

CENG 491

Computer Engineering Design

Requirement Analysis Report

BUGBUSTERS

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1. INTRODUCTION

a. Project Title

The title of the project is ***Railway Information System (Demiryolları Bilgi Sistemi)***.

b. Problem Definition

The major problem with the current system used in TCDD is that there are many daily jobs and most of them are done manually. Also some features are not public and some services used in abroad are not yet introduced to passengers of TCDD yet.

- i. There are many kinds of machines and machinists must have the appropriate brevet to use a machine. Every day hundreds of machines goes somewhere to somewhere and every machine is controlled by a qualified machinist. In current system the assignment of machine – machinist is done daily and machinists get information about their schedule before 24 hours. If the really extreme cases are not considered, the schedules may be prepared for a longer period, for example weekly or monthly, and automatically.
- ii. All railways in Turkey are partitioned and for every partition the speed limit are determined. All these information are listed on tables in a book called livre. When a machinist starts the journey from some point, he/she (he will be used later) opens the relevant page of livre. Machinist knows his position with the help of the position signs near the railway and checks the speed limit from the table for his current position until the end of the journey. With the help of a GPS device, the necessity to follow both the position signs and the speed limit tables may be reduced to just follow a panel in locomotive.
- iii. About 15 trains of TCDD have a GPS device currently. But the information fetched from these devices are visible to only some supervisors, even machinist cannot see them. If basically the position information and some relevant information such as speed, the estimated time of arrival, etc are made visible to public, the public interest on railways will surely increase. Because railway is safe,

cheap, fast and environment friendly; increasing public interest on railways is something greatly desired.

- iv. Although some optimum cost / optimum time train suggestion systems are in use abroad, there does not exist a similar system in Turkey. If TCDD intends to attract more people, besides introducing some high speed trains, it should also install such services. Perhaps considering the railway net of today's Turkey one may say that there is no need such a system but after a few decades it may become a highly desired service.

c. Goals

The aim of **Railway Information System Project** is mainly to enhance the service quality of TCDD for passengers and relevant TCDD employees by eliminating the problems mentioned above. To list the project goals:

- Make the current TCDD train control system better
 - Automate the machinist – machine matching (IMA)
 - Remove the “checking the speed limit from livre” and replace it with “checking needed information from machinist panel”
 - In case of an emergency, establish a faster and easier communication with control center and deliver the train position more accurately
- Make the public interest on railways increase
 - Make the train position tracking public
 - Install a optimum time / optimum cost train suggestion system
 - Meeting this goal also has a side effect of highly use of public transportation which means less traffic jam and

accidents

- The use of system will be made easier for every category of users (administrators, machinists, passengers) with knowledge database, help pages and manuals

d. Abbreviations

<i>RIS</i>	: Railway Information System
<i>IMA</i>	: Intelligent Machinist Assignment
<i>OTSS</i>	: Optimum Train Suggestion System

And some words in railway jargon:

<i>Machine</i>	: The locomotive.
<i>Brevet</i>	: The certificate to use a machine.
<i>Livre</i>	: The speed/position tables book.

e. References

i. Web Sources

- A German train suggestion system:
<http://www.bahn.de/international/view/tr/index.shtml#>
- Construction of Optimal Databases for Railway-Station Restoration Knowledge Management Systems – Istvan PALYI
http://www.pp.bme.hu/tr/2003_1/pdf/tr2003_1_07.pdf
- Rail Vehicle Positioning System - Roger D. Burns et al
<http://www.google.com.tr/patents?id=GtckAAAAEBAJ>

ii. Books

- 3d Modeling & Surfacing – Bill FLEMING
- GPS Satellite Surveying – Alfred LEICK

- GPS Made Easy: Using Global Positioning Systems in the Outdoors - Lawrence LETHAM
- User Interface Design – Ray E. EBERTS

Probably more references will be needed. They will be cited in following reports.

f. User Classes & Characteristics

i. Administrators

We assume that they have good programming experience and they have some idea about maintenance of a program. In addition to using the program they will also improve the structures and solve the problems related to the system.

ii. Machinists

We assume that they also don't have any programming experience. Apart from that they only use a limited part of the program and they will only let the administrators know that there is a problem about the system.

iii. Passengers

We assume that they don't have any programming experience and any database knowledge. They will only use the system interface and the basic structures.

g. Operating Environment

Because the system is web-based, it will be platform independent. Also we will guarantee that it will operate without any problems on major browsers such as Internet Explorer, Mozilla Firefox, Opera, and Safari.

2. SYSTEM FEATURES

In this section; we clarify all of the features of our system. Because our system will be a web based application, it would be better to describe these features with respect to the functionality of each page.

a. Web Based Application

i. Login Page

- Administrator Login

- Machinist Login
- Passenger Login

Our Railway Information System will be a secure system which requires membership to the system for all the users.

There will be three categories of users of system: passengers, machinists and administrators. All of them will be registered to the system differently. For instance every passenger who wants to use the system will firstly fill in a registration form. Some personal information like name, surname, user name, password, address, telephone will be taken and stored in a user database. This database will also save some additional statistical information apart from the personal data, which will be explained later in this document. User name field will be unique and passwords will be encrypted for the system security. Since the administrators will be able to access all information, they will be able to create their accounts without a restriction and they will also create accounts for the machinists and other relevant TCDD staff. Regarding to different logins into the system, the interfaces will change. For example, the administrators will always have an editing option in all web-pages. Other users will never access to the editing options and the machinists will only reach their schedules and trains' related information.

ii. Home Page

- Passenger :Travel Planning
- Machinist :Daily Schedule

After logging into the system a home page will welcome the users. The home page will be one of the most important pages for the passengers. This page will offer the passengers the best traveling options to their destination places. To accomplish this task, it will combine some information obtained from the passenger with an effective algorithm. First of all, the passengers will determine their current position and target position with the drop down menus. The contents of the menus will change if the passenger chooses another place to go. Then 3 other drop down menus will appear. These menus let the passenger choose when to travel, at most how long to travel, how many times at most they want to change the trains and which trains they prefer (fast / normal).

According to supplied information an intelligent decision will be made by the system. The results will appear in a table which allows user to sort them according to his preference: time, cost, train or changes in train. All of the information about trains will be kept in a huge database table. The user will be able to clean the results by using the cancel button or save the results in their personal page. In the personal page, the results will appear as a link. A print version of this table will also be available to user so that he can refer to the printed information before buying the tickets.

Machinists' home page will show different kind of information. During the interview, we have reached the information that they have to begin the daily preparations (like taking the schedule, going to the trains they will use) 2 hours before the departure. This time can be reduced by proper online communication. The machinists will be able to reach their daily schedules via their home pages. The home pages will be updated regularly by administrators.

iii. Personal Page

- Passenger :Personal Data & History

The personal page will have 2 different options for a passenger. Passengers will be able to update their personal information like name, surname, password, and user name. Because the user name is unique in database, it will be checked by the system if such a user name already exists in database via restrictions. Another thing is the control of the mail address of the user. If it doesn't include a '@' symbol after sending a form, system will give a warning (Also there are many tutorials on web for php e-mail validation, we may use one.). Secondly this page will also include some information about the usage of the system for a specific passenger. To exemplify; this page will show how many tickets the passenger has bought so far, which trains he has preferred, which search results he has saved and the news about his most preferred trains (such as promotions in ticket prices). We also attach a big importance to travel history of the passengers. In the future, the passenger may collect some points / bonus from the tickets he has bought. In this way people's attention can be attracted to the public transport vehicles such as trains.

iv. Live Train Monitoring Page

- Passenger : Control Panel & Monitoring Window
- Machinist : Control Panel & Monitoring Window

One of the most important parts of the project is that all of the users will be able to track the trains via web connection. This page will be different for different users.

For the passengers, there will be a control panel and a screen showing the current position of the trains with the points on the map. With the help of the panel, they will be able to choose specific trains or some specific areas. According to the preferences on this panel the points on the map, which shows the positions of the trains according to the information obtained from the GPS, will be updated. If a train is clicked some information about this train like name, speed and position will also be shown. The update rate of this page will be optimized to give the sense of a real time monitoring. With this property the passengers will be able to know where the train is and what the next station will be. For a long distance travel, such information can be useful not to pass the train stations.

TCDD staff will use this page with the same purpose but their page will be specific to their areas. According to the information that we have taken from the machinists, they have to check continuously from a booklet where they are and what the speed limit in this area is. They also have to check the signs on the railroad to indicate their current position. But they have to be careful during the train service too. For this reason, the panel of the machinists will be different than the panel of the passengers. We have decided to add some guide information to this panel during the travel, so that they won't have to search for the maximum speed in the booklet. This page will show the current position of the train on the map. The optimum speed will be determined according to the position information taken from the GPS. Trains current speed, which is also available on the panel, will be compared to the max speed and a warning will be given if this speed limit is not obeyed. They will also get the information, how far the next stop is. Via this service they won't lose time with searching any speed limit or they can optimize their speed if they are close to the station. The panel will also show

supplied a chronometer for the machinist. This chronometer will work in accordance with the speed of the train and the position of the train. It will count down from the time the train stops until the train should leave the station.

For the admin this page will have a different property. In an emergency situation an emergency signal can be given manually or automatically from the train. A button on the screen will be supplied to the machinist. If they push the button a number of useful information about the train will be sent to the related persons and the point of the train will be animated in this situation. (Like a bigger and colorful point showing that there is a problem with this train). Although the machinist and the control points stay in contact with a transmitter, in an emergency situation communication with a transmitter can be problematic. The automatic signal will be activated according the signal received from the accelerometer. If the angle between the train and the rails is smaller / bigger than a certain value an automatic message will be sent to the nearest control point.

v. Contact Page

- Passenger : Contact Data
- Machinist : Emergency Calls

In the contact page all the information considered important for the users will be given. The stations, the places where train tickets can be bought, the call centers are some examples for the addresses, e-mails and telephone numbers. All of this information can be filtered when the passenger chooses a location in the drop down menu in this page. All contact data will be supported by Google maps. When the passengers click on the e-mails, a division on the screen will appear. This division will allow passengers to send their requests or complaints.

Machinists will also have a contact page of emergency situation. Also for the communication via transmitters they might need to have a contact information or they might need to ask a question to a specific person during the travel.

vi. Administration Pages

- Administration :Edition Options / Schedule Planning

For the administrators, there will be update/edit options in all pages. They will also update the database tables and they can prepare daily schedules for the machinists. In fact, the program will assign the machinists to the trains according their properties and skills. But, the administrators can change the schedule of the machinists and trains with respect to some exceptions. While doing this task, the system will help administrator to find the proper machinists for this train service. The administrator will have a page where it can easily execute search queries on the machinists' properties such as; their available time, experience and driving license. Administrators can also see all of the trains in this system. In case of emergency, the system will warn them on this page properly.

vii. Help Page & FAQ

- Passenger :System Manuals / Features & Tips / FAQ
- Machinist :Train Manuals
- Administrator :Administration Manuals

The help page will provide useful information regarding to the proper usage of the system and describe all the features elaborately. Apart from the documentation of this system, which can be used for the prospective developers, manual pages for all users will also be provided. Manuals will describe how to use the system for each of the users.

A list of the frequently asked questions will be provided especially for the passengers and administrators. The passengers can search a specific topic in the "Knowledge Database", which will both be created after the development and be improved by administrators related to the questions asked by the passengers. Thinking that, the answers to the questions may concern every passenger such a database let the administrators not to lose time answering similar questions.

Passengers can also search on the system features like how to edit the personal data or how to save the search results and they may also find

the answers to their questions. Features and tips will help them to solve some minor problems easily.

Machinist can also use this page. During the interview, we have reached the information that the machinists often attend trainings, so that they learn how to drive the train and eventually to get a driving license. The range of the trains may make it difficult to memorize each detail of the complicated trains. To help them find related information regarding to that train and ease their job, the manual of the train may be uploaded to the system. In case of an emergency, finding information about this train can be easier and faster than finding that in a booklet.

Administrators may also create their own Knowledge Database when they solve some problems regarding to the system. If they add this solution to the database, the other administrators may not lose time with the same kind of problems again.

viii. News Page

This page will give the latest news about trains and schedules like the canceled train services, changed schedules and any promotions about the train tickets. Personal page will also filter this information and retrieve passenger related news to this page. News page will always updated by the system administrators.

b. Simulation

Simulation is the imitation of some real thing, state of affairs, or process. The act of simulating something generally entails representing certain key characteristics or behaviors of a selected physical or abstract system. Computer simulation is a computer program that attempts to simulate an abstract model of a particular system. Computer simulations vary from computer programs that run a few minutes, to network-based groups of computers running for hours, to ongoing simulations that run for days. The scale of events being simulated by computer simulations has far exceeded anything possible. That's why simulation is so popular and useful.

In our case; since it's very hard for us to work with real trains and GPS devices, we will simulate the trains, their movements and some emergency situations,

GPS receivers and the signals sent from these devices to main application, data coming from the little sensors like accelerometer. First, nearly the whole project will work like a simulation application. It's hard to get many GPS devices and it's harder to test the application with these kinds of devices. In the test part we must get GPS devices on moving devices like trains and they must be very far from each other. And we also have to create database of stations and speed limits according to the test cases. Also we need to test emergency situations. It's difficult to meet all conditions of a test case. So, simulation is a better and easier solution for testing.

To simulate the whole system we will find out the working principles of the hardware parts included. We will implement our own simulator and use this information as preparing the inputs for the simulator.

Although, the program will mainly work as a simulation, it will have the capability of working with real objects.

3. REQUIREMENTS

a. Functional Requirements

i. Software Requirements

- Google Maps API

In the Contact page, passenger will be able to see the exact places of stations and ticket counters. For the users, it's easier to locate some place by viewing on a map rather than just knowing the address. So, we decided to use Google Maps API to indicate the positions of these places. The Google Maps API lets someone embed Google Maps in web pages with using JavaScript. The API provides a number of utilities for manipulating maps and adding content to the map through a variety of services.

<http://code.google.com/apis/maps>

But we cannot use these maps for the machinist console, because there is a limitation on the number of requests per day for a particular IP address. We will handle this condition with implementing our own 3d models.

- Doxygen

Documentation makes big software project easier to understand, manage and participate. While a software project is getting bigger and complicated, it becomes much more difficult manage the parts of the program. Sometimes it goes out of control. Documentation ensures all the things to be in order.

There is two main popular documentation tools used in Java: Doxygen and Javadoc. Many of their properties are similar. Doxygen can produce outputs as HTML, PDF, and PS or as a man page, while Javadoc can only produce HTML pages. So, we think that Doxygen can be much more useful for us.

- Other Software Requirements

We will use MySQL as DBMS. For the web pages we will use PHP, JavaScript, AJAX, CSS and HTML technologies. PHP and JDBC will do the database connections.

ii. Hardware Requirements

- GPS Device

Since this project is mainly a GPS tracking project, we will need GPS receivers to track the trains on the road. GPS receivers will send the current coordinates to the program and the program will find the current maximum speed limit from the database looking at the coordinates. And it can also calculate the remaining time to the next station.

- Accelerometer

Accelerometers are used to measure the angle between a surface and ground. We will use the accelerometer to understand if there is a problem with the train on the road. If the train goes out of the railroad and tumbled, we can understand this from the accelerometer on the train. The data from the accelerometer will be checked regularly and in case of an inconsistency a warning will be sent to administrative center. We can implement an interface for the accelerometer as a part of the console of the machinist. The

Java program will handle the data from the accelerometer and process it to show on the screen.

b. Nonfunctional Requirements

i. Accessibility

One of the main purposes of this program is accessibility. TCDD is currently using a system like ours, but it's not accessible by passengers. Actually, some parts of the system concerning time tables are even not accessible by machinists. The main goal here is to make a system accessible by everyone.

ii. Extensibility

Since the railway system in Turkey is always open to improvements. Recently, some new technology trains and railways are being added. And there is always a potential of extending. So, the program should respond the needs of the system. Also the program itself should be extensible for new features (like being used on ticket kiosks).

iii. Documentation

Since the system will be available for all users, a detailed documentation for end user should be prepared. In addition to user documentation, a technical documentation will be done as design reports and weekly progress reports.

iv. Security (Privacy)

Since the users in the system will give some personal information to the system. We must ensure that the information will not be seen by any unauthorized person. And also the passwords of the users will be kept with an encryption system.

v. Efficiency

In the user page, users will be able to find an optimum way according their choice of trains, routes, destinations, train changes. The calculation held by the program should be done efficiently to show the results as

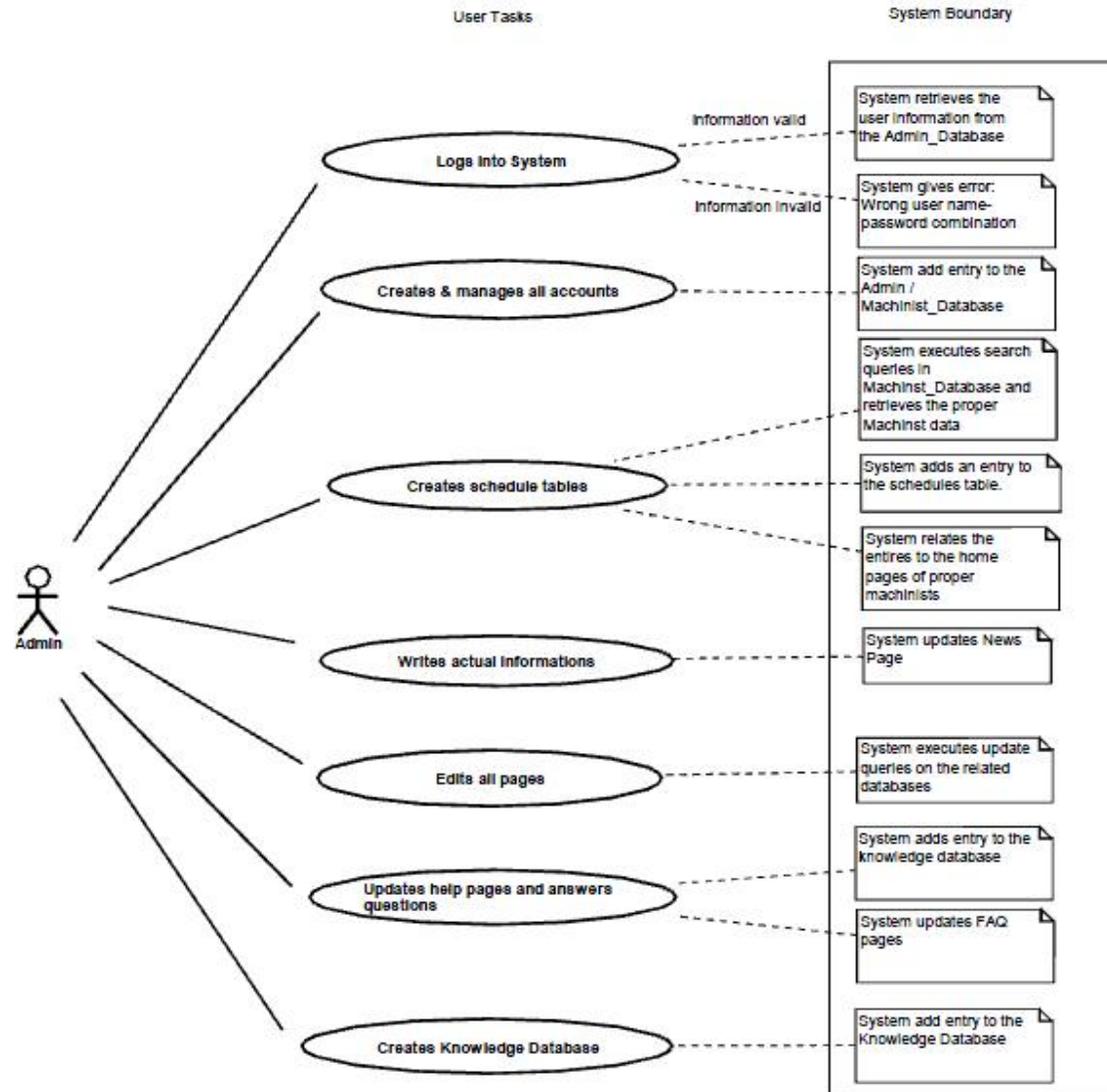
fast as possible to passenger. And also the program will execute many data queries for speed limit on machinist console, scheduling of machinists, finding information related to users, finding optimum way. These queries should be held efficiently; especially the queries working on machinist console should be executed fast. We must find a good algorithm to calculate the optimum way and we should do some optimization to execute queries faster.

4. DIAGRAMS

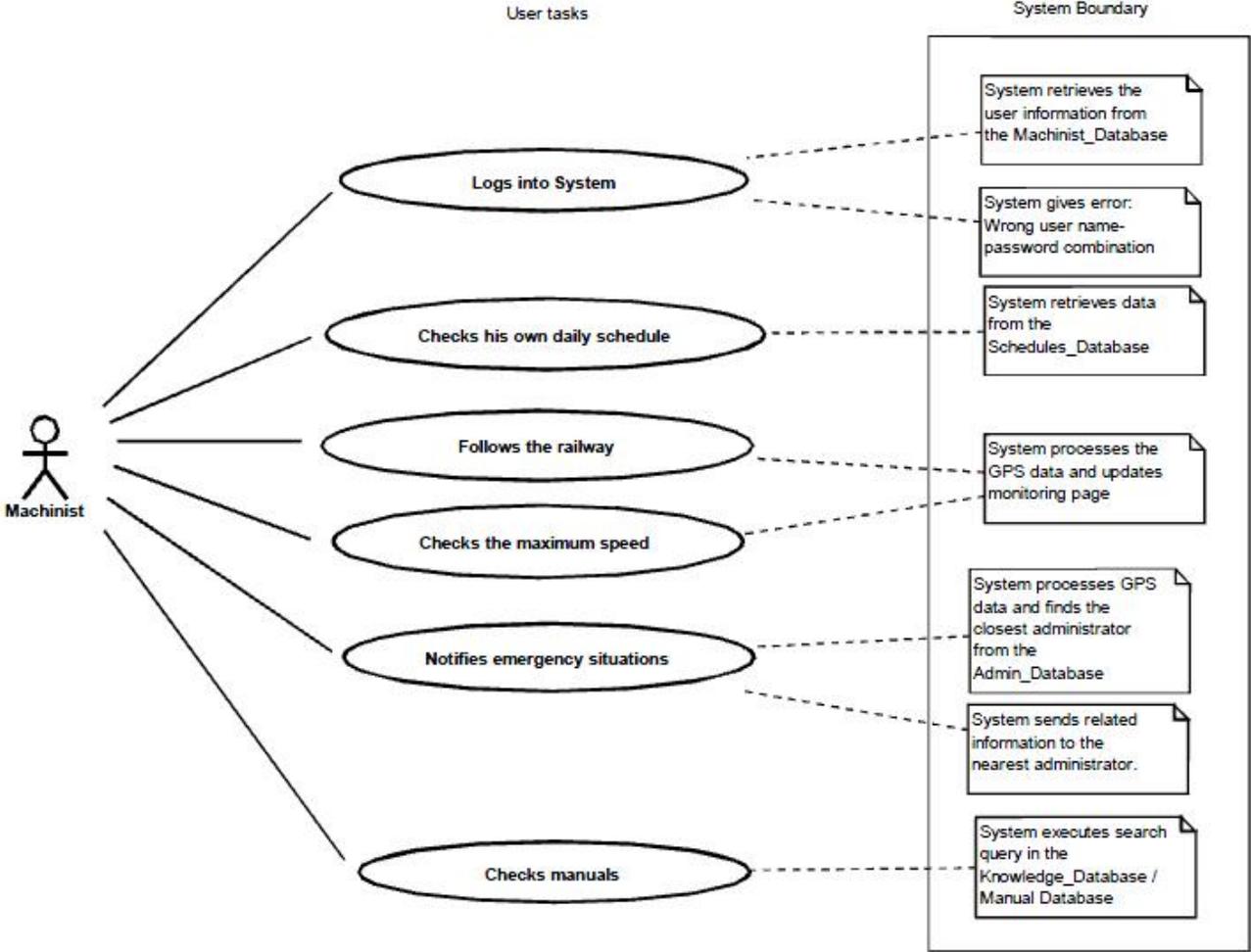
(All diagrams are also added as separate files.)

a. Use Case Diagrams

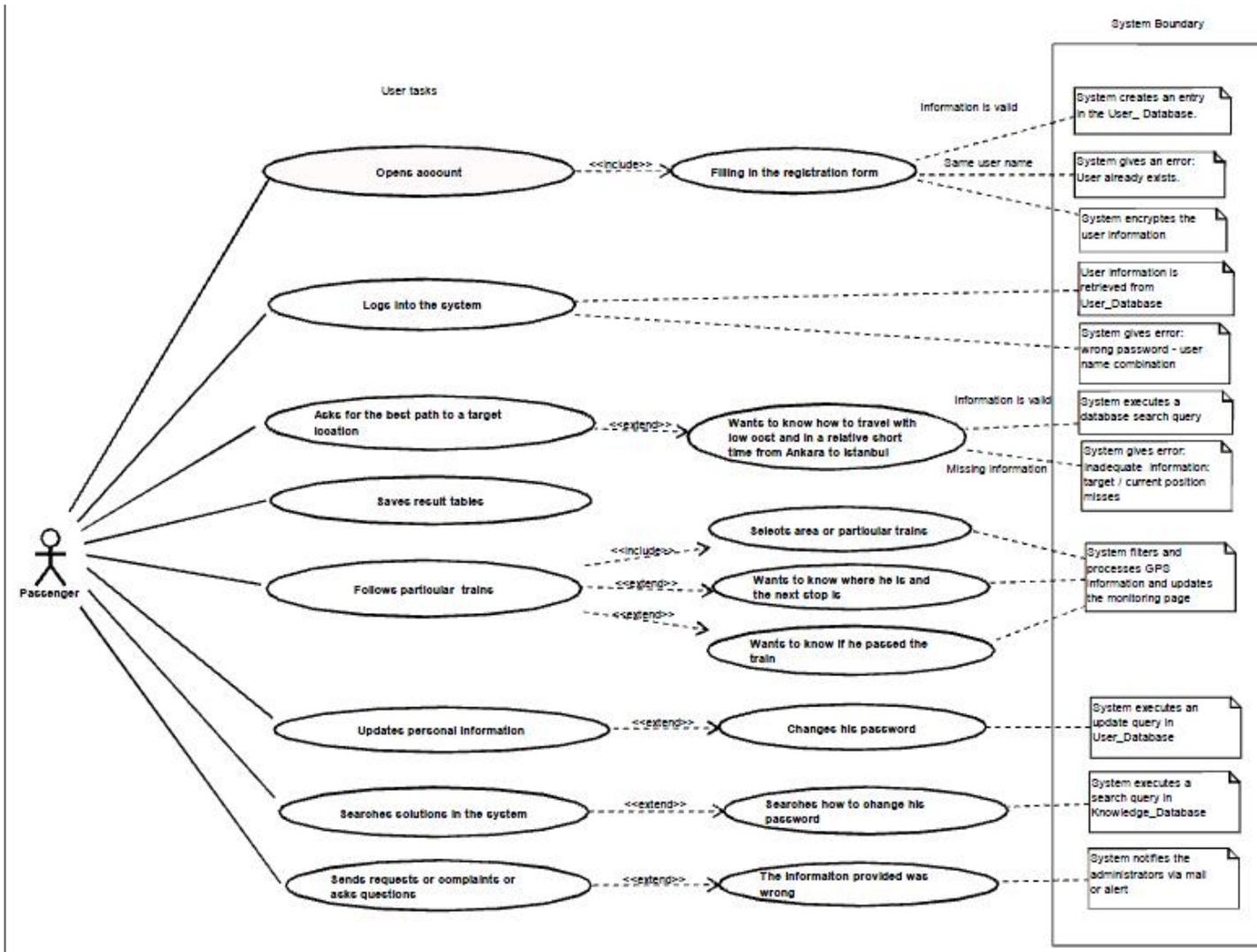
i. Administrator Use Case Diagram



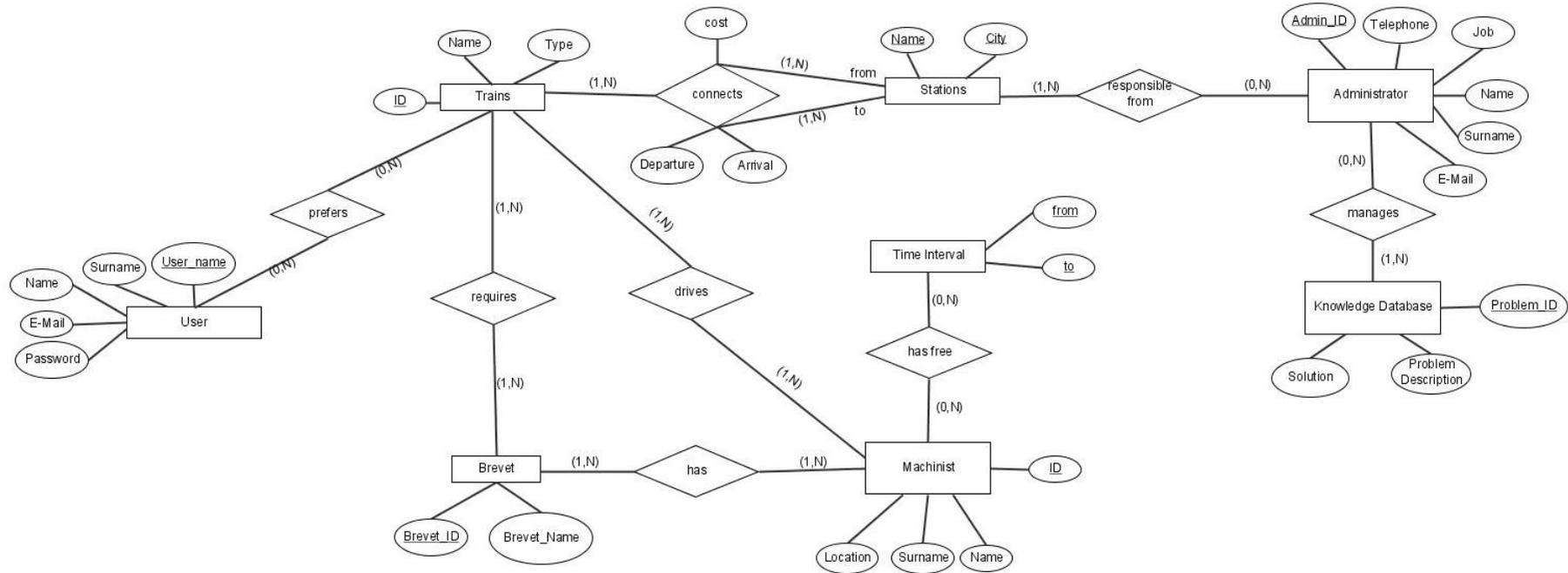
ii. Machinist Use Case Diagram



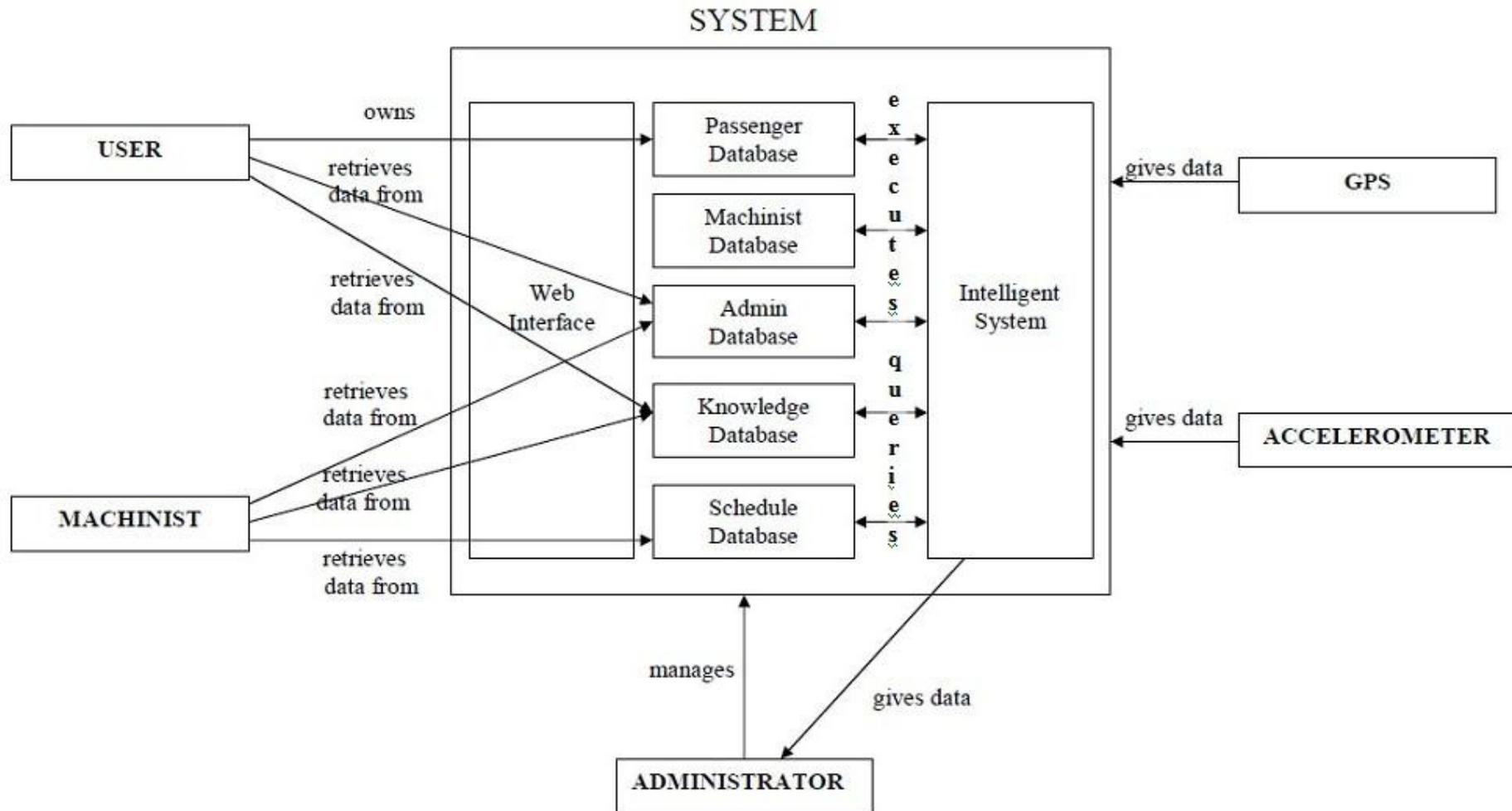
iii. Passenger Use Case Diagram



b. ER Diagram



c. System Diagram



5. TASK ASSIGNMENTS

a. Burkay

Burkay will deal with 3D modeling of the system, which includes a train monitoring application. He will implement 3 interface for each category of users in the system.

b. Caner

Caner will implement user interfaces and design our web pages. This part is modeled as “web interface” on the system diagram.

c. Çağrı

Çağrı will deal with the simulation part. Since we can't continuously prove our system in the real world, we will implement our system based on the datas coming from his simulator programs.

d. Işıl

Işıl will code background part of the system. She will code Java applications and develop algorithms for them. This part is shown as “Intelligent System” on the system diagram.

6. PROJECT SCHEDULE

	October 2009				November 2009				December 2009				January 2010				F		
	39	40	41	42	43	44	45	46	47	48	49	50	51	52	Week 1	Week 2	Week 3	Week 4	W
Research																			
Topic Proposal																			
Field Research																			
Paper Research																			
Analysis																			
Requirement Analysis																			
Project Planning																			
Design																			
Initial Design																			
Detailed Design																			
Final																			
Prototype																			
Design Analysis																			