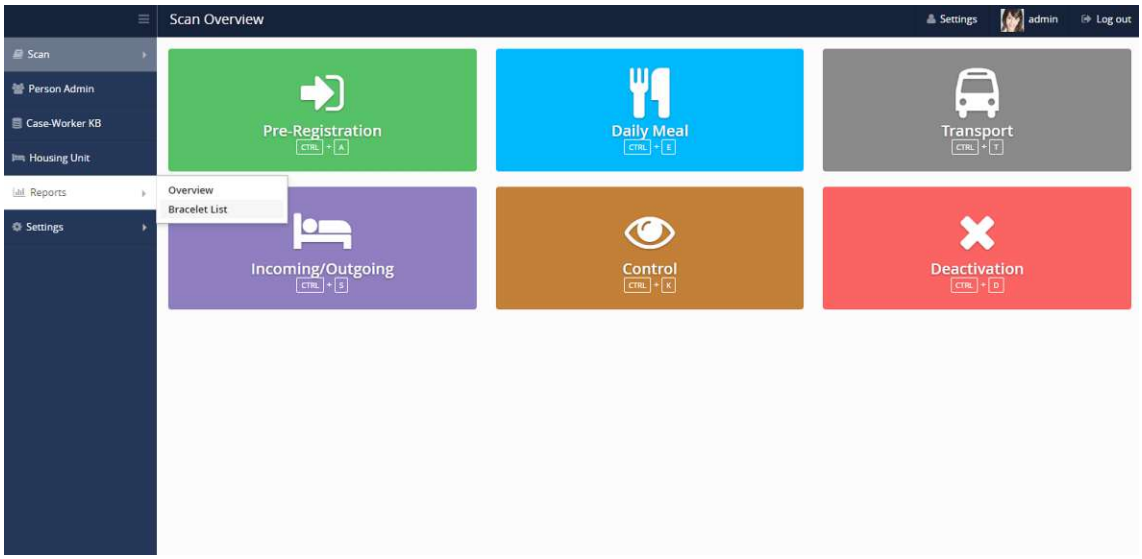


Figure 74: Prototype Welcome Screen

The QR codes used for this prototype were printed out as bracelets and can be easily applied. Nevertheless, a QR code can be printed anywhere. Depending on the financial situation, the demand, the environment, and the acceptance of the refugees, QR codes could also be printed on identification cards and badges.
Figure 100 (*Appendix*) shows some bracelets used for this prototype and a QR code scanner. The scanner can scan every QR code; the application triggers the scanner request and executes the demanded service (for instance, scan for transport). In addition the QR code scanner, the user can also use a webcam.

4.5.2 Scan Features

The scan features are critical services that are needed within the refugee camp for daily work. Hence, the scan features are displayed front-and-center on the *Welcome* page. As shown in Figure 74, the scan options are displayed in large tiles with different colors and icons. This helps to be able to choose the correct function very quickly. The less time needed to execute the correct action in a refugee camp, the smaller the queues are. The first scan action is *Pre-Registration*. The next figure illustrates the content area with the selected *Pre-Registration* action.

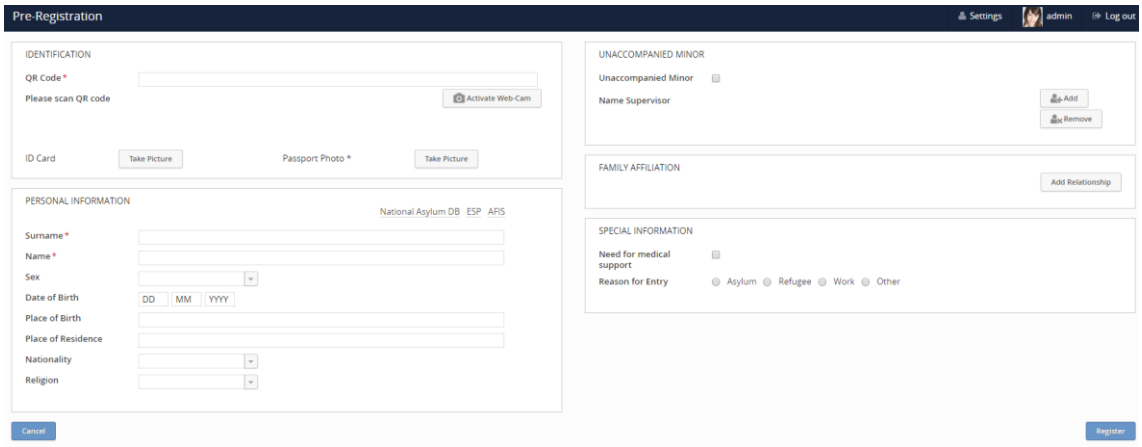


Figure 75: Prototype Pre-Registration

Furthermore, the user can now use a QR code scanner or activate the webcam. This version of the *Pre-Registration* has another arrangement of the panels. *Identification* is now the first panel because the user has to scan the QR code in the first place. Afterward, all other fields and options can be filled out or selected. The pictures of an identification card or passport can be done via the *Identification* panel.

The next figure illustrates the user interface with a scanned QR code, and some filled out data. The author uses only dummy icons to display the photographs of the identification card and the passport. In this example, the refugee was defined as an unaccompanied minor.

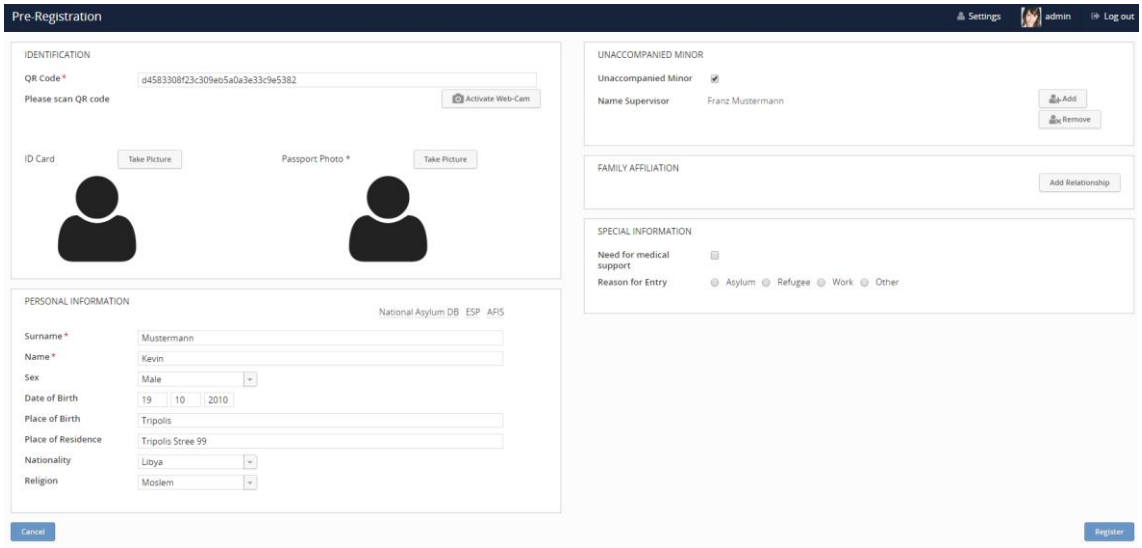


Figure 76: Prototype Pre-Registration Filled

In case the employee wants to select a person as a family member, a dialog appears. This is illustrated in the next figure. It makes sense to add a search within the dialog, but this will be considered for future work. The user can select between already registered persons in the dialog and select a specific relationship type.

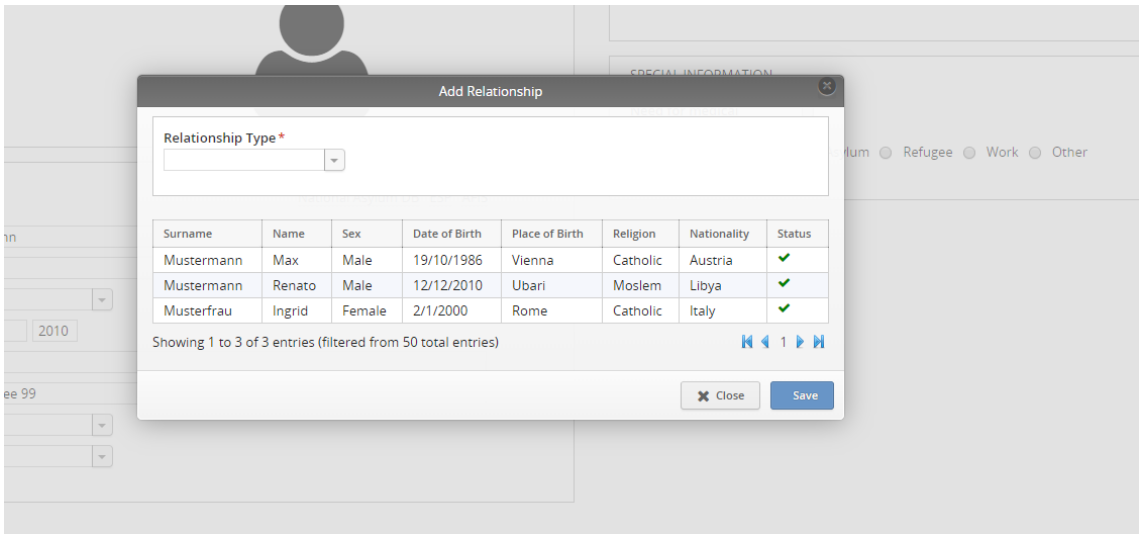


Figure 77: Prototype Pre-Registration Family Member Selection

Next, the scan for the daily meal is illustrated in the next screenshot. Before a QR code is scanned, the user interface shows the pending state (question mark icon on the right-hand side). Again, the user now has the possibility to scan with a QR code scanner or the webcam.

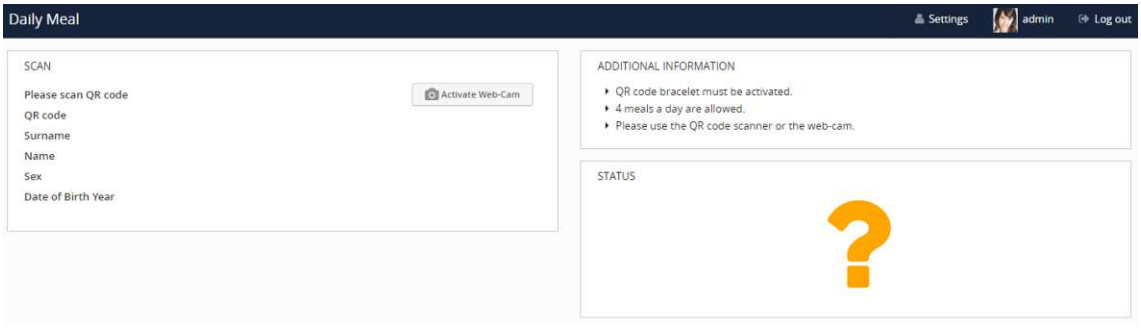


Figure 78: Prototype Scan Daily Meal

After scanning the QR code successfully, personal data is displayed on the left-hand side. The *Identification* panel will also be displayed, including the picture of the current scanned person and the *Show Personal Information* button. This button redirects to the detail page of the person. The detail page shows all data that was entered during the Pre-Registration step. Additionally, the scan protocol history is also displayed on the person detail page. If no boundaries or limits were exceeded, the icon changes to a green tick. Otherwise, the icon changes to a red cross and shows the error notification to the user. In case the daily meal scan exceeds the daily limit, the user can still accept the scan. Sometimes it makes sense to grant a person one more meal than the configured daily meal limit.

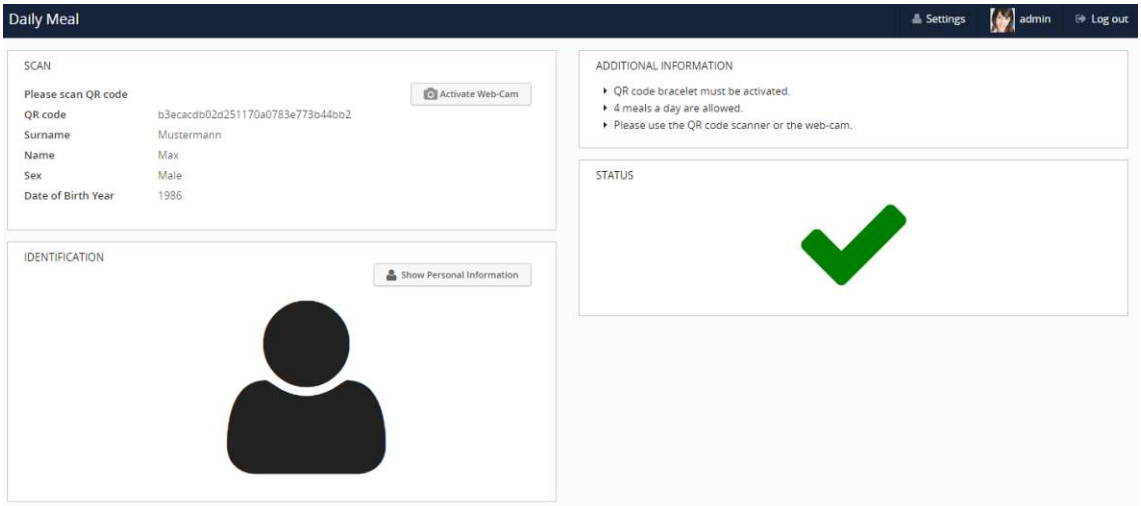


Figure 79: Prototype Scan Daily Meal Success

The *Transport* scan works in the same manner as the *Daily Meal* scan. It provides the creation of the current bus transport, including the maximum number of seats, departure date, and license plate. Also, it is possible to display the current passenger list as dialog. The dialog also provides the functionality to remove a person from the bus transport. A person cannot be scanned twice to the same bus transport. Furthermore, the seat limit cannot be exceeded. The user can create a new bus transport event in the user interface, in case persons have to be transported to another place.

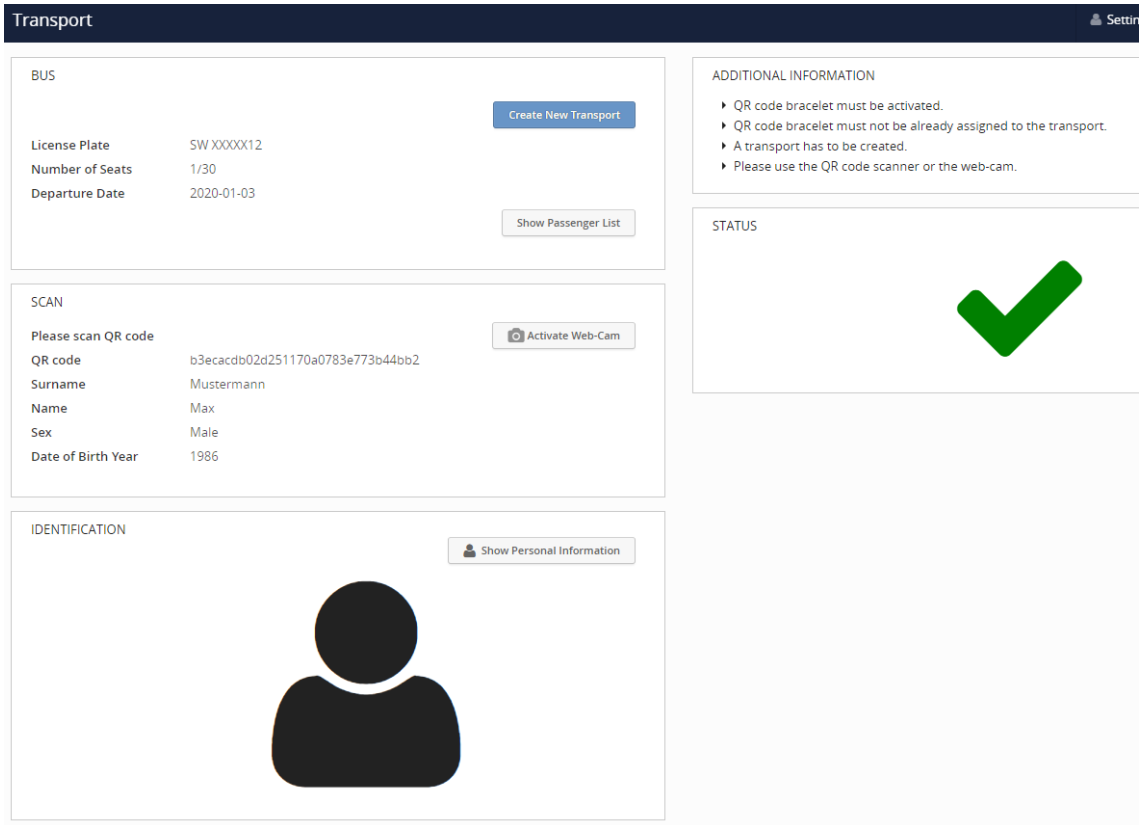


Figure 80: Prototype Scan Transport

It should be considered that for large refugee camps, the ability to add multiple bus transport instances at the same time may be desirable. In the current prototype, however, only one bus transport instance at a time can be created.
The next scan option enables the logging of incoming and outgoing persons for a housing unit.

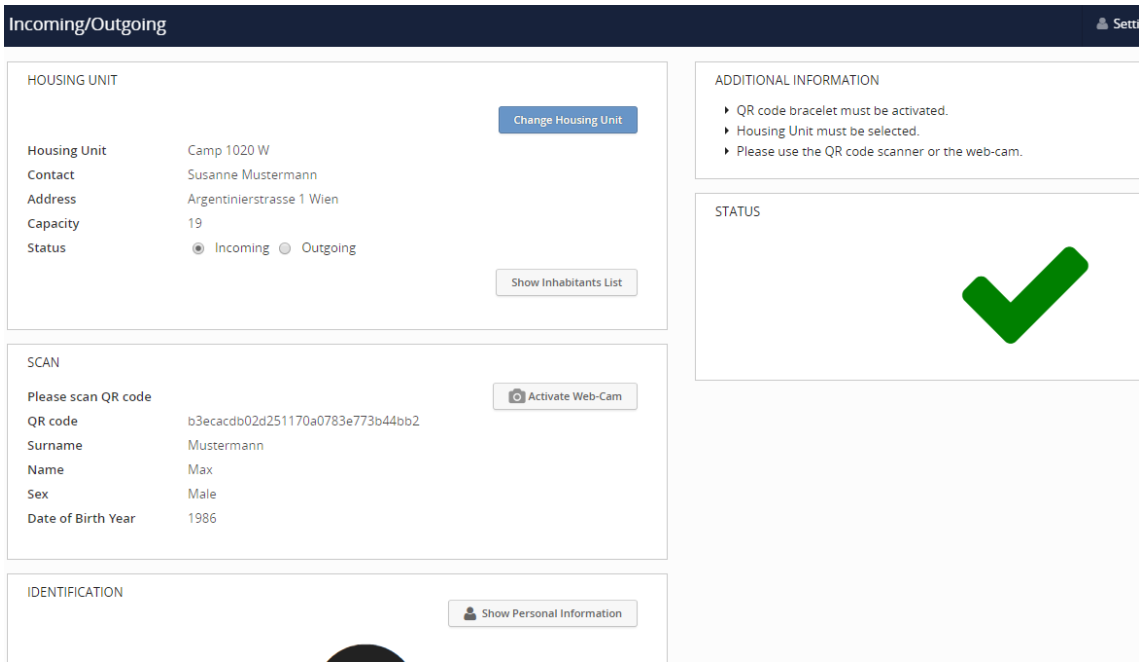


Figure 81: Prototype Scan Incoming/Outgoing

The user must select a housing unit and the status (*incoming/outgoing*). Furthermore, it is possible to view the current inhabitant list. The housing units are configured in the system. In case the person was not assigned to the select housing unit, an error appears. This is important in order to detect person movements that are not allowed. Some housing units should not be entered by specific persons, because of cultural or religious issues with other ethnic groups. Furthermore, the scan option helps to find lost people by notifying if someone left the housing unit or not (via the legal way).

The *Control* scan is the simplest form of a QR code scan. It can be used to identify people by checking the picture of the person and details. The *Control* scan can be done as long the QR code bracelet is active; no further limitations are defined. If the current QR code bracelet is not active anymore, an error will be displayed. Police officers and authorities could use this tool. Furthermore, it could help to find missing people such as children or other family members.

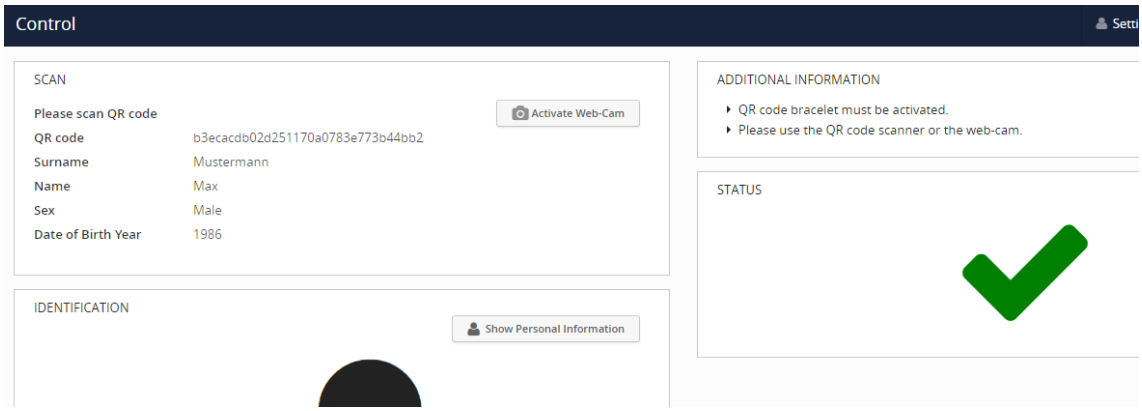


Figure 82: Prototype Scan Control

The last scan option, *Deactivation,* works somewhat differently compared to the other scan options. As first, the user has to scan the QR code. If the QR code was identified successfully (the green tick appears), the user must select a deactivation reason on the right-hand side or provide an alternative text. The authorities need to know why a QR code bracelet had to be deactivated.

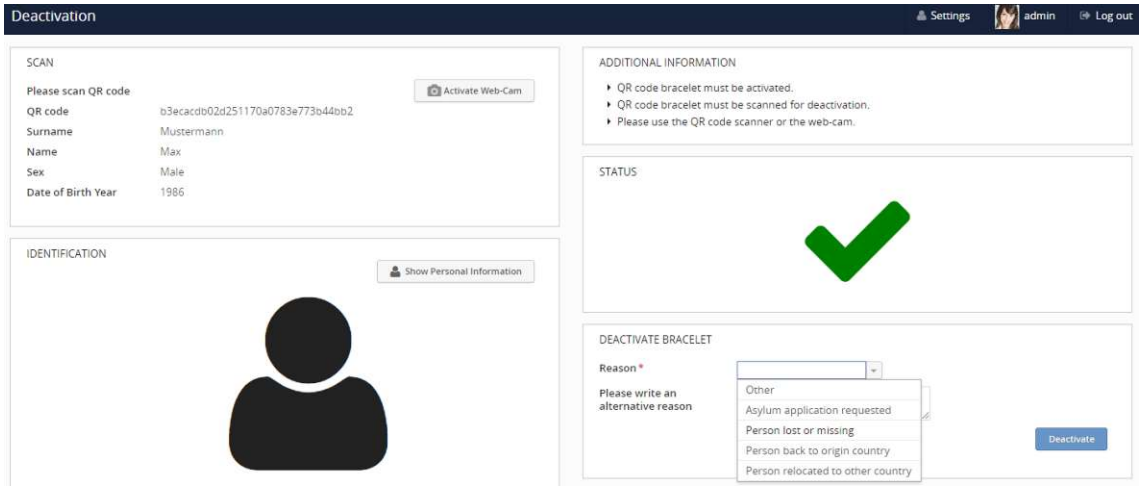


Figure 83: Prototype Scan Deactivation

If all data was loaded and selected, the user must click on the button *Deactivate* and confirm the action in a confirmation dialog. The design of this user interface helps to decrease the possibility of accidentally deactivating a QR code bracelet by the user.

4.5.3 Housing Unit Management

The *Housing Unit Management* component helps to determine where refugees can sleep or stay. As mentioned in *Section 4.4.4*, the user interface is composed of three parts: the *Search Panel*, the *Housing Unit Panel,* and *Selection Overview*.

The next figure illustrates how the user interface looks when the employee clicks on the *Housing Unit* menu item on the left. The so-called *Treemap* with the colored squares enables a quick and simple overview of the refugees who have to be assigned to a specific housing unit. Every square represents a particular amount of people filtered through a specific condition. In this case, the refugees are filtered through their country of origin: Afghanistan, Syria, Iraq, and so on. The efficient key in this *Treemap* is that depending on the number of people, the squares are larger or smaller than others. As can be seen in the figure, the largest square is Afghanistan, followed by Syria. That means the most people to assign are from Afghanistan. The algorithm of the *Treemap* automatically sorts the rectangles, defines their size and the position on the map. Hence, the employee has an efficient overview of persons filtered by their country and a proportional view of their number.
The search input field on the top helps filter more strictly by typing the searched person's name. Furthermore, each country-square includes more squares that represent the ethnic groups. Here again, the squares are sorted by their number of people assigned to the ethnic group.

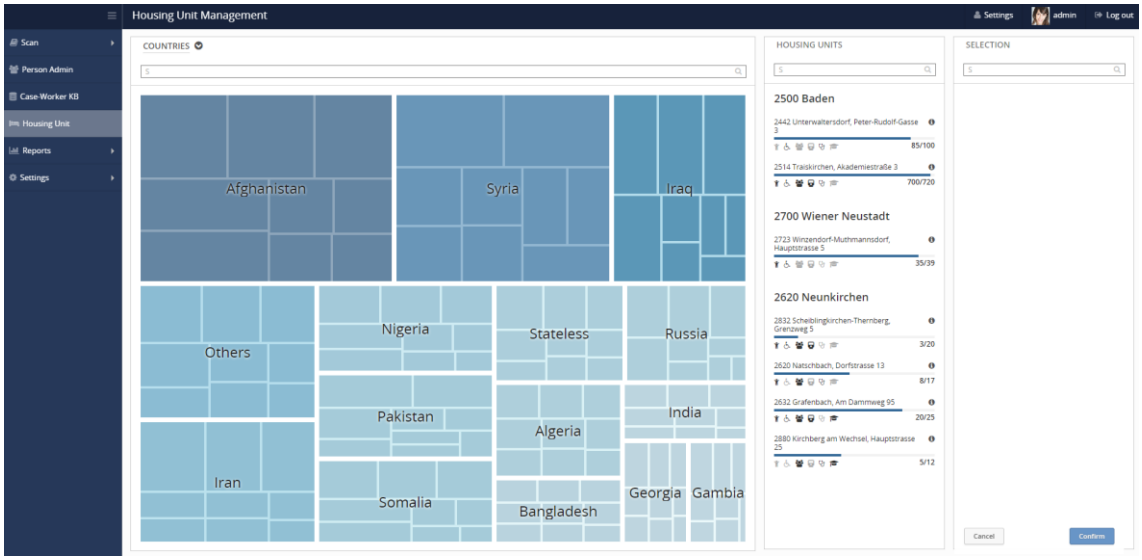


Figure 84: Prototype Housing Unit Management

The ethnic group-squares are visible when clicking on a country-square. Figure 85 illustrates this view. In this case, most people are from the ethnic group "Hazara" followed by "Pashtuns," and so on. The author decided to use the country of origin and the ethnic group as main filter criteria due to the tensions between the refugees that can arise when conflicting religious or ethnic groups are put together at the same place. The interviews with the experts in the first stage (*Section 4.1*) confirmed this assumption. Hence, it is essential to consider these criteria to enable a well-organized refugee relocation to the different housing units.

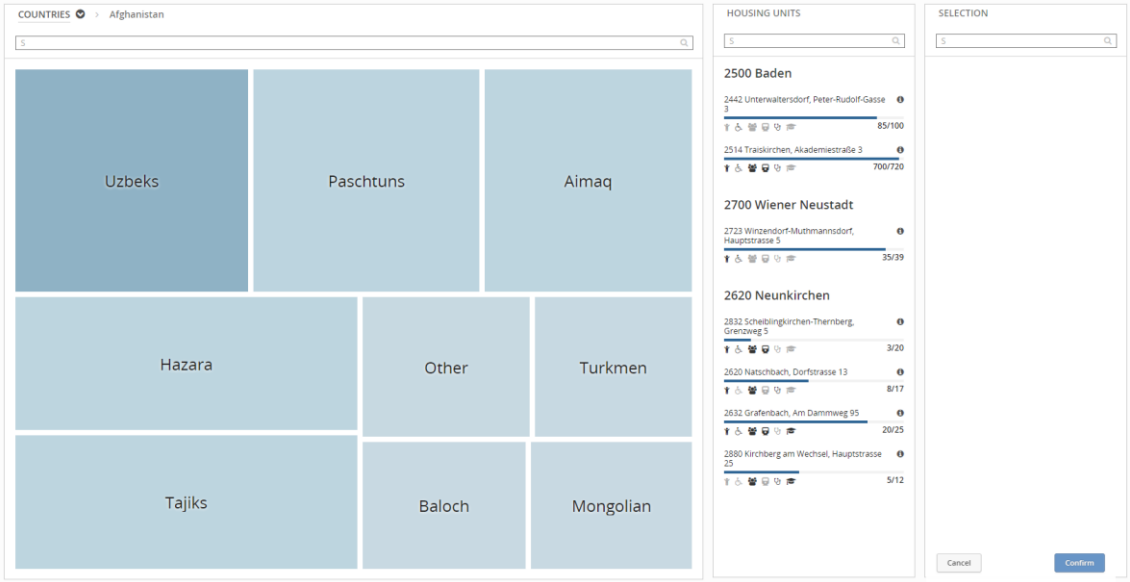


Figure 85: Prototype Housing Unit Group Selection

When clicking on one of the ethnic groups, the search view changes, and the employee has more options to filter the people. The next figure illustrates this step. The employee can now add more filter criteria: an additional country, the religion, orientation, stream, and another ethnic group. Furthermore, person properties such as "Male," "Female," "Group," "UM" (unaccompanied minor), "Disability," and "Medical Support" can also be added to the search query. As mentioned in the mock-up, the persons or groups have specific symbols. The user can distinguish between groups, men, women, and children. Furthermore, every child is assigned the "School" symbol automatically.

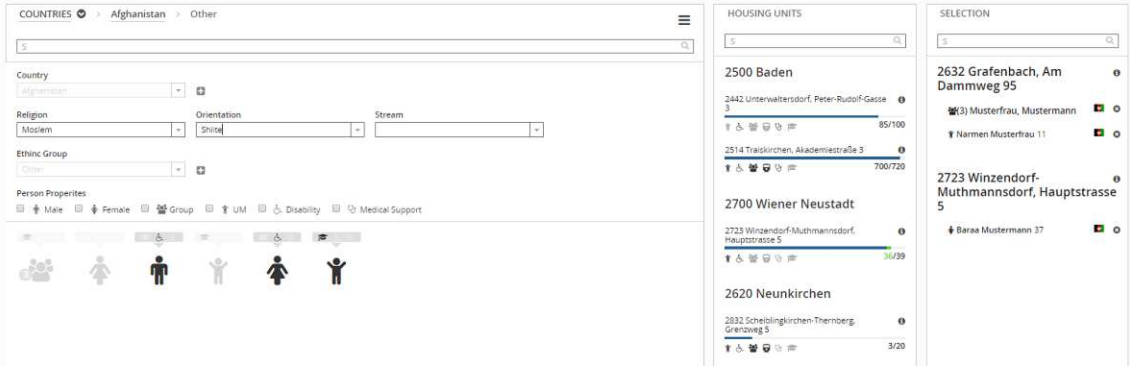


Figure 86: Prototype Housing Unit Person Search

Hovering over one of the people or group symbols opens a tooltip with the essential data about the person or group. This is illustrated in the next figure. The name, citizenship, sex, age, birthday, religion, orientation, known stream, ethnic group, and requirements for a housing unit are listed.

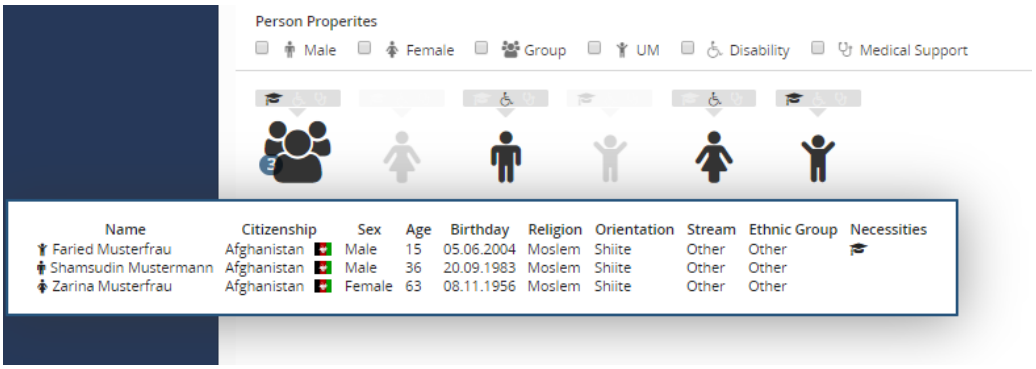


Figure 87: Prototype Housing Unit Person Details

The assignment to housing units depends on the person's properties and the services provided by each housing unit. A person with a disability can only be assigned to a housing unit that is appropriate. The same applies for unaccompanied minors, specific religions, and ethnic groups.

A person can be added to a housing unit via drag-and-drop, as shown in the next figure. A woman from the list was selected and dragged to one of the proposed housing units. The appropriate housing units are highlighted with a green color. It is only possible to drop a person-item to one of these housing units. At the same time, the selection list on the right-hand side will be filled by the person's name, including a flag of the country. Figure 88 illustrates the scenario where five persons were assigned to two different housing units. On the left-hand side, all successful assigned persons (according to the current assignment step before clicking on “Confirm”) are shown inactive in the search list. The user is not able to select these persons unless the selection was already discarded.

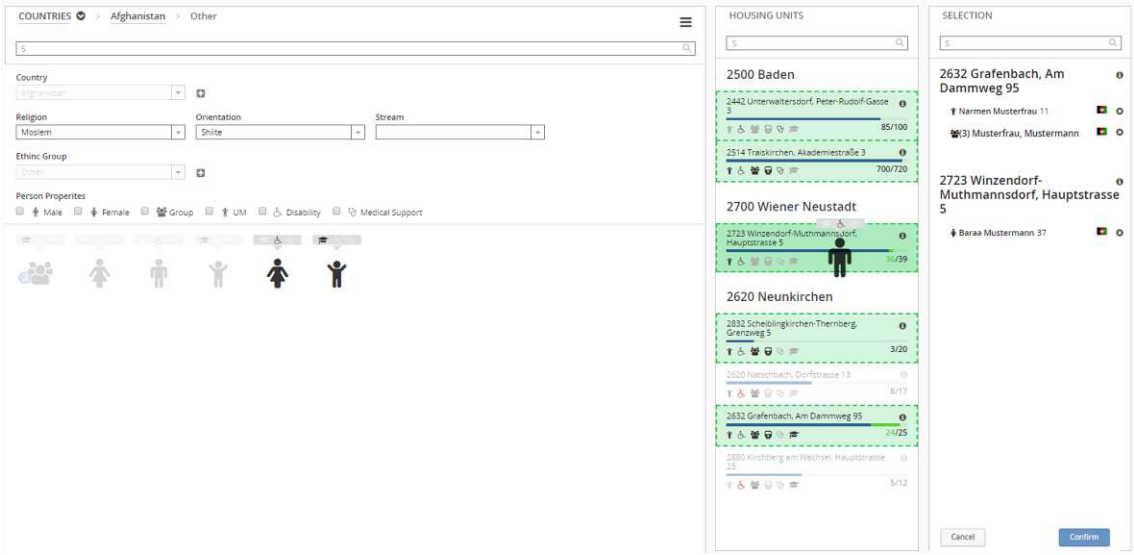


Figure 88: Prototype Housing Unit Person Selection

The user is also able to view more detailed information about the housing units. This can be done when clicking on the *information* icon. A new dialog window appears containing the contact details, a diagram of all countries of origin, a map with the housing unit's geographical location, and the inhabitant list.

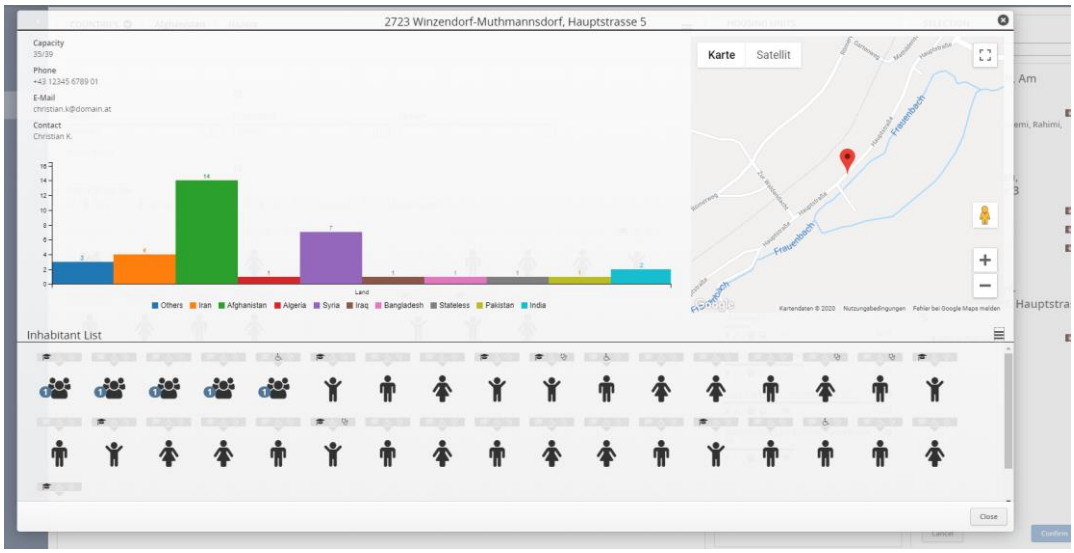


Figure 89: Prototype Housing Unit Contact Details

4.5.4 Settings

The *Settings* section is essential for the administrator and the pre-configuration of the entire system. The system configuration depends on the current refugee camp environment, whereas the menu entry *Settings User* shows all stored users. Also, the employee can filter via the search filter input fields (see Appendix). Next, the S*ervice Provider* view lists all service providers. The user can add, edit, and remove any service provider. The next figure shows the user interface of a selected service provider ("Admin"). The *Available Rights* tab illustrates that all available rights are activated for the administrator. Every service provider can contain a sub-service provider. This is useful for better categorization and delegation of already defined permission groups or rights.

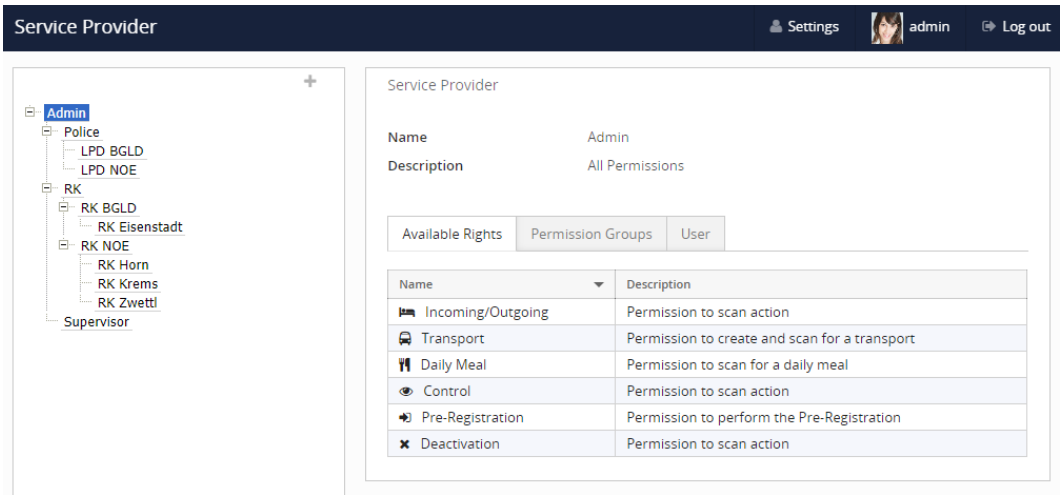


Figure 90: Prototype Settings Service Provider List

A new service provider can be added by clicking on the *plus* button on the left-hand side. A new panel appears on the right-hand side, which is illustrated in the next figure. The user has to define the name, description, and the available list of rights for the service provider. In the picture below, all rights were selected except for the right “Pre-Registration.” Afterward, the user can define new permission groups and users. The customization of the permission groups depends on the selection of the available rights.

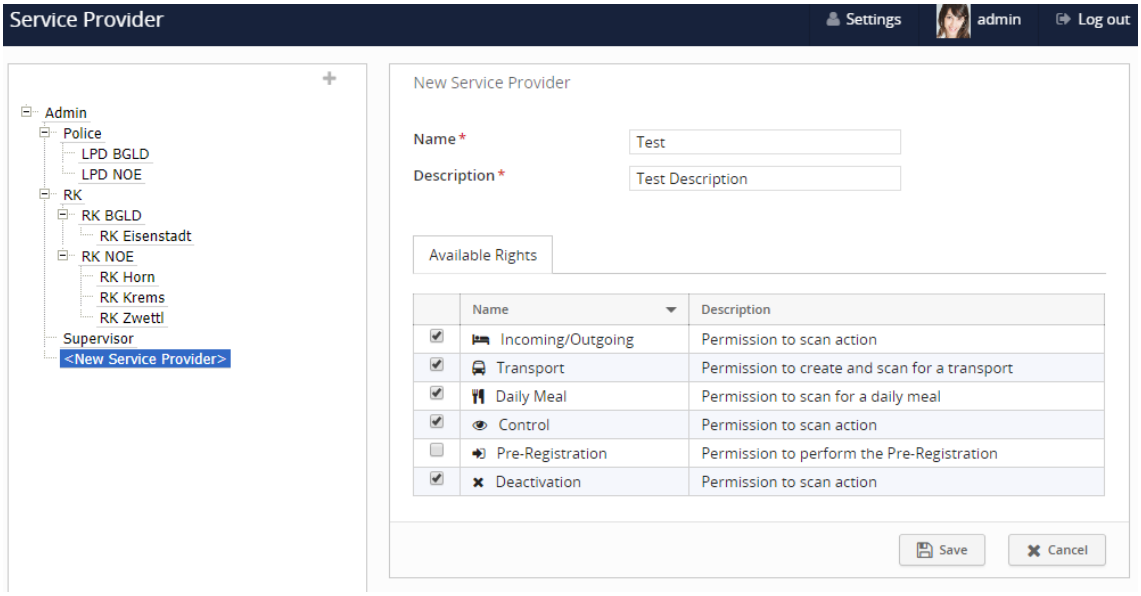


Figure 91: Prototype Settings Add Service Provider

The next figure illustrates the *Permission Group* tab of the administrator service provider. In this example, the user added two permission groups with the name “All Permissions” and “NGO.” Every permission group can be deleted by the *trash* button on the right-hand side. The rights that were activated for a permission group have a bold icon.

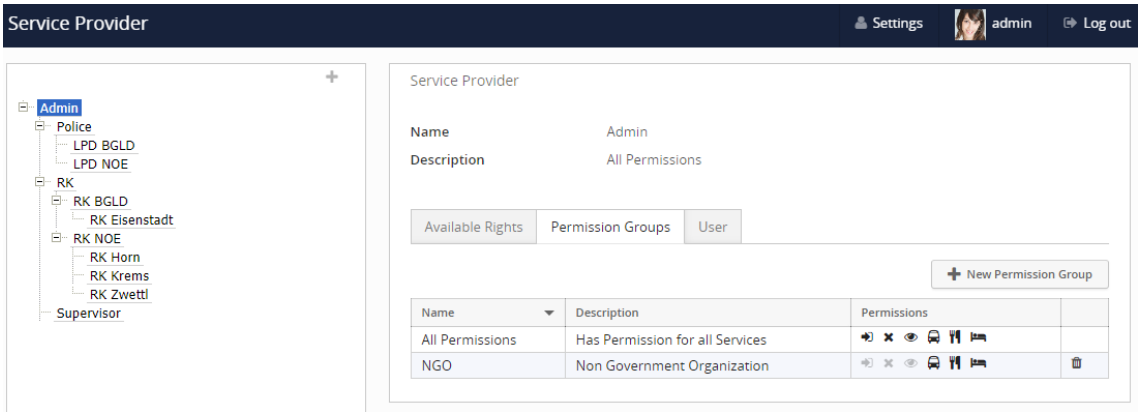


Figure 92: Prototype Settings Permission Group Tab

The button *New Permission Group* triggers a new dialog, which is illustrated in the next figure. The user can define the name and the description of the permission group. The table below contains the available rights which were selected during the creation of the current service provider. For this prototype, only the scan rights were added.

New rights can be added to the system by configuring them during the installation. For instance, a new right could be “Case Worker,” “House Unit Manager,” “Person Administrator,” and so on.

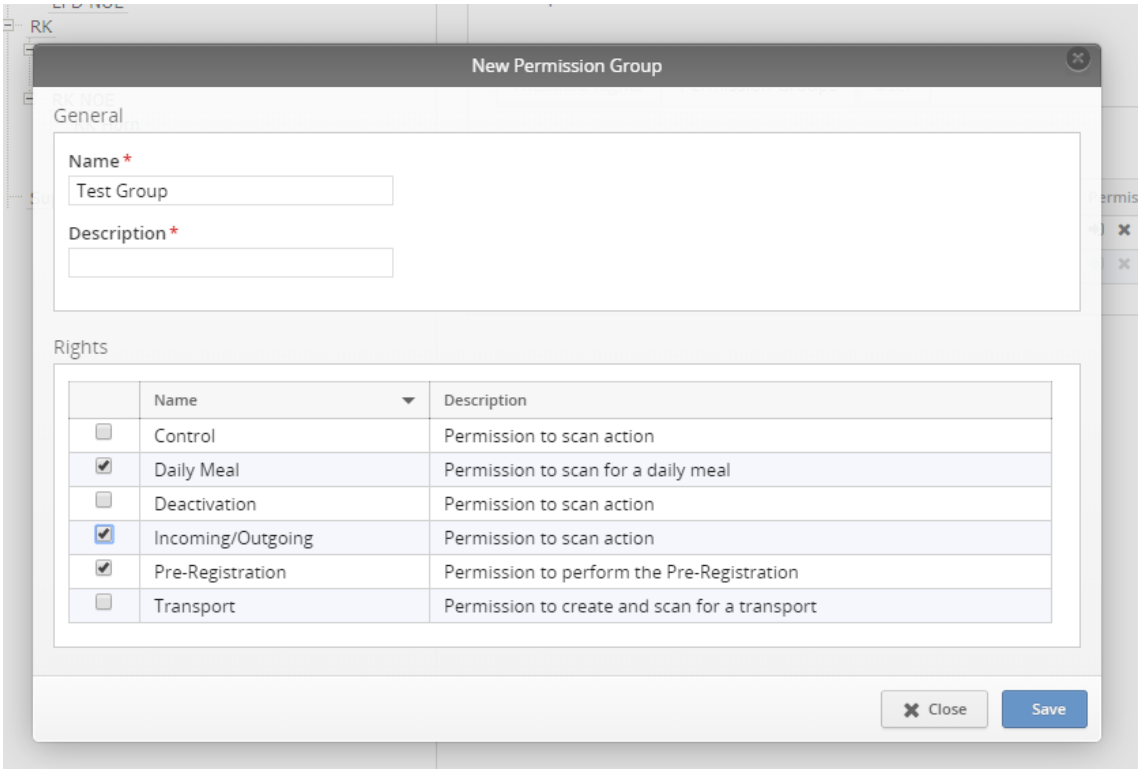


Figure 93: Prototype Settings Add Permission Group

The next figure demonstrates the *User* tab of a service provider. The employee can view all users assigned to the service provider. Additionally, it is possible to create a new user and assign it to the current service provider by clicking on the *New User* button. Furthermore, each user can be deactivated (*cross* icon) and removed from the list (*trash* icon).

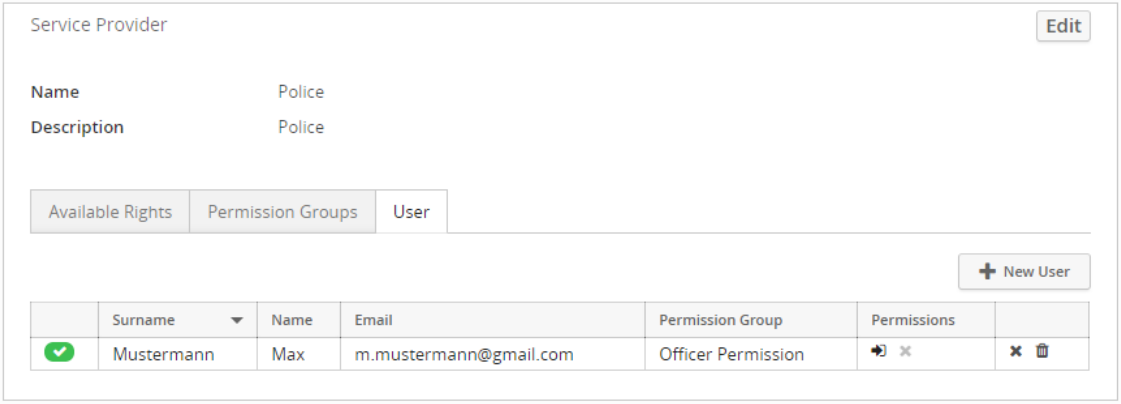


Figure 94: Prototype Settings Service Provider User

The figure below illustrates the *Settings Daily Limit* user interface. The prototype provides three configurable limits: *Registration*, *Asylum Requests,* and *Daily Meal*. The *Registration* limit triggers if, in one day, more than 200 pre-registrations (in case the warning limit was set to 100%) were made in the same refugee camp. Notification to the configured user will be sent when a specific percentage of the limit was reached. This can be defined by moving the bar from left to right. A user is notified if one of the notification checkboxes (email or SMS) was activated in the *Edit User* view. The *Asylum Requests* limit triggers when more than 80 persons requested asylum per day. This is defined by selecting the "Asylum Application" in the *Pre-Registration* view. Finally, the Daily Meal limit determines how many meals are assigned to a person a day. When a person wants to receive one more meal than defined, the employee can decide to permit or decline this request via a confirmation dialog.

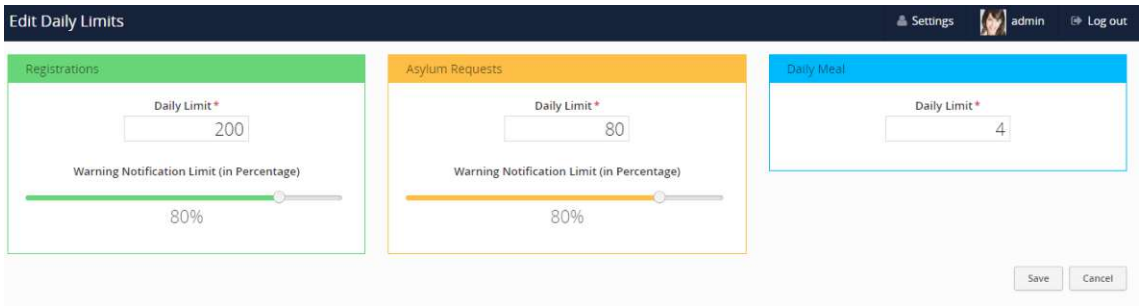


Figure 95: Prototype Settings Daily Limit

4.5.5 Mobile View

Due to the lack of time and resources, the high-fidelity does not provide a mobile app. Instead, the app can switch to a mobile view when decreasing the size of the browser window. The application changes automatically to the mobile view when opening it via a mobile phone or tablet. The implementation of a mobile app will be considered for future work. The next figure illustrates two mobile view examples of the *Scan Overview* (on the left-hand side) and the *Daily Meal Scan View* (on the right-hand side).

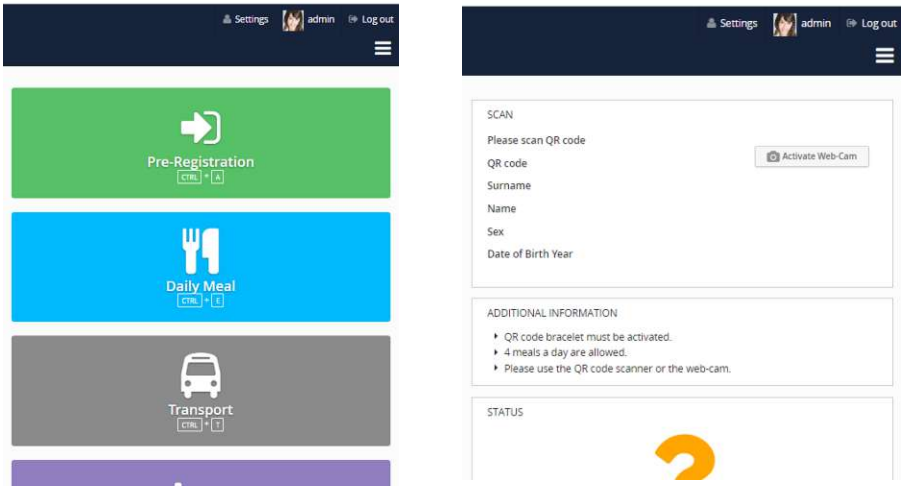


Figure 96: Prototype Mobile Version Example 1

The user interface was implemented to be very simple and clear to understand. The mobile version is dedicated to facilitating the use of the scan features.
The next figure shows two more examples of the mobile view: *Bus Transportation* and the *Incoming/Outgoing* scan function.

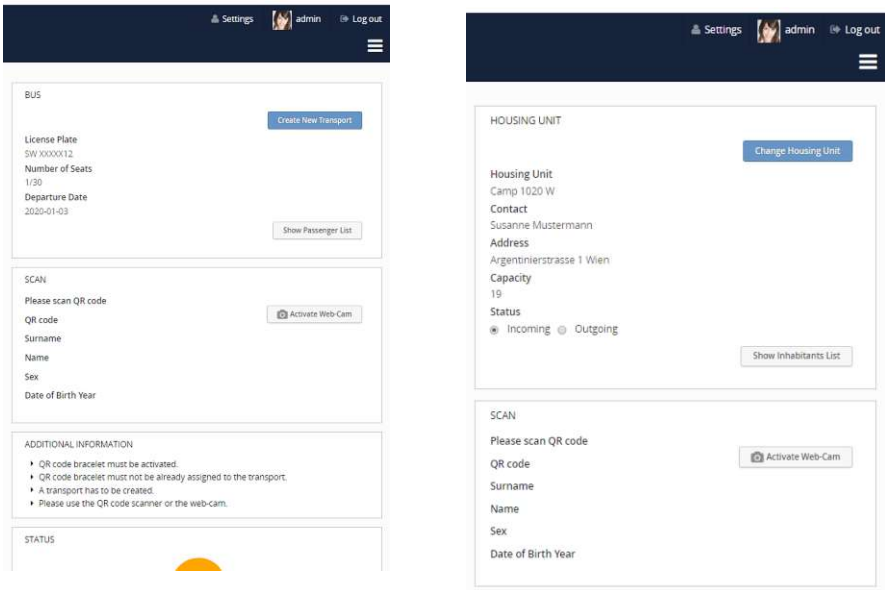


Figure 97: Prototype Mobile Version Example 2

5 Conclusions

The evaluated refugee management concept will be summarized and discussed in this chapter. It includes the responses to the two research questions, the final discussion, and a description of future work.

This thesis described the current state of the common European asylum system, including the most important directives and regulations of the European Commission. These directives and regulations are essential boundaries that have to be considered for the application of a European refugee registration system. Legal boundaries such as the Dublin regulation, the relocation scheme, and the EU-Turkey statement were also described in this thesis. Besides these regulations, this thesis described institutions and European border information systems required for refugee camps. Moreover, topics such as the GDPR, requirements engineering, and ethics in software engineering were also introduced. The technical and organizational facts about requirements engineering provide the needed knowledge for the definition of requirements and implementation of a comprehensive system. Ethics is a crucial aspect of the implementation of a refugee registration system that involves working with vulnerable people.
Furthermore, the author analyzed the state of the art of economic and scientific registration and identification solutions in the context of refugee camps and other applications. Economic solutions such as the European Hotspots and other commercial software products are essential for understanding the needs and requirements of a registration system. On the other hand, the scientific solutions, which were mostly applied outside the European Union, emphasized the used technologies and research methods. All presented solutions were compared with each other by analyzing the advantages and disadvantages of each approach. This information served as the basis for elaborating on the requirements of a standard European refugee camp solution.
The result of this thesis (the EU Refugee Management System), is composed of five stages. The definition of the requirements and the implementation of the proposed registration system were aligned with the User-Centered Design technique. The author conducted several interviews with experts, European institutions, and refugees to analyze the requirements of a European refugee camp.
Moreover, quantitative surveys were used to confirm the overall acceptance of the analyzed requirements. These results were elaborated and described in three publications. The author presented functional requirements such as the registration of refugees with a QR code bracelet, fingerprint acquisition for the Dublin regulation, housing management, integration of European information systems, and a mobile application. The non-functional requirements include the consideration of GDPR, security, ethics, and much more. These requirements were used to create use-case and mock-ups for a low-fidelity prototype, which was evaluated by experts and served to implement the high-fidelity prototype, which includes a web application and a mobile version.

5.1 Research Question 1

The first research question tries to emphasize the design complexity of a European refugee registration system.

"How can an identification and registration system for European refugee camps be conceived and evaluated, including the integration of European information systems and considering ethical issues?"

To answer this question, a significant amount of research and surveys were carried out (as mentioned in the chapter before). It should be considered that regulations and directives change from year to year and are continuously updated by the European Union. Hence, some laws have changed during the implementation of the doctoral thesis in the last years. For instance, the EU-Turkey statement is currently failing. Due to the Syrian war and internal political problems, Turkey opened the borders to the European Union. It seems that Europe has to face the same issues again as in 2015. Hence, it is crucial to apply a standardized refugee registration system for the European Union.

Nevertheless, the author answered the research question with the aid of systematic literature research, the evaluation of the state of the art, and qualitative and quantitative surveys (with refugees and European institutions). The requirement areas were evaluated through the results of the state of the art research and a qualitative survey with experts in the domain of refugee registration systems. The functional and non-functional requirements contain essential features such as the integration of European information systems and the organizational process within a refugee camp.

The biggest challenge was to provide a system that is applicable to all European Member States. The author would have to work together with the European Commission to define a possible integration of European information systems. Hence, this solution provides a conceptual integration. The concept should help to identify a standard solution and define further steps for the European Union. It should be seen as a blueprint for the EU. Nevertheless, it is essential to have a standardized concept to react quickly and efficiently to changing refugee streams in Europe. The evaluation of the requirements emphasized crucial components for a refugee camp.

The first component is the registration and identification step. It includes the registration of masses of people via a QR code bracelet and a simple identification procedure. The integration of the European information systems and the fingerprint acquisition with Eurodac helps to find any discrepancies or double registrations. A case-worker application is used to analyze and control given documents. The transport coordination and housing unit management are essential tools for transporting and assigning people to specific housing units. To avoid ethical issues and dangerous situations, these steps should consider cultural and religious issues between different ethnic groups.

The defined requirements were evaluated through a quantitative survey with different European institutions and experts. The results illustrated an overall acceptance rate for all requirements.

This is a positive outcome because this concept is very complex and specific. Moreover, several experts mentioned that some requirements might provoke ethical issues, such as applying a QR code bracelet. Hence, the author evaluated a quantitative survey conducted by refugees. The results helped define some adaptations and modifications in using a QR code bracelet: high transparency in information, colored bracelets, alternatives such as ID badges and cards.

5.2 Research Question 2

The second question addresses a low- and a high-fidelity prototype for a refugee registration system:

"How could a blueprint for a European refugee management system be designed and implemented that supports the integration of a contactless identification medium and provides features for the refugee registration process?"

The author designed several use-case diagrams and mock-ups to answer this question. The resulting mock-ups served as the basis for the high-fidelity prototype, which shall be applied in a refugee camp.

The use-case diagrams were implemented according to the requirement areas, which were elaborated in the stage before. The use-cases illustrate the most crucial user interactions with the proposed refugee registration system. The author defined all use-case diagrams for the given functional requirements, including a web and mobile version.
Afterward, mock-ups were designed according to the use-cases. The mock-ups represent possible user interfaces for the proposed system. The result helped to find discrepancies and other problems in the requirements analysis.

Moreover, the author conducted a qualitative survey with experts due to the complexity of the different requirements and conditions. The experts in user interface design proposed some adaptations and modifications to the UI. These adaptations were made in the fourth stage. Some user interfaces had to be changed due to usability or functionality reasons.

The last stage forms the basis for the high-fidelity prototype, which should look like a real refugee registration application. The prototype was implemented according to the rules of the modified mock-ups. The system illustrated how such a refugee registration system could be designed and implemented. It includes a comprehensive registration and identification framework with QR code bracelets. The bracelet can be imported and scanned via the application with a simple QR code reader or webcam. The prototype can manage personal data, assign people and families, create transportation requests, manage scan activities such as food consumption, provide statistical diagrams, relocate persons through a complex housing unit system, and configure user permissions.

The integration of the European information systems was not included due to the lack of resources and time. Furthermore, the integration of the external system is only feasible if all European Member States are willing to accept the standardized concept. Hence, the prototype should help the European Commission define and evaluate the refugee camp requirements and what it could look like.
The general data protection regulations will be considered for future work and are not included in the current prototype. According to the ethical issues, the system supports all kinds of identification types as long they provide a readable QR code. Hence, it does not matter where the QR code is printed. The prototype uses bracelets in paper form to offer a reliable and secure identification process. Each bracelet has a unique QR code.

5.3 Discussion

The state of the art chapter presented the four basics requirements for a refugee camp in the European Union: Implementation of an *Identification Medium*, *Support Services*, integration of *European Information Systems*, and *House Unit Management*. The quantitative and qualitative surveys emphasized the overall acceptance for these four components, by rating all defined requirement areas of the RMS system positively.
Hence, the RMS system covers the first component (Identification Medium) with the QR code bracelet and a comprehensive identification process. The application of QR codes helps to be flexible in different situations. The refugee camp coordinator can print the QR codes on various surfaces (such as paper, cards, bracelets, and so on). The medium suggested here still a bracelet, considering the ethical issues that can arise. The quantitative survey about the impact of the ethical problems through an identification medium demonstrated that refugees are willing to use it in specific circumstances. In the author's opinion, the ethical issues relate primarily to the own perception of identity and the definition of Otherness. Refugees may feel like objects during the complete identification and registration procedure in a refugee camp. By applying the QR code bracelets, someone may feel as if they are only an anonymous and unimportant part of a complex system. Branding persons with IDs can suppress the development of personality. Moreover, putting people in a specific group, such as the "refugees," enables the separation of the citizens from refugees (the "Other"). Furthermore, the refugee crisis in Europe demonstrated that groups with more power (in this case, the European citizen) could classify refugees as other groups (the Other). Refugees are dependent on the organizational and human resources of European Member States; putting them into disadvantaged groups happens very quickly. As mentioned in the ethics section, responsibility is a crucial topic in postmodernity. Considering the allocation of power between two groups (the origin and the counterpart), one should think about the responsibility of the group with more power. Government authorities in refugee camps have to consider how they should act in specific situations. Nevertheless, providing more transparency and the option for different bracelet styles (as mentioned in the quantitative survey) can reduce the insecurity and negative impact.

The defined support services cover the second component (Support Services) for medical supplies and food distribution. The possibility of scanning and managing the food distribution within the refugee camp is useful to find and avoid bottlenecks due to changing refugee streams. An overview of the consumption of goods is critical to guarantee food delivery for every refugee camp inhabitant.

The results demonstrated that integrating European information systems is one of the most challenging components (third component). Due to the lack of time and resources, this work is limited to a local solution. The integration of all needed EU information systems is very complicated and must be planned with the European Commission. Nevertheless, the ESP (European Search Portal) implementation would be a great benefit for the RMS system. It would cover the most critical EU information systems via one interface. The national systems such as AFIS and the asylum database have to be coordinated with each European Member State. Hence, the limitations of these components rely on a political and economic perspective. The defined requirements area about the European information systems were accepted by European institutions (quantitative survey). However, the practical implementation is challenging. This depends on the collaboration of governmental authorities, the European Member States decisions, and the European Commission.

The RMS system includes the fourth component, the House Unit Management. The survey emphasized the importance of a house unit management application. The authorities can manage the relocation of refugees between different housing units, taking the religion and the ethnic groups into account. This is very important to avoid conflicts between different groups from other countries. The visualization of users in groups or single individuals helps to keep families together. In particular, unaccompanied minors and persons with disabilities should receive special focus during the allocation process.

The research emphasized that the scientific contribution for European refugee camps and the asylum procedure is very low. However, the refugee crisis in 2015 demonstrated the need for better solutions in European refugee camps. The fact that refugee streams will never stop is crucial to thinking about better long-term solutions in the European Union. A standardized and mobile application shall be applied to react to changing refugee streams in the different European Member States. Currently, every Member State designs and develops its own solutions and systems for refugee camps. The public interest increases and decreases over time, but still a situation as in 2015 will happen again; it is only a matter of time. Therefore, it would be beneficial for the refugees and the authorities to have a standardized refugee camp management system in place. It could help prevent long queues in front of the camps, and reduce stress for employees and refugees. Moreover, the solution could reduce the financial resources and the time and effort for establishing a new refugee camp management system. An important key is to increase the European Commission's awareness of the integration of a standardized refugee camp system. The result illustrated a set of requirement areas for the application of a refugee management system in Europe. This information could help to understand the requirements for a European refugee camp and serve as the basis for a standardized refugee registration system, including the needs of refugees and employees. The applicability depends on the European Commission and the legal boundaries of the Member States.

This work illustrated the high complexity of a European refugee registration system and the need for such a standardized concept. On the other hand, the high-fidelity prototype emphasized the limits to implementing such a comprehensive application. Nevertheless, in the author's opinion, this blueprint could help the European Commission develop and apply a European refugee camp solution for all Member States.

This work relies on a highly interdisciplinary topic, which cannot be fully covered by one dissertation. The topic has significant potential in several scientific fields, such as economics, politics, human rights, European law, and so forth. The integration of this work into different areas requires much more personnel, time and resources from other institutions and departments.

5.4 Future Work

According to the results of the chapters before, the proposed system does not include every requirement area. The topic of this thesis has a wide range of technical and organizational barriers as well as legal and ethical boundaries. Hence, not every requirement area could be implemented. This section describes the missing requirements in the high-fidelity prototype. Table 10 includes all requirements which are considered for future work and are not included in the prototype. These are the requirements that require a high level of involvement of the European Commission and the Member States. Moreover, the evaluation of all non-functional requirements shall be considered for future work. The review of these requirements makes sense only when applying the RMS system in a real-world scenario - for instance, using the RMS system for a small community or another test environment.

Table 10: Not Implemented or Adapted Requirements in High-Fidelity-Prototype

ID	*Description*
R2	Local (*International*) Refugee Camp Database
R3	Fingerprint identification and registration (AFIS and Eurodac)
R4	Case-worker Knowledgebase
R5	Integration national asylum database
R6	Integration of Search Interface for SIS II, VIS and national police database

A local refugee camp database replaced the international refugee camp database. The international refugee database can only be implemented with the collaboration of the European Member States.

Nevertheless, the local database can provide all crucial functionality for the refugee camp application and give the basis for the international data exchange. The next step would be to enhance the database with a decentralized unit.

That means that there will be a central database (accessible for all Member States) and a local (national) database. The current prototype includes only the local database.

The fingerprint step was not included because no Eurodac machine was available. Usually, every European refugee camp has a Eurodac machine for fingerprinting. The device is connected to the national AFIS system and the Eurodac system. This step has to be considered for future work.

Due to the complexity of the entire refugee registration system, the author had to decide between two requirements: the case-worker knowledge-base and the housing unit management. The prototype includes housing unit management because this is more important in the first instance. The refugees need a place to live and sleep.
Hence, the case-worker knowledge-base will be considered for future work due to the complex implementation of a central document database. Furthermore, data from each country has to be imported and elaborated on. The collaboration with European Member states is also needed here.
Next, the author will implement an agent-based model of a European refugee camp, including all steps of the proposed registration system. The optimal order and constellation of the refugee registration process could be determined by configuring the model with different variations of the steps. The agents will illustrate the bottlenecks of the system.

As mentioned before, the integration of European information systems is also considered for future work. This includes the national asylum database synchronization and the inclusion of the European Search Portal (ESP). The ESP shall be finished in 2020 and could be integrated into the application as an external link. The national asylum database can only be integrated with the specifications of the European Member State.

The prototype provides a mobile version of the web application by providing responsive design. The implementation of a mobile application (accessible via an app store) would make sense and will be considered for future work.
A mobile app provides a stable and simpler version of the refugee registration system and would be very handy for mobile scan activities. The current prototype is accessible via the mobile phone, but it only provides a responsive design, including the entire application.

Moreover, according to GDPR, the author will implement anonymization functionality for personal data. Furthermore, every request has to be protocolled and archived.

As mentioned before, this work is a highly interdisciplinary topic that should be considered in other scientific areas. The potential for other scientific contributions is present and should be evaluated by experts in different fields.

6 Definitions

Person eligible for subsidiary protection:

"... means a third-country national or a stateless person who does not qualify as a refugee but in respect of whom substantial grounds have been shown for believing that the person concerned, if returned to his or her country of origin, or in the case of a stateless person, to his or her country of former habitual residence, would face a real risk of suffering serious harm ... " Article 2/f [3]

Application for international protection:

"... means a request made by a third-country national or a stateless person for protection from a Member State, who can be understood to seek refugee status or subsidiary protection status and who does not explicitly request another kind of protection ..." Article 2/h [3]

Applicant:

"... means a third-country national or a stateless person who has made an application for international protection in respect of which a final decision has not yet been taken." Article 2/h [3]

Residence permit:

"... means any permit or authorization issued by the authorities of a Member State, in the form provided for under that State's law, allowing a third-country national or stateless person to reside on its territory." Article 2/m [3]

Hotspot:

"The hotspots approach is described as a measure of support offered to frontline MS to "fulfil their obligations under EU law and swiftly identify, register and fingerprint incoming migrants." [2]

7 Appendix

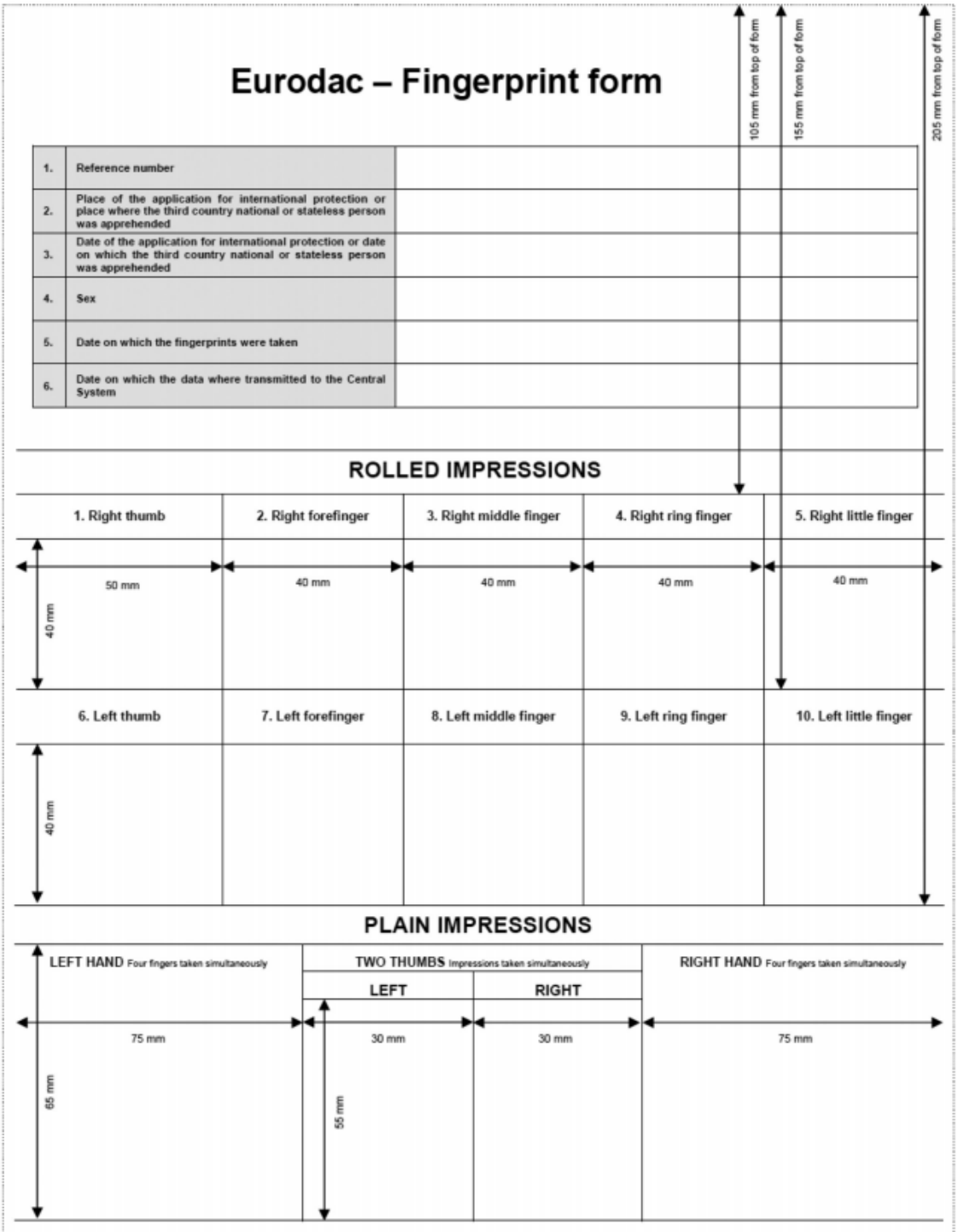
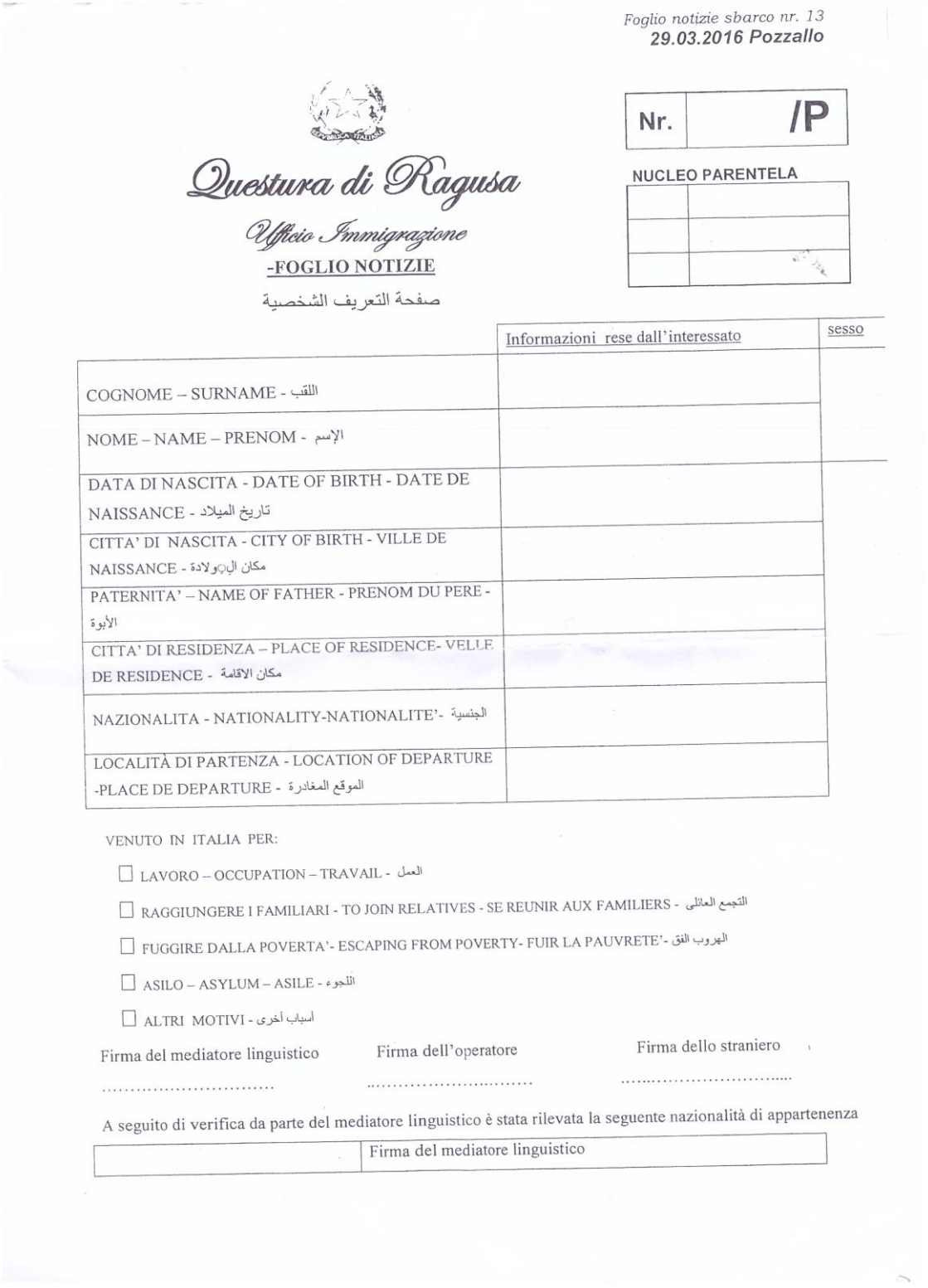


Figure 98: Eurodac Fingerprint Form [24]



Foglio notizie sbarco nr. 13
29.03.2016 Pozzallo

Nr. /P

NUCLEO PARENTELA

Questura di Ragusa

Ufficio Immigrazione

-FOGLIO NOTIZIE

صفحة التعريف الشخصية

	Informazioni rese dall'interessato	sesso
COGNOME – SURNAME - اللقب		
NOME – NAME – PRENOM - الإسم		
DATA DI NASCITA - DATE OF BIRTH - DATE DE NAISSANCE - تاريخ الميلاد		
CITTA' DI NASCITA - CITY OF BIRTH - VILLE DE NAISSANCE - مكان الولادة		
PATERNITA' – NAME OF FATHER - PRENOM DU PERE - الأبوة		
CITTA' DI RESIDENZA – PLACE OF RESIDENCE- VELLE DE RESIDENCE - مكان الاقامة		
NAZIONALITA - NATIONALITY-NATIONALITE'- الجنسية		
LOCALITÀ DI PARTENZA - LOCATION OF DEPARTURE -PLACE DE DEPARTURE - الموقع المغادرة		

VENUTO IN ITALIA PER:

☐ LAVORO – OCCUPATION – TRAVAIL - العمل

☐ RAGGIUNGERE I FAMILIARI - TO JOIN RELATIVES - SE REUNIR AUX FAMILIERS - التجمع العائلي

☐ FUGGIRE DALLA POVERTA'- ESCAPING FROM POVERTY- FUIR LA PAUVRETE'- الهروب الفق

☐ ASILO – ASYLUM – ASILE - اللجوء

☐ ALTRI MOTIVI - أسباب أخرى

Firma del mediatore linguistico ..... Firma dell'operatore ..... Firma dello straniero .....

A seguito di verifica da parte del mediatore linguistico è stata rilevata la seguente nazionalità di appartenenza

	Firma del mediatore linguistico

Figure 99: Foglio Notizie[33]

[33] http://www.integrationarci.it/wp-content/uploads/2016/04/allegato1-foglio-notizie.jpg

Figure 100: QR Code Bracelets

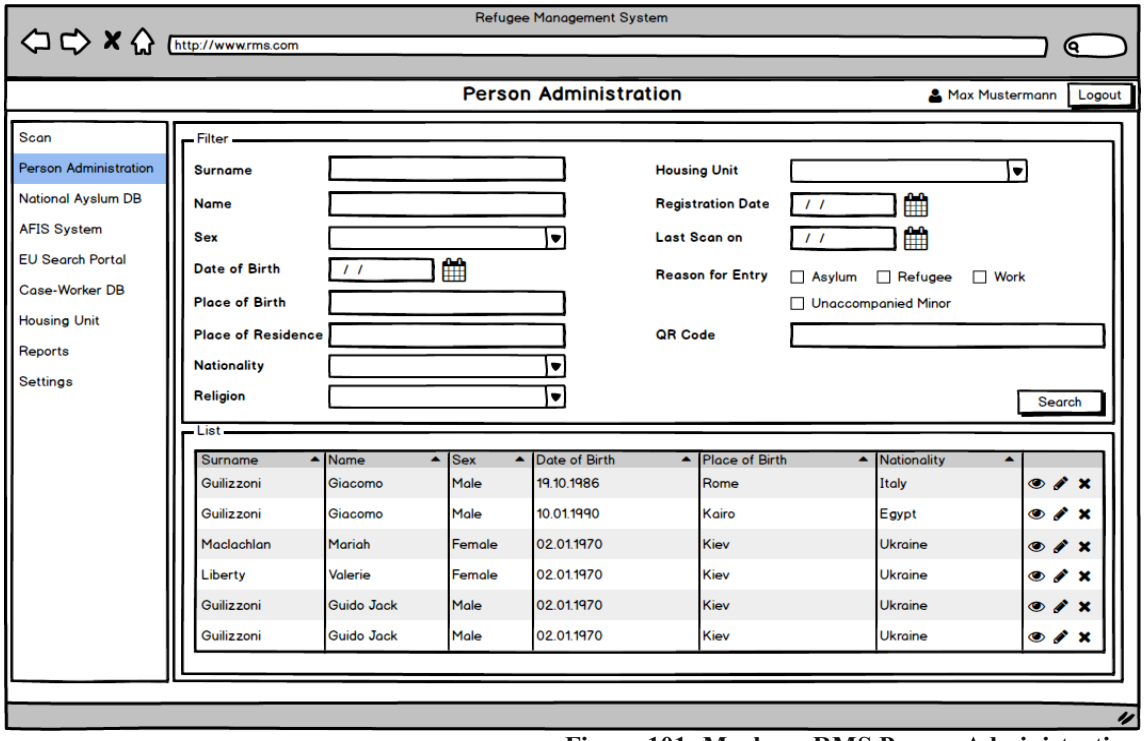


Figure 101: Mock-up RMS Person Administration

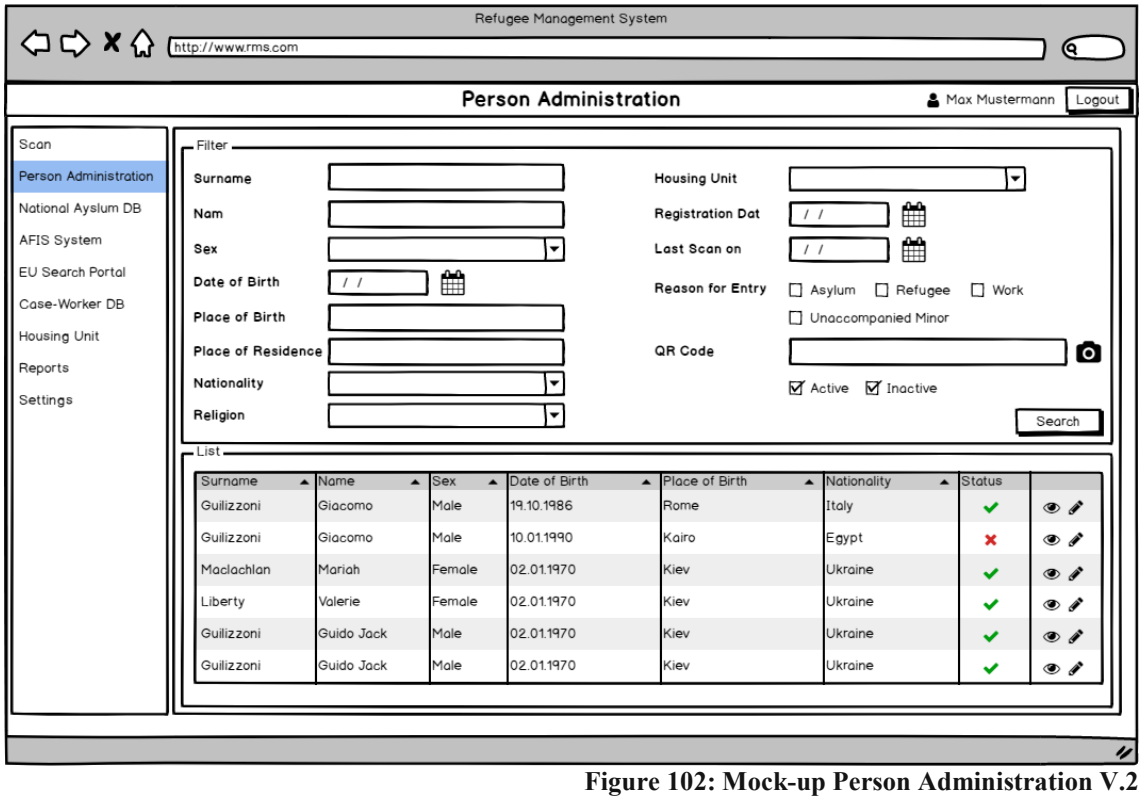


Figure 102: Mock-up Person Administration V.2

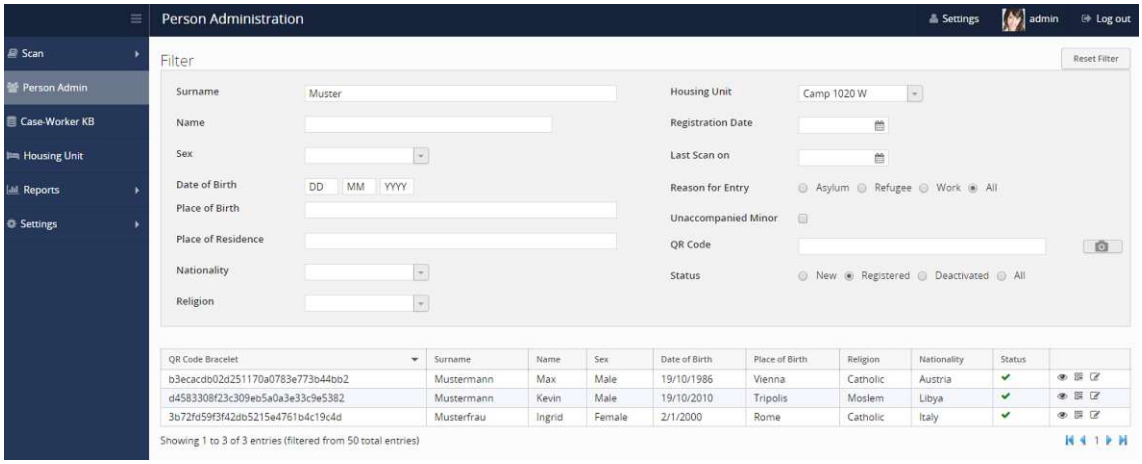


Figure 103: Prototype Person Administration

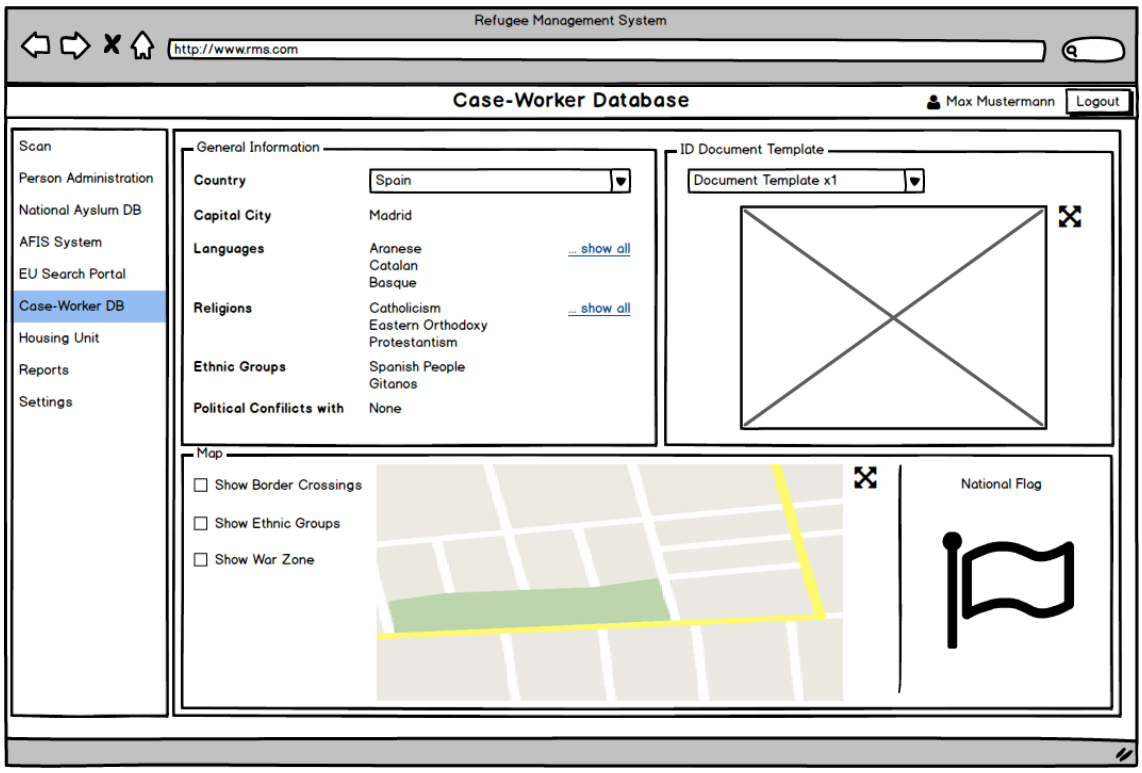


Figure 104: Mock-up RMS Case-Worker Database

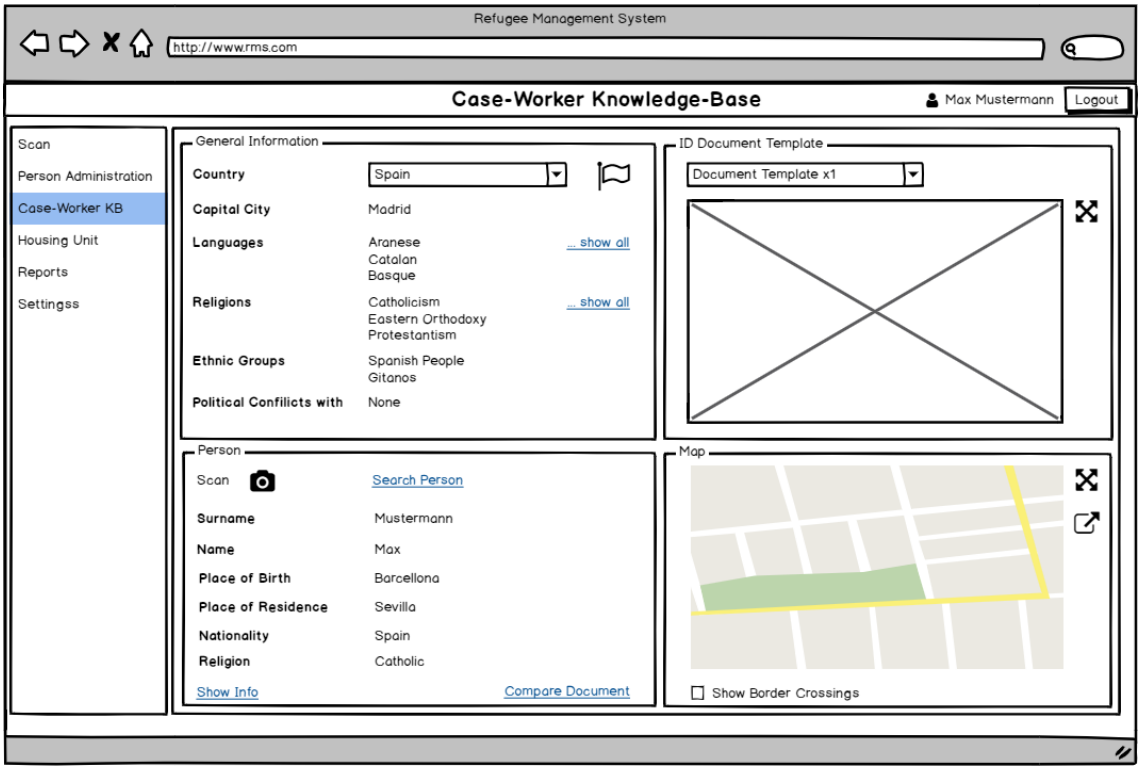


Figure 105: Mock-up Case-Worker Knowledge-Base V.2

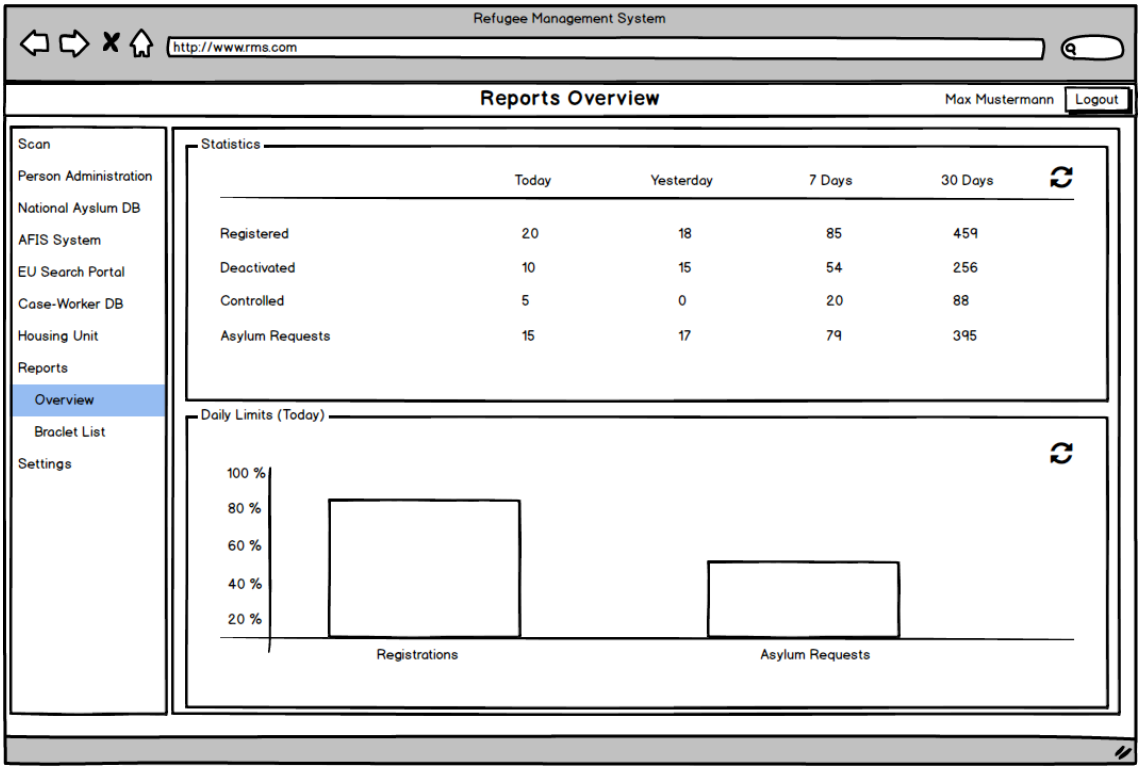


Figure 106: Mock-up RMS Reports Overview

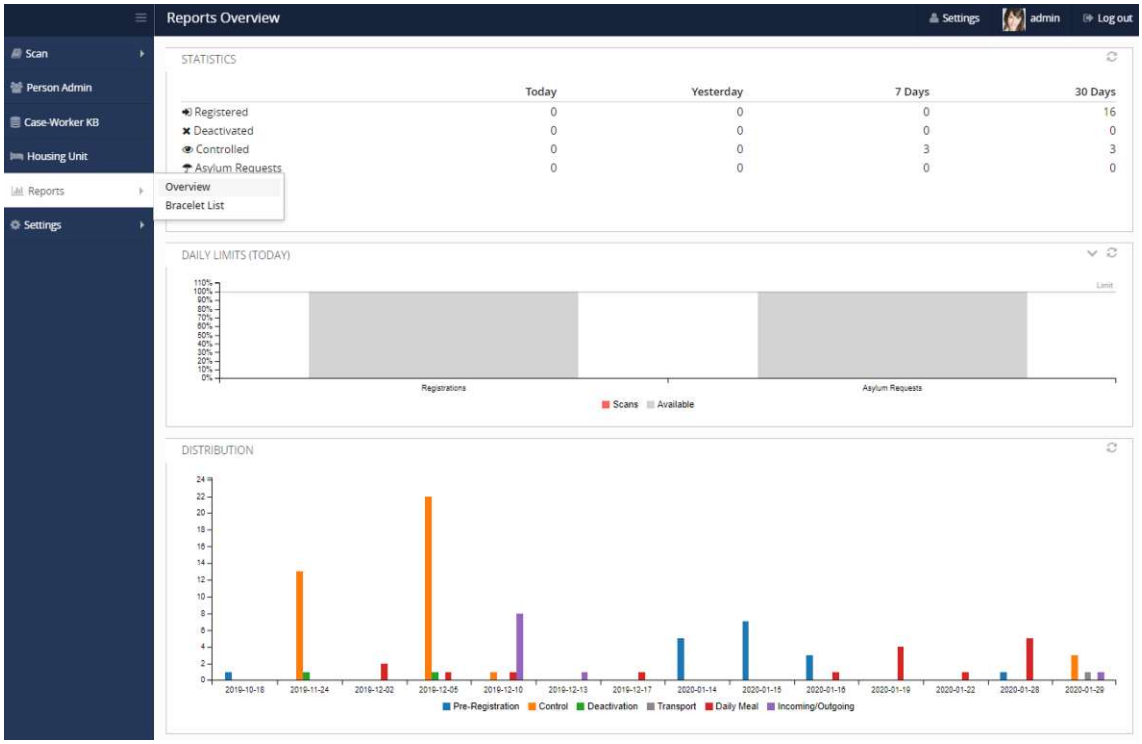


Figure 107: Prototype Reports Overview

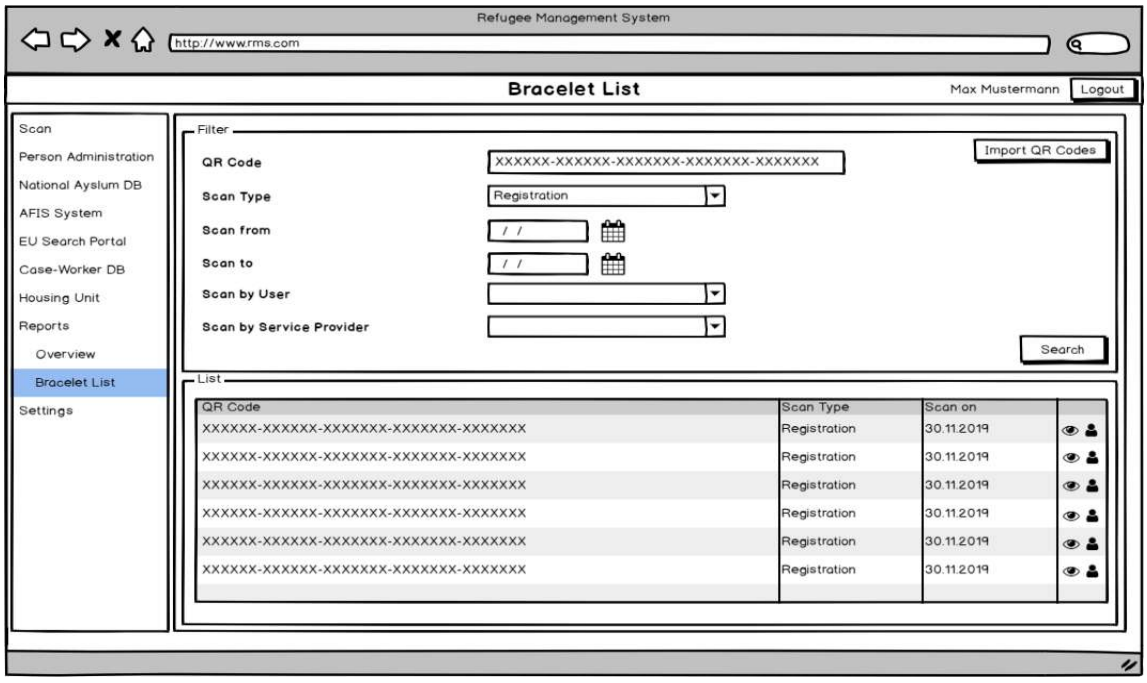


Figure 108: Mock-up RMS Reports Bracelet List

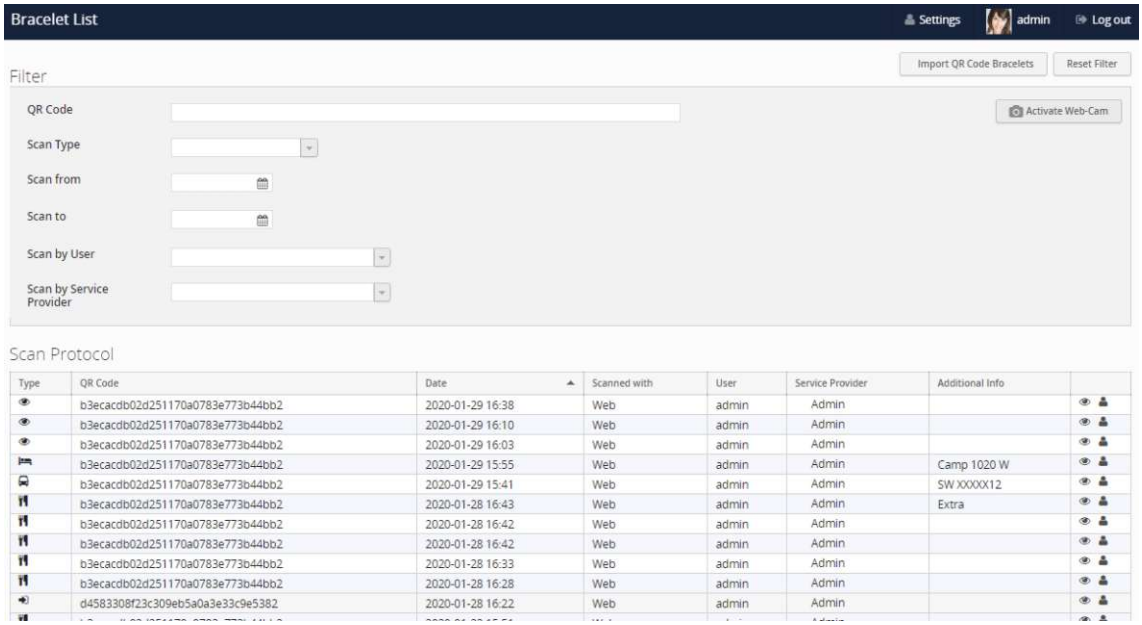


Figure 109: Prototype Reports Bracelet List Scan Protocol

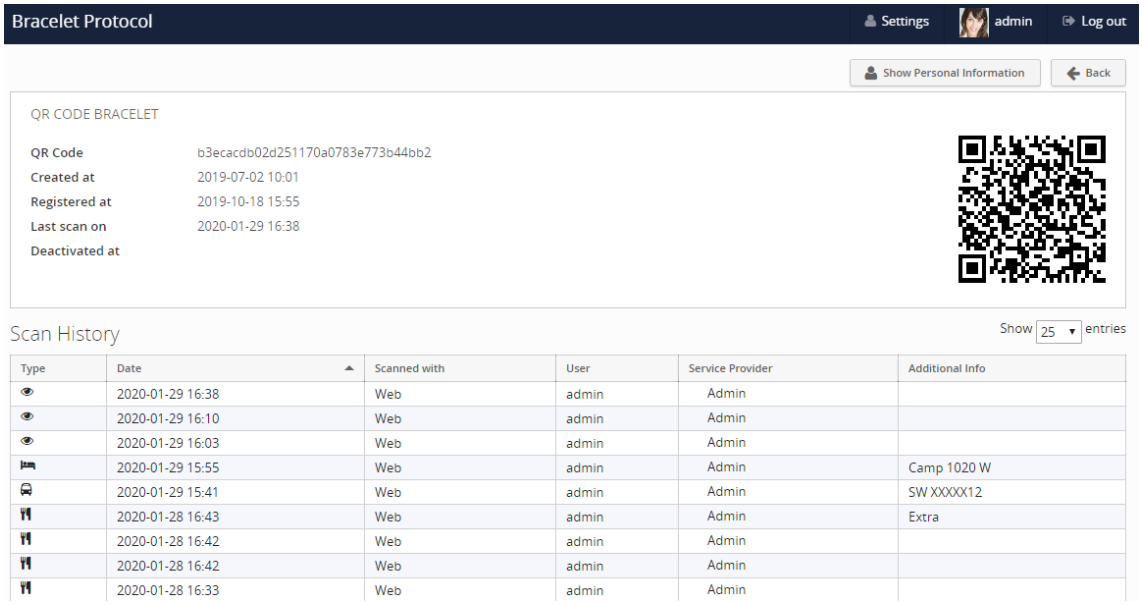


Figure 110: Prototype Reports Bracelet Protocol

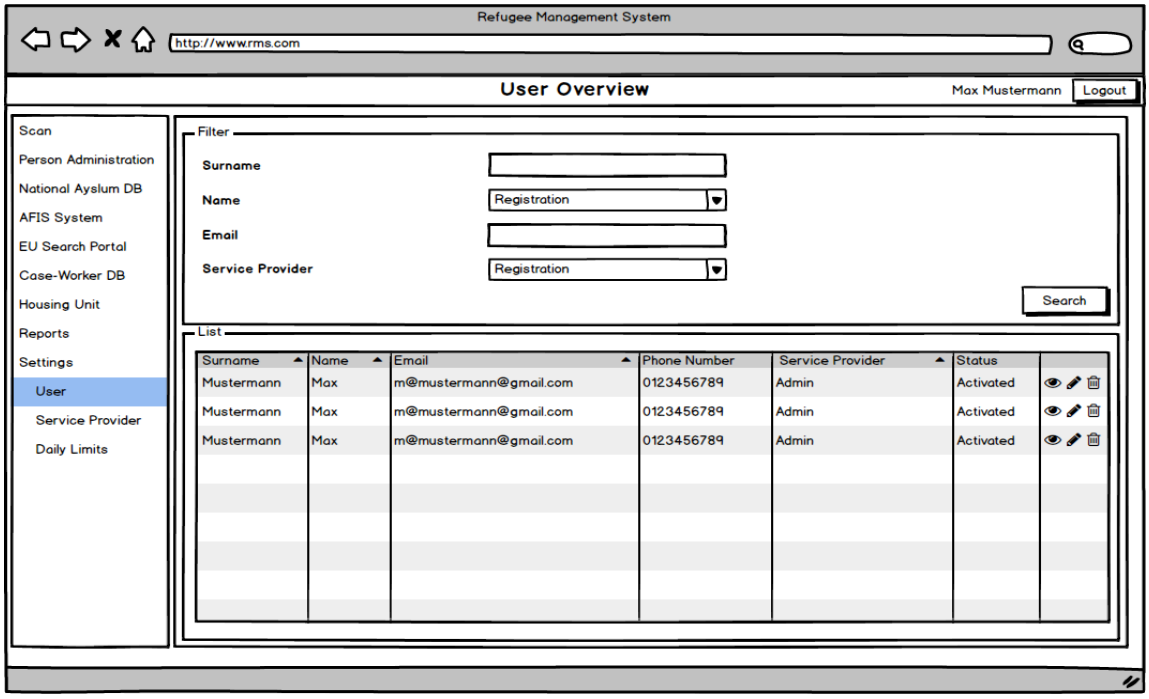


Figure 111: Mock-up RMS Settings User Overview

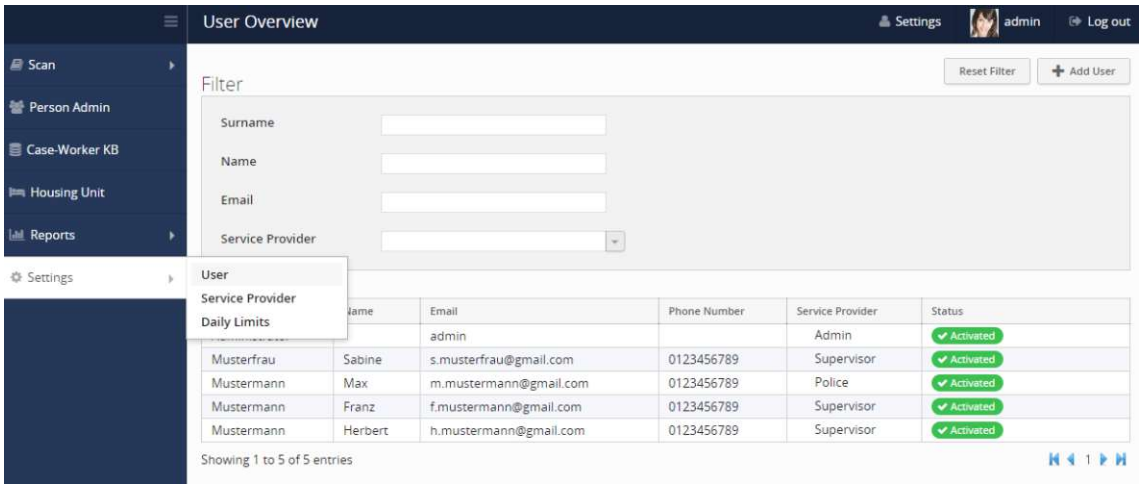


Figure 112: Prototype Settings User Overview

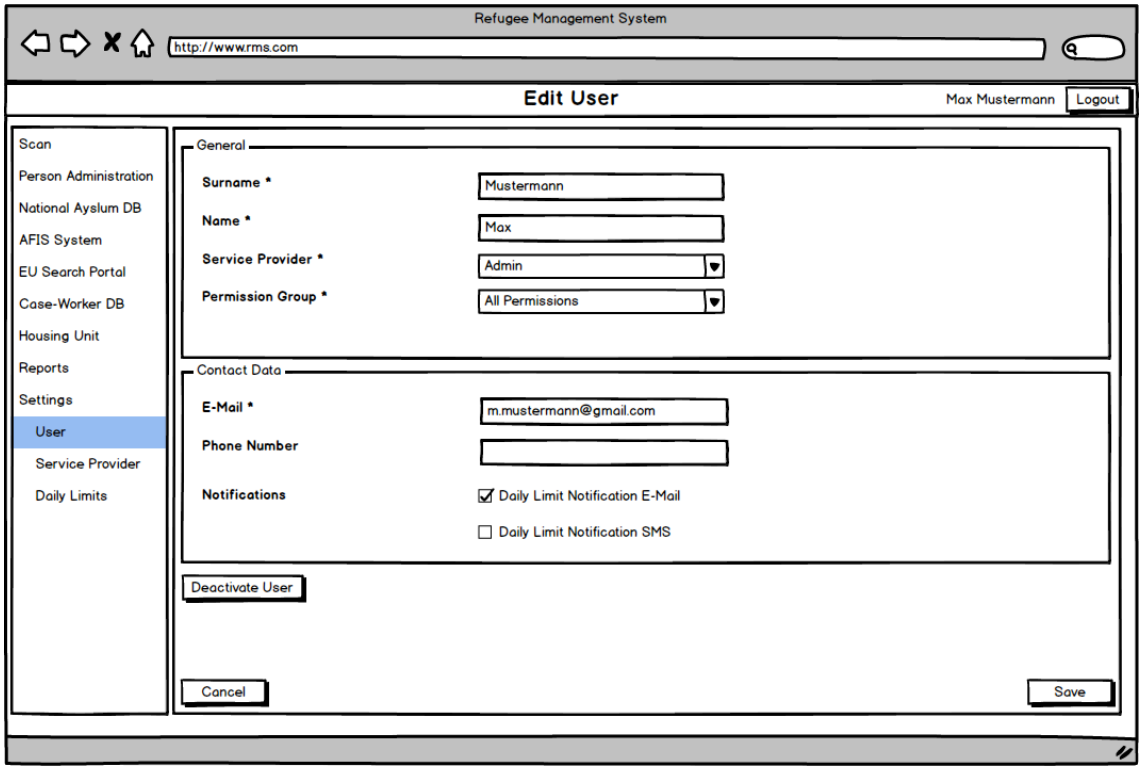


Figure 113: Mock-up RMS Settings Edit User

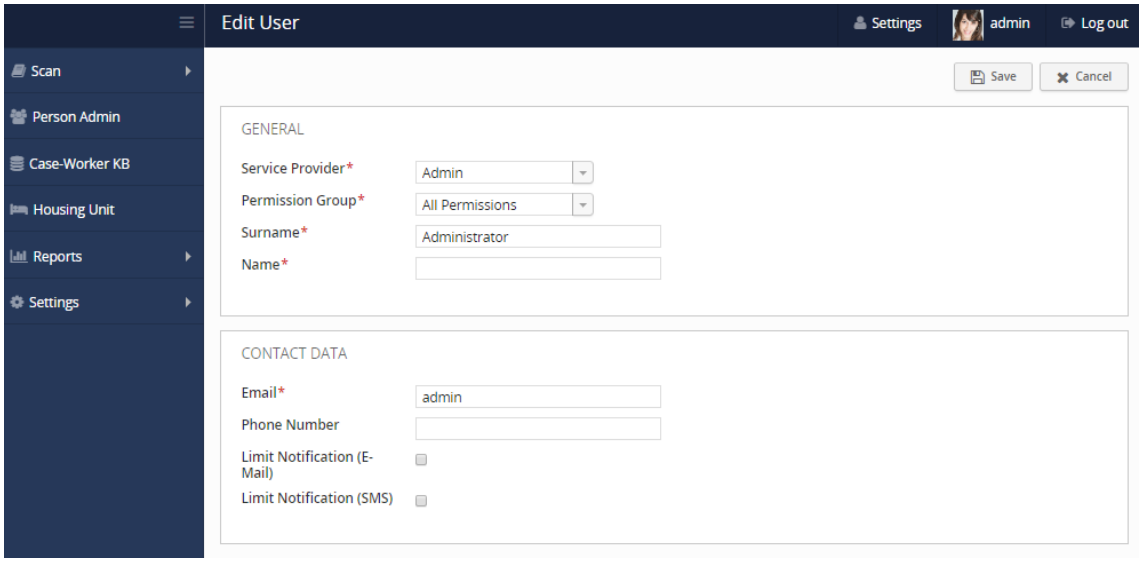


Figure 114: Prototype Settings Edit User

Figure 115: Mock-up RMS Mobile Control and Deactivation

Figure 116: Mock-up RMS Mobile Deactivation V.2

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