

RAILWAY INFORMATION SYSTEM

CENG 491 Computer Engineering Design

Detailed Design Report

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1. Introduction

Current TCDD (Turkish State Railways) control system is based on signalization to track the train positions. Although some trains have GPS devices, the GPS system Savronik ^[1] is rarely (almost never) used by system administrators. The communication between administrators and locomotive drivers is established via radiotelephones or mobile phones. A new communication system is being constructed by Siemens nowadays. Administrators have no problem with signalization system, do not like and use Savronik system, and describe the communication system as messy. For the passengers side, TCDD provides an online system which only provides ticket reservation and buying ^[2].

Railway Information System is intended to simplify the current complicated system used at Turkish State Railways. Railway Information System will not only ease the work for system administrators and machinists; but also it will improve and add new features to the online system for passengers.

1.1. Purpose of the Document

In this document Railway Information System structure will be explained. This structure will be constructed such that it will satisfy the requirements mentioned in Software Requirements Specification.

In Software Requirements Specification, Railway Information System's general features and requirements are mentioned. In this document, they will be analyzed in detail.

1.2. Scope of the Document

This document covers the architectural design, data design, procedural design, design constraints, and development schedule. Also hardware and software requirements and working environment will be explained.

1.3. Abbreviations

RIS	: Railway Information System
IMA	: Intelligent Machinist Assignment
OTSS	: Optimum Train Suggestion System

Some words in railway jargon:

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

2. Project Description

2.1. Project Title

The title of the project is “Railway Information System”.

2.2. Detailed Problem Definition

One of the current system’s problems is that there are many daily jobs and most of them are done manually. Secondly some features of this system are not public, which might be used to increase the public attention to railways if they were. Another problem is that some services already in use in abroad ^[3] have not been introduced to TCDD customers yet.

- There are many kinds of machines and a machinist is required to have the special brevet to use a machine. Everyday hundreds of machines goes from somewhere to somewhere and every machine must be controlled by a machinist having the appropriate brevet. In current system, the assignment of machine – machinist is done daily and manually. Machinists learn the next day’s schedule just 24 hours ago.
- 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 for convenience) opens the relevant page of *Livre*. Near the railways, there are position signs and with the help of them, machinists know their positions. Knowing the position, a machinist looks up the speed limit of that position from the *Livre* and adjusts the speed accordingly. Machinists have to follow both the position signs and the speed limit tables from beginning to the end of the journey.
- Current system has been developed as time passed and new technologies appeared. So it has been always built on the old one. Each time taking care to preserve the backward compatibility, adding new features have caused the current system to be very complicated and dirty.
- About 15 trains of TCDD already have a GPS device. But the information fetched from these are visible to only some supervisors, even machinists cannot see them.
- In abroad, there exists some optimum cost / optimum time train suggestion systems ^[3] but there is not a similar system in Turkey.

2.3. Project Definition and Goals

Railway Information System is a project to enhance the service quality of TCDD for machinists and administrators at TCDD and passengers by eliminating the problems stated above.

The aims of the RIS project include:

- Design a better train control system
 - 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

- Attract public interest on railways
 - Make the train position tracking public
 - Implement a optimum time / optimum cost train suggestion system
 - Meeting this goal means highly use of public transportation, less traffic jam and accidents

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

3. Design Constraints and Working Environment

3.1. Design Constraints

3.1.1. Time

In order to meet the deadlines and complete the project on time, team members have to strictly obey the time constraints stated on Gantt chart.

3.1.2. Versioning

As soon as the implementation starts, different states of process have to be versioned. SVN ^[4] will be used as the version control system.

3.1.3. Financial Constraints

All implementation software and tools are open source except AutoCAD Map 3D ^[5]. Autodesk gives free license for this program to students.

3.2. Assumptions

3.2.1. Hardware Assumptions

In every train which will be included in Railway Information System, there will be a netbook computer, a GPS device, and an accelerometer. Netbooks will be connected to internet via a 3G modem. Because showing the current speed, speed limit and angular information coming from accelerometer to the machinist is a time critical mission, GPS device and accelerometer will be directly connected to netbook. The sensitivity of GPS device is 1 meter.

3.2.2. Software Assumptions

Windows 7 Professional^[6] operating system will be used on netbooks. Because showing the speed limit to the machinist is a time critical mission, speed limit databases will be stored locally on netbooks. To query these databases, as the database management system, MySQL^[7] will be installed on netbooks. Even if the internet communication is lost, the system has to work. So a web server is needed on netbooks, Apache HTTP server^[8] will be installed for that purpose. To track the train positions on the map, MapGuide Viewer^[9] will also be installed.

3.2.3. Schedule Assumptions

It is assumed that train schedules are 24 hours periodic, meaning if a train leaves from station X at time t and goes to station Y, tomorrow it will again leave from station X at time t and go to station Y.

Trains will be given five digit id numbers. The first digit will be 1, unless same type train on the same line left the same station before that train. To clarify with an example, assume 18540 is the id of the train which goes from Ankara at 07.00 to İstanbul. If there is a same type train which will go from Ankara at 09.00 to İstanbul, then its id will be 28540. Also for the return, the id will be one incremented if it is even and one decremented if it is odd. For the above example, the returning train ids will be 18541 and 28541 respectively.

It is also assumed that there are not more than 9 same type trains on same line on a day.

There will be 5 type of trains which will be symbolized with a letter from 'A' to 'E'.

3.2.4. Network Communication

During the journey of a train, the netbook will send the train id, GPS information and accelerometer information to main server per 10 seconds. The protocol of packages will be as TRAINID|GPSINFO|ACCINFO. '|' will be used as the separator.

Main server will receive and process the incoming data. It will also send the incoming data of a train to the other trains which are on the same line with it. Main server will redirect the incoming packages also to the web server. To decrease the processing load of the main server, public access to tracking system will be to the web server.

3.2.5. Best Path Search Assumptions

To decrease the computational complexity, number of train changes will be limited to 3 for the best path search module.

3.3. Working Environment

The system will be implemented on *Java* ^[10] language. Users will be able to reach the system within a browser page, so a java running server will be needed. *Apache HTTP server* and *Apache Tomcat*^[11] will be used for that purpose. The map implementation will be done on *AutoCAD Map 3D*. For GPS simulation, java libraries will be used. *NetBeans IDE*^[12] will be used as the development environment.

4. System Modules

4.1. User Module

4.1.1. Registration Submodule

Administrators and machinists will be preregistered to the system. They will be informed about their accounts. Only passengers will register after the system is started to be used. Registration will be done by selecting a username and a password and supplying name, surname, telephone, e-mail, and birthday information. Users are identified with unique usernames. The sequence diagram of registration process is pictured in Figure 2.

4.1.2. Login Submodule

Login part of this module checks the user's username/password and gives access to the system if username/password matches and opens a session for that user. If a user forgets his/her password, user will be able to generate a confirmation e-mail and reset the password by clicking the link being sent to his/her e-mail. The sequence diagram of login process is pictured in Figure 3.

4.1.3. Update Submodule

Users will be able to update their information via update module. Only username field will be unchangeable. If the user clicks "Kaydet" button, then the new information on the form will be overwritten to the old information on the USER database. If the user clicks "İptal" button, then the information on the database will remain same. The sequence diagram of updating personal information process is pictured in Figure 4.

4.2. Scheduling Module

The schedule of the next day is prepared by administrators by hand. It will be edited in a csv (comma separated value) file [20]. The structure of the file will be *machinistID, trainID*. Administrator loads the file via scheduling module and the entries in csv file are loaded to the relation table SCHEDULES. The scheduling sequence diagrams for administrators and machinists are pictured in Figure 13 and Figure 14 respectively.

4.3. Best Path Search Module

When a passenger fills the form on the best path search page, the input fields (departureStation, arrivalStation, dateInterval, timeInterval, maxFare, maxTime, maxTrainChanges) are sent to the searchBestPath function. This function uses the TRAINS database and searches for optimum paths according to given parameters. The results will be showed to user. If user selects to save the query results, they will be added to the BESTPATHS database with the userID. Whenever a user opens the page “Seyir Defteri”, the saved search results will be showed to the user. The sequence diagram of best path search is pictured in Figure 7.

4.4. News Module

Administrators will add the news about some special offers such as a cutoff on ticket prices with detailed information, due date and related trains. The entries will be stored on NEWS database and relevant news (a query with trainIDs, in which the user is interested, on NEWS table’s relatedTrains field) will be showed to the passengers on their home pages. The sequence diagrams of adding news and reading news are pictured in Figure 8 and Figure 9 respectively.

4.5. Journey Module

A machinist logs in to the system via login module before the journey. After that, the machinist module operates. The trainID is checked on SCHEDULE database with current time and machinistID. Then from the TRAINS database, other information for that train is fetched. Until the departure time, the home page of machinist is displayed. On that page the current day’s tasks for the machinist is listed on that page, and a countdown clock to the departure time is showed. When the departure time comes, the page will be automatically directed to the train tracking page. On that page, the warning “Hareket saatiniz gelmiştir.” will be displayed on the warning field of the page until the train moves. Train movement will be decided with the velocity value coming from the GPS device. As soon as the train moves, the map is centered on the train position (the coordinate values are fetched from GPS device). Also with that coordinates, the current speed limit is queried from SPEEDLIMIT database. Current speed, speed limit, departure station, arrival station, expected arrival time information will be displayed on that page on the right frame. In case the angle value coming from accelerometer exceeds 23 degree, the warning “Tren devrilme tehlikesi, lütfen yavaşlayın.” will be displayed. When the train arrive its last station, the machinist logs out and the

corresponding entry is deleted from the schedule database. Train tracking sequence diagram for machinist is pictured in Figure 6.

4.6. Knowledge Database Module

Users will be able to search through four categories in Knowledge database of the system. Frequently Asked Questions; include the questions most asked by passengers and answered before. General Questions & Answers; includes some question about some information about general structure of the system and TCDD. Questions Waiting Answers are the questions added by the users and not yet answered by administrators. The other category is Useful Links.

After the user enters the keywords, the entries from Knowledge Database are returned and listed on the page. If User cannot find the question he is looking for, he can add a new question to system. The user is required to enter the title and choose the problem topic from menu. After the question is submitted, it will be added to the Questions Waiting Answers until an admin enters the solution for the problem. Knowledge database sequence diagrams are pictured in Figure 10, Figure 11, and Figure 12.

4.7. Hardware Modules

4.7.1. GPS Submodule

GPS module establishes the connection of GPS device with netbook computer at locomotive. NMEA^[21] protocol will be used for GPS data. JavaGPS^[22] will be used to simulate GPS.

4.7.2. Accelerometer Submodule

Accelerometer module establishes the connection of accelerometer module with notebook.

4.7.3. Internet Communication Submodule

Internet communication is needed to send and receive the GPS and accelerometer information from trains to the main server and back from main server to trains. This connection will be established via a 3G modem.

5. Architectural Design

5.1. Overall Design

There are many modules in Railway Information System. This modular structure allows later modification of existing modules or integration of more modules in case of a development in one device or technology being used. Also this modular structure eases the implementation of the project.

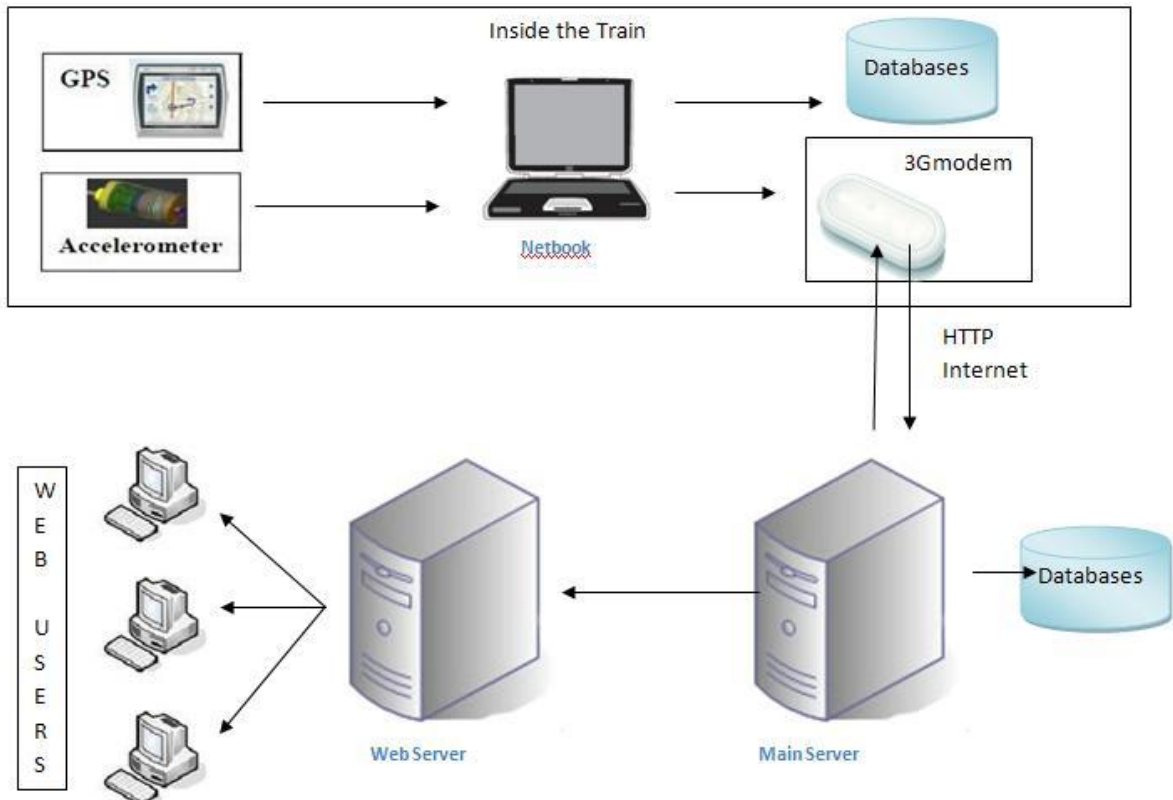


Figure 1 – Design Overview

As shown in Figure 1, every train contains a GPS device, an accelerometer device, a netbook computer and a 3G modem. GPS and accelerometer devices feed the information directly to the netbook. Netbook hosts the SPEEDLIMIT tables, so even if the connection is lost with the main server, there will be not critical failures. Via a 3G modem, netbook sends the information packages to main server over http. Main server processes the incoming packages, sends other trains' information, which are on the same line, back to the train. Main server also sends the packages to the web server. Passengers may connect to the web server and track the trains they select. The web server is separated from the main server in order to decrease the load on the main server.

5.2. Sequence Diagrams

5.2.1. Registering New Users

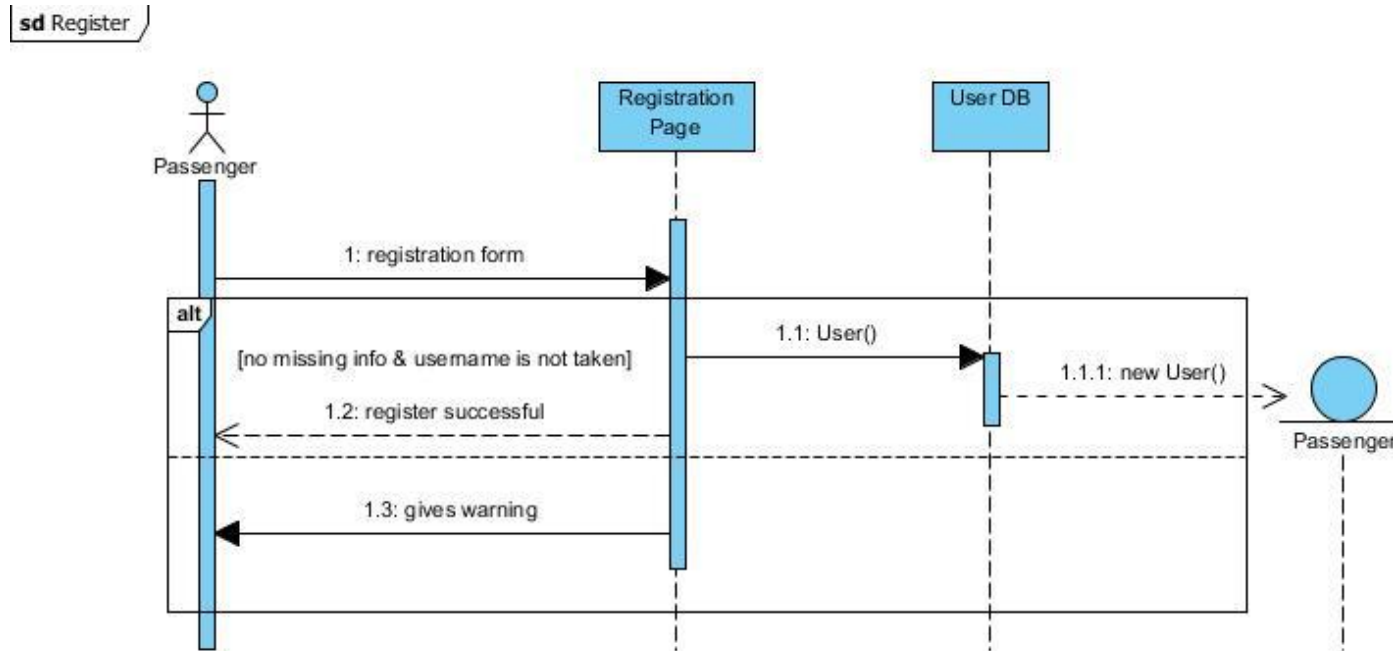


Figure 2 - Registering sequence diagram

- A new passenger who has not an account yet clicks to the link “Yeni Kullanıcı” on the Login Page.
- The registration page will be opened. The passenger fills the registration form and click “Tamam” button to create an account
- System creates a new entry in the passenger database if the required areas are filled properly.

- Otherwise:
 - The system shows an error message if there is an empty required field in the registration form.
 - The system shows an error message if the username the passenger types in registration form already exists.
- Administrators create their own accounts and machinists' accounts directly by executing a query on the database table.
- System encrypts all user information properly.

5.2.2. Logging into the System

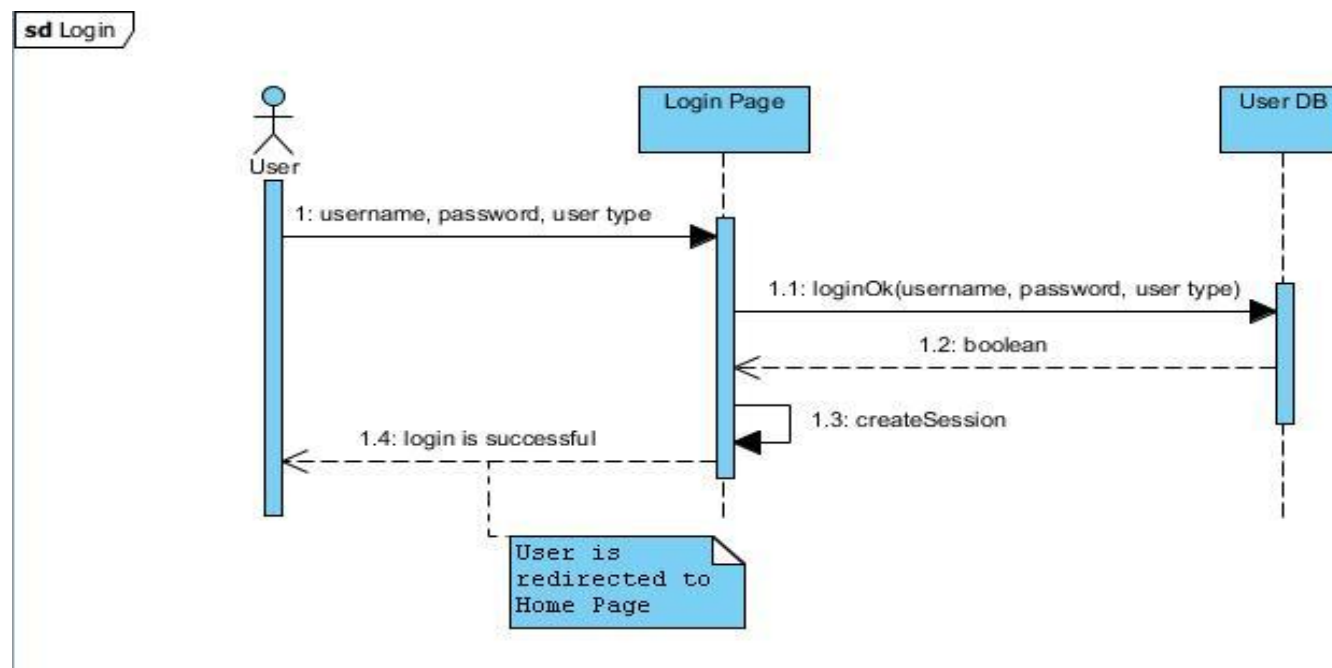


Figure 3 - Logging sequence diagram

- Users logs into the system via Login Page web interface. To log into the system, a user provides his username, password and user type.
- There are three user types: admin, machinist and passenger.
- After filling username and password areas and selecting the user type, a user clicks Login button for confirmation.

5.2.3. Updating Personal Information

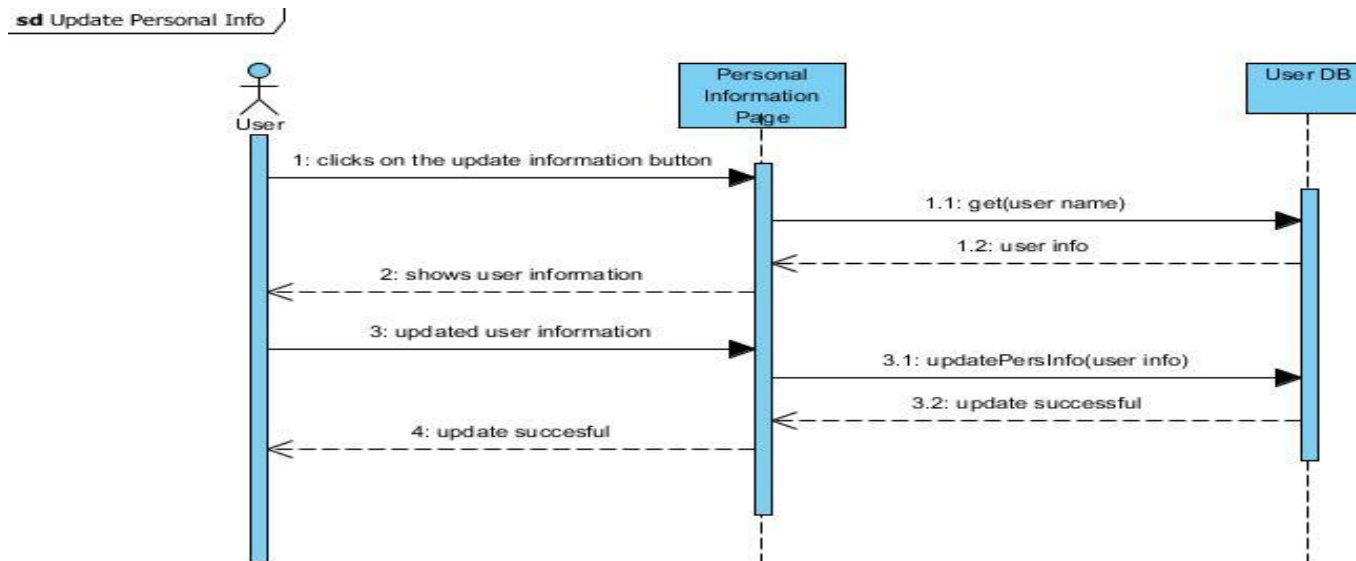


Figure 4 - Updating personal information sequence diagram

- Passenger clicks the personal information link on their home page to update their personal information.

- The Information Page is opened allowing the passenger to change their personal information.
- Passenger clicks on “Kaydet” button to save the changes.
- The system executes an update query if all information provided meets the requirements.
- System encrypts all users’ information properly again.

5.2.4. Live Train Monitoring for Passengers

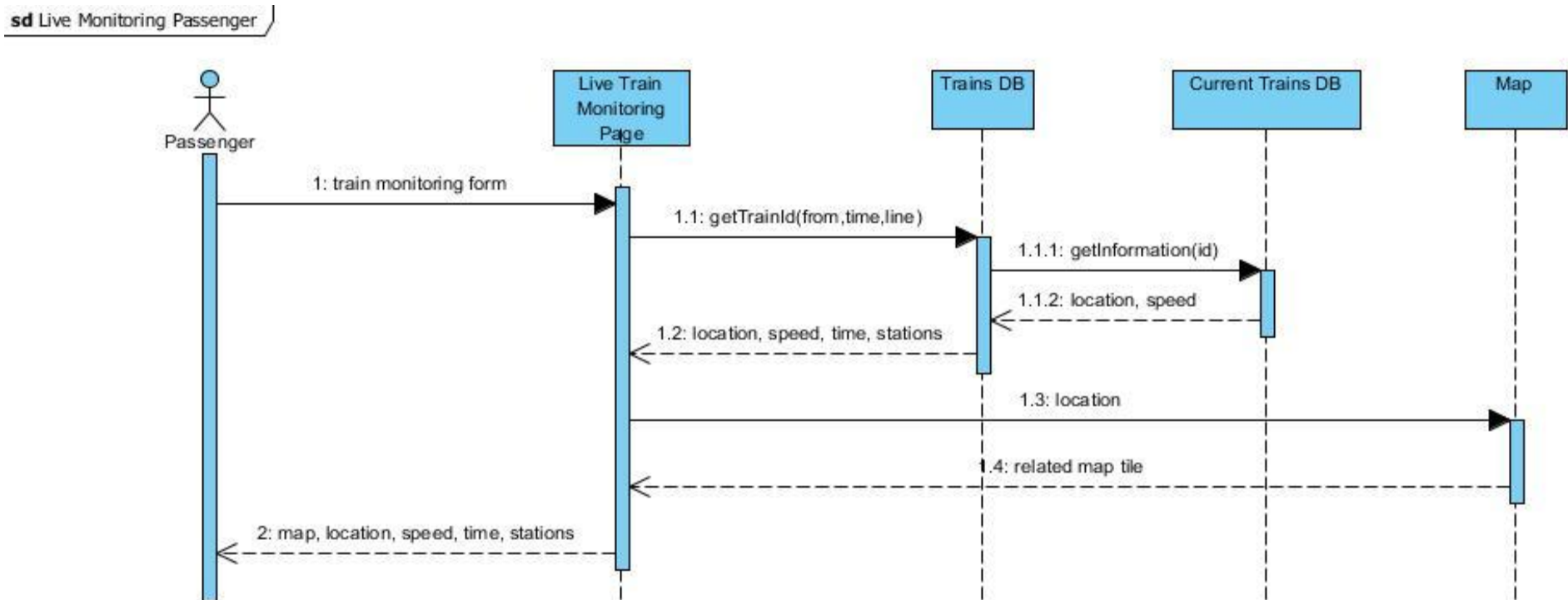


Figure 5 - Passenger train tracking sequence diagram

- Passenger opens the “Tren Takip Sistemi” page which allows users to decide a specific railway to follow a train.
- Passenger clicks the “Seçtiğiniz Hat” combo box to choose a specific railway. System updates the other combo boxes, text fields and the map according to this decision. The “Seçtiğiniz Tren” and the “Çıkış Yeri” combo boxes become enabled. Text fields remain empty.

- Passenger clicks the “Seçtiğiniz Tren” combo box to choose a specific train on this railway. System updates the other combo boxes, text fields and the map according to this decision. The “Çıkış yeri ” and “Çıkış Saati” combo boxes become disabled and are set by the system automatically. All text fields are set automatically too and the map focuses on this specific train. After this point simulation begins and this page is updated periodically according to the given information from the GPS of this train.
- Passenger clicks the “Çıkış Yeri” combo box to choose a specific on this railway. “Seçtiğiniz Tren” combo box becomes disabled and “Çıkış Saati” combo boxes remains enabled. System doesn’t set any text field until the user determines the departure time of the train.
- Passenger clicks the “Çıkış Saati” combo box to complete the needed information to specify a train. After the user specifies departure time of the train, all text fields and the “Seçtiğiniz Tren” box are set automatically and the map focuses on this specific train. After this point simulation begins and this page is updated periodically according to the given information from the GPS of this train.
- Live Train Monitoring Page sends provided information to Trains DB.
- System finds the train id from Trains database and sends it to Current Trains database which keeps position and speed information of the trains
- Live Train Monitoring Page sends the position information which came from Current Trains database to get the related Map tile.

5.2.5. Live Train Monitoring for Machinists

sd Live Monitoring Machinist

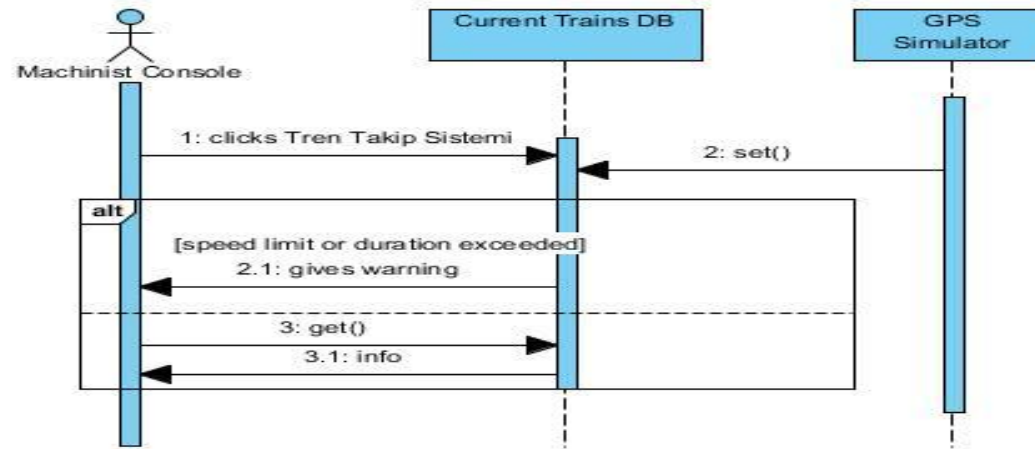


Figure 6 - Machinist train tracking sequence diagram

- Machinist clicks the monitoring link “Tren Takip Sistemi” on his home page to access the monitoring page.
- The “Tren Takip Sistemi” page is opened allowing machinist to watch the train and get current information.
- System gives a warning message if the machinist exceeds the speed limit.
- System gives a warning message if the machinist stays longer than expected at a station.
- System gives a warning message if the train is still very fast but not far away from the next station.

5.2.6. Travel Planning

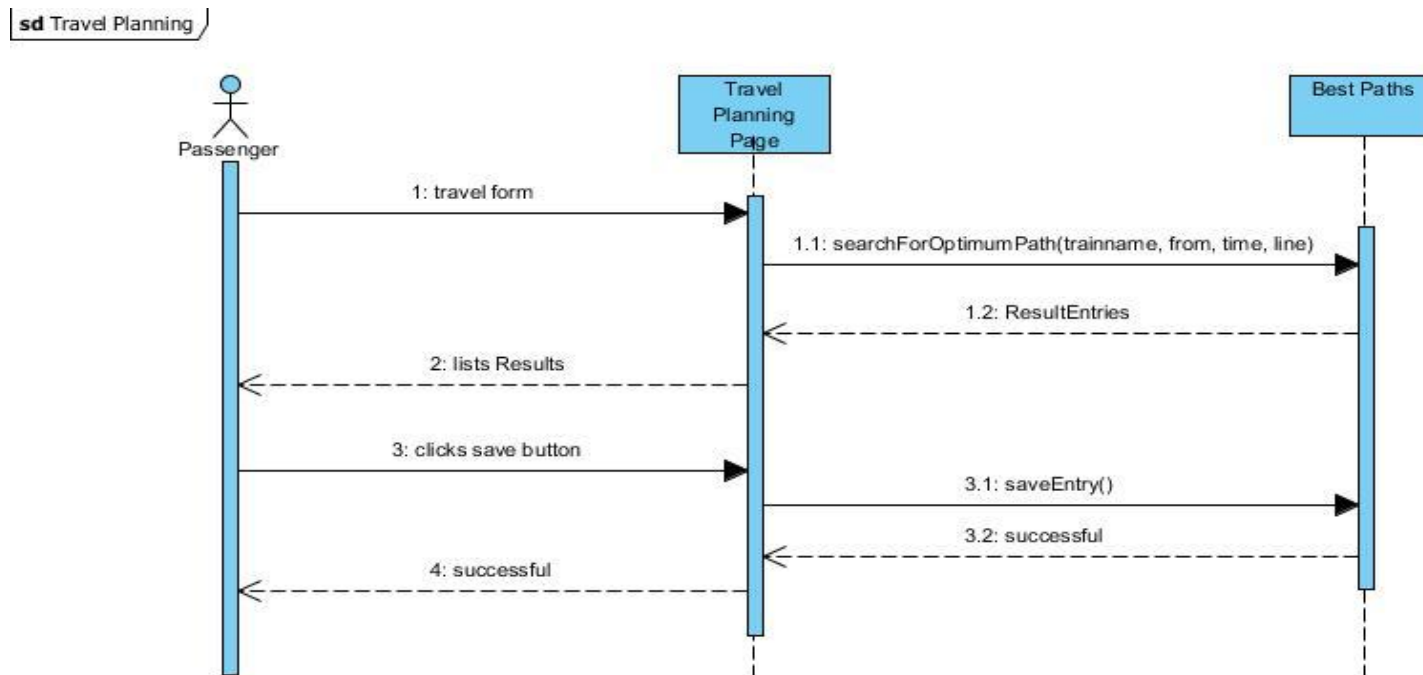


Figure 7 - Travel planning sequence diagram

- After passenger logs into the system, “Ana Sayfa” is opened.
- Passenger fills in the form according to his travel plan and presses the “Listele” Button.
- System executes an optimized search query on the database table “connects” to find the appropriate travels for this specific destination and target.
- After a successful query operation, system loads the table of results to the end of the page and 2 more buttons “Kaydet” and “Sil” appear.

- Passenger chooses some of the results from the table and clicks “Kaydet” to save the chosen results.
- System adds an entry to the “Best_Path” database.

5.2.7. Adding / Reading News

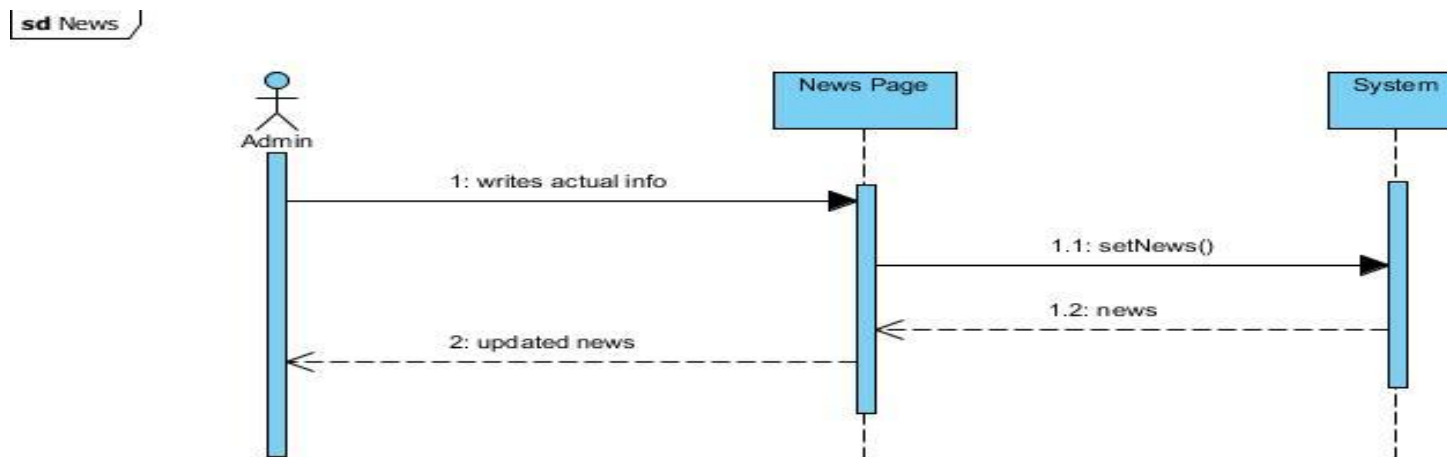


Figure 8 - Adding news sequence diagram

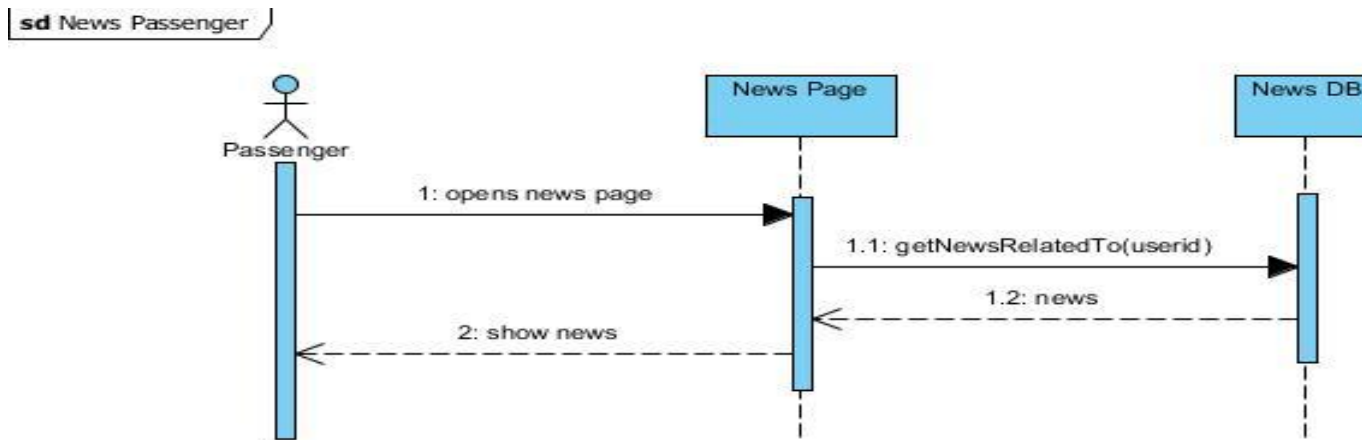


Figure 9 - Reading news sequence diagram

- Administrator creates a “news entry” in the system via the interface of News Database.
- System adds an entry to the table and updates the News Page, which is only available to the administrators in the system.
- System relates this news with the passengers according to their location and preferred trains.
- If no such a passenger is found, system shows 3 random news entries, which are relatively newer than the other news on the home page of passengers.

5.2.8. Knowledge Database

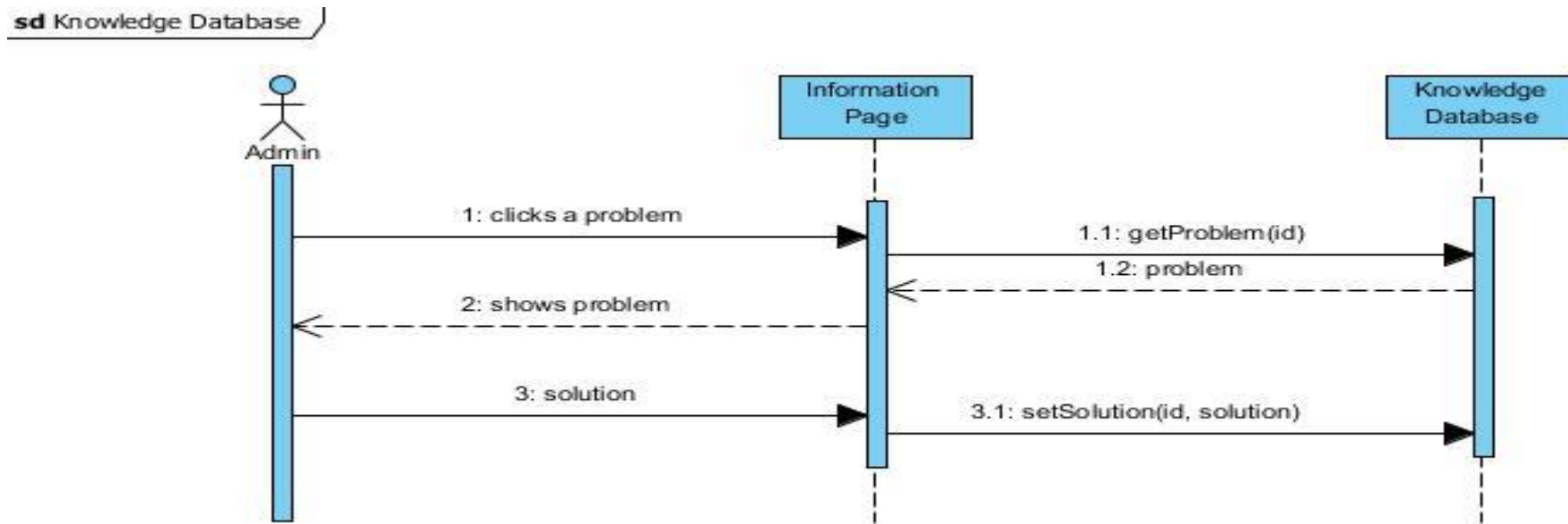


Figure 10 - Knowledge database sequence diagram for admins

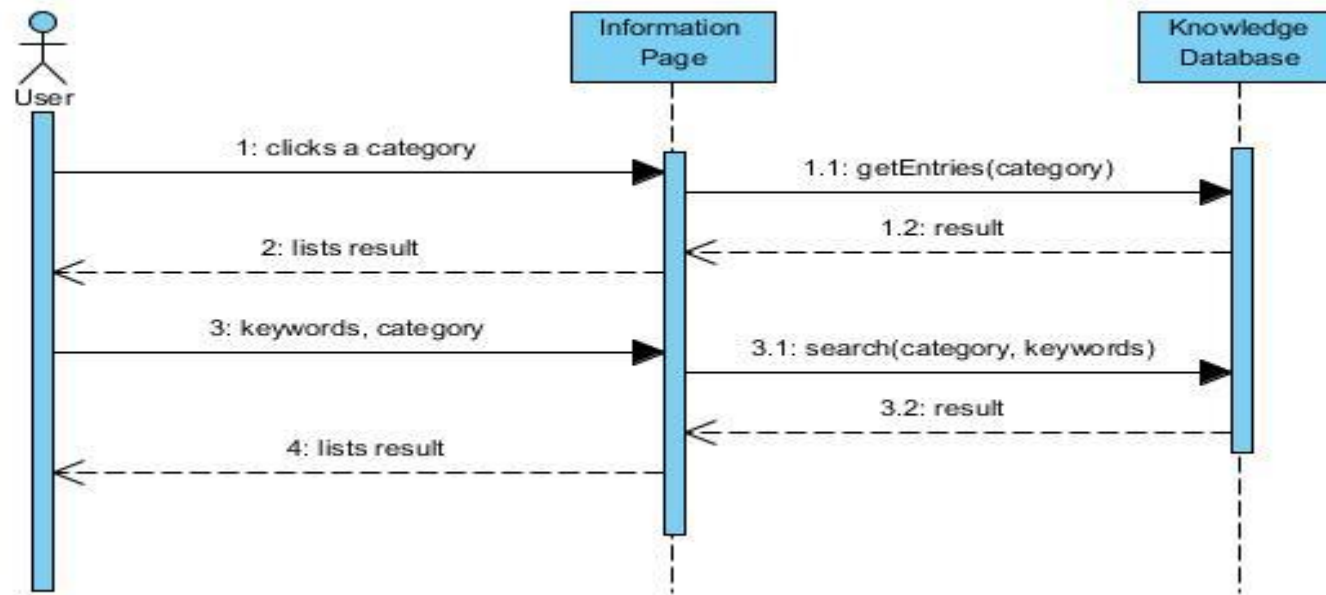


Figure 11 - Searching knowledge database sequence diagram

- Passenger clicks “Sorun Giderme” button on the home page and the “Bilgi Sistemi” Page is opened.
- Passenger clicks a related topic in the section “Sıkça Sorulan Sorular”, which are given as links in this page, to find a solution to his question.
- Passenger finds a similar question and clicks to it to see the details.

- The chosen problem is displayed in a problem specific page.
- If there isn't any related topic to his question, passenger returns to the "Bilgi Sistemi" Page and clicks "Diğerleri" link at the end of this category.
- The page of problems, which don't belong to any general topic is opened.
- Passenger clicks to the similar problem if such a problem exists.
- If there isn't any relevant question in this section, user returns to the "Bilgi Sistemi" Page and writes some keywords related to his question into the text field reserved for search purpose and clicks "Ara" button.
- The results are listed in a separate page if there is any.
- System gives an information message "No matching question " if there isn't any question related to these keywords.
- This operation can also be repeated with other categories: "Genel Sorular ve Çözümler" or "Çözüm Bekleyen Sorular".

5.2.9. Creating a New Question

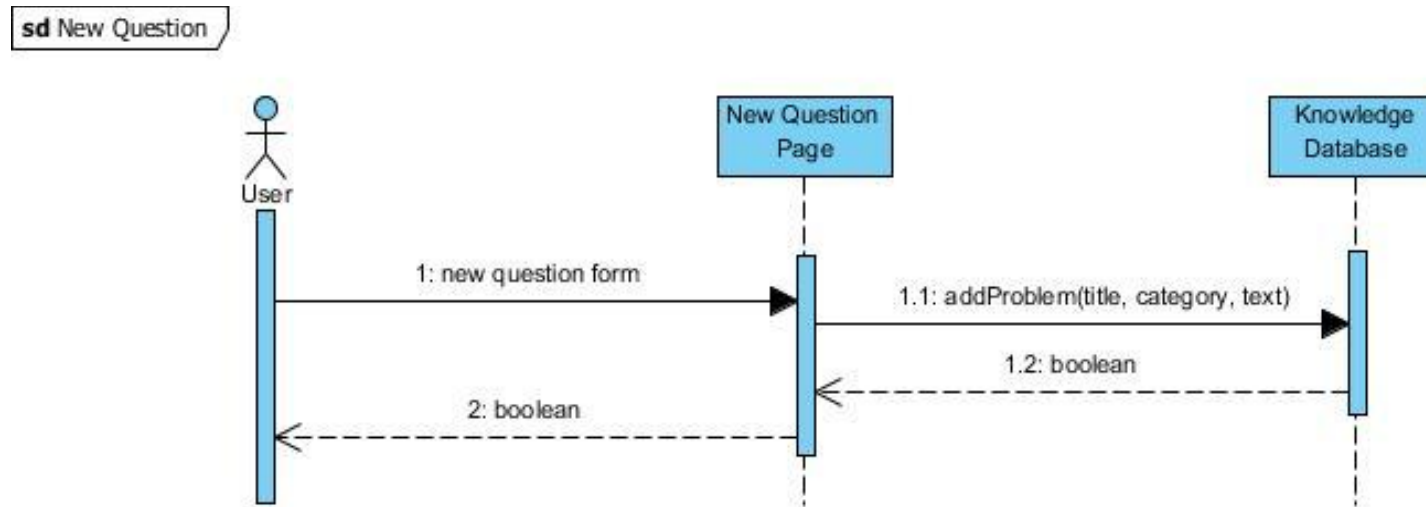


Figure 12 - Creating a new question sequence diagram

- If the search operations result in failure, passenger clicks the button “Yeni Soru”.
- The page of “Yeni Soru Girişi” is opened allowing passenger to write his question and some related information
- Passenger fills the form of new question and clicks “Gönder” button to send his question to the administrators.
- System creates an entry in the Knowledge Database if the required fields like problem title and description are filled. Otherwise system gives error “Missing Information”.
- System assigns this problem to an administrator whose job description includes problem solving.

5.2.10. Scheduling

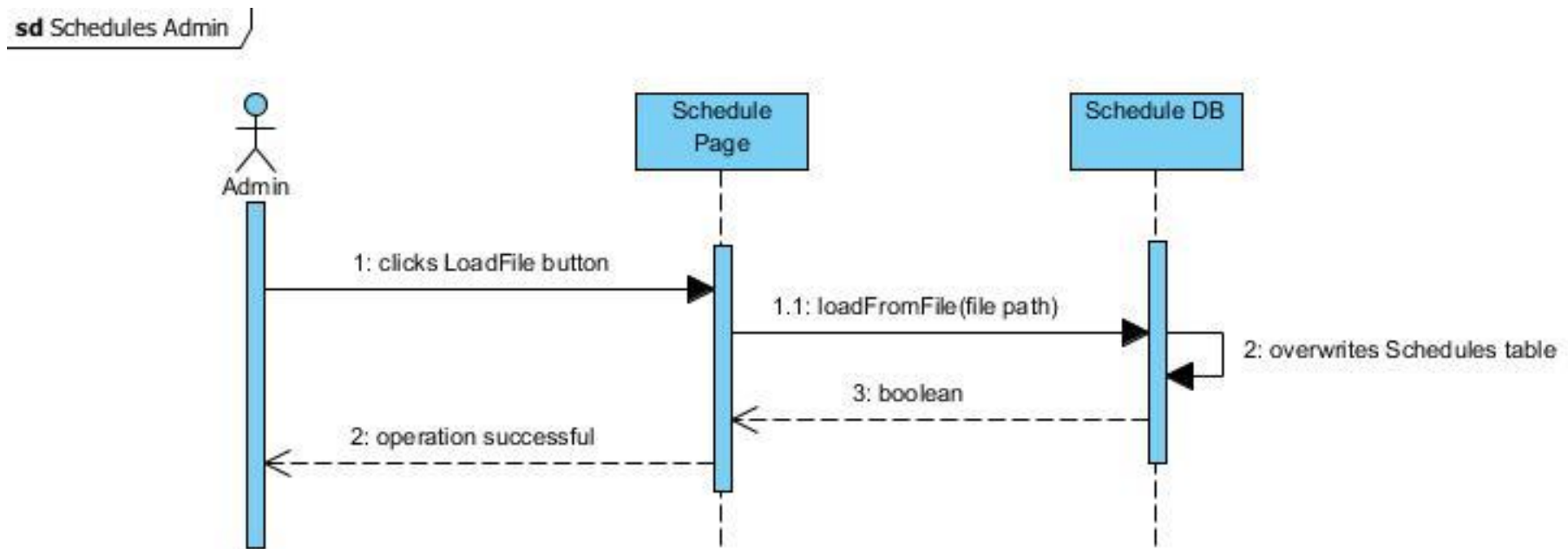


Figure 13 - Scheduling sequence diagram

sd Schedules Machinist

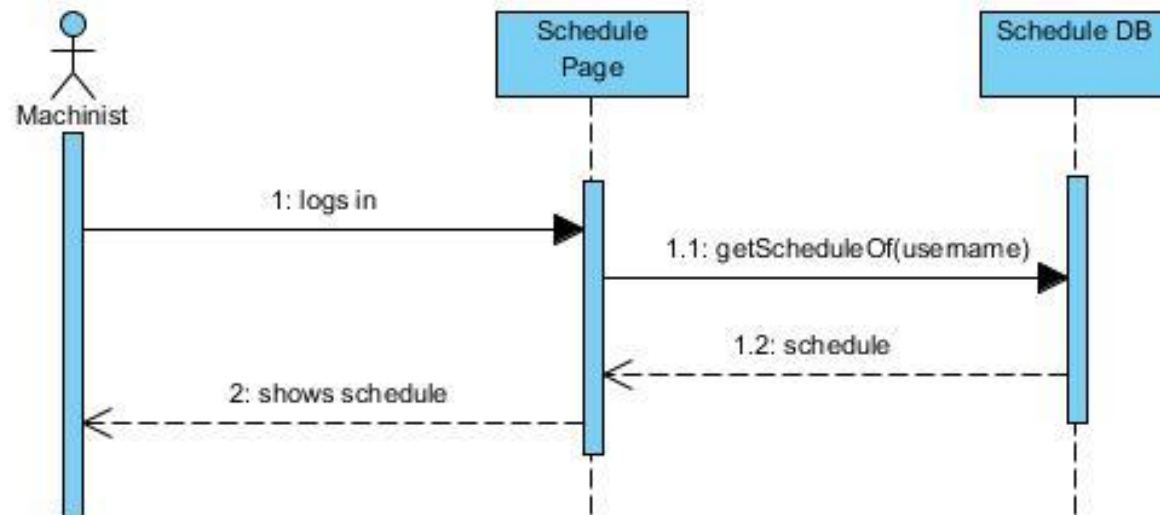


Figure 14 - Checking schedule sequence diagram for machinists

- Administrator executes a search query to find proper Machinists who can drive a specific train in a specific time interval.
- Administrator creates schedule tables via database interfaces.
- System creates a schedule table which stores daily schedules of all machinists.
- Machinists logs into home page to see his daily train schedule.
- System relates these entries in the schedule table with the proper machinists and loads them to the home page of machinist.

5.3. Activity Diagrams

5.3.1. Login Activity Diagram

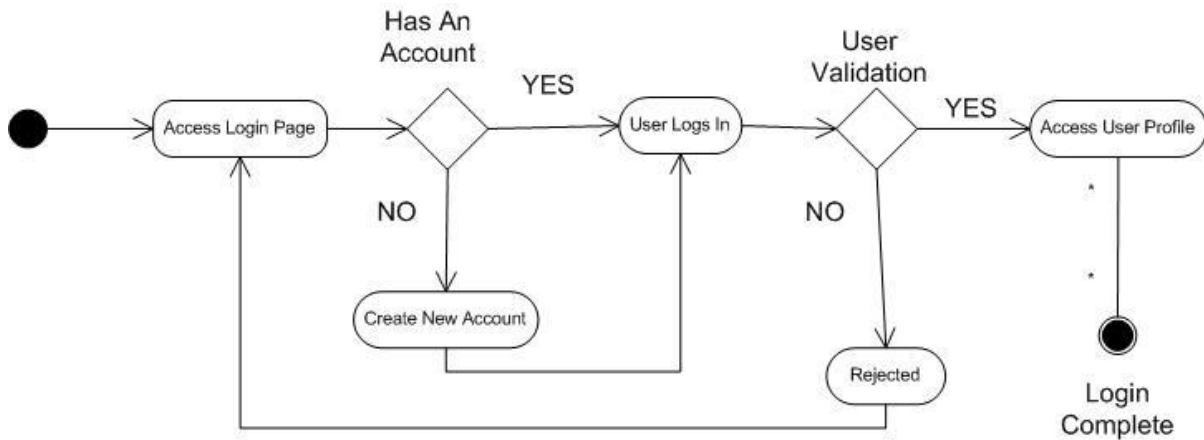


Figure 15 - Login activity diagram

The first activity in Figure 15 is to access login page. A decision then has to be made, depending on having account. If there is no account to login the system, create new account.

If there is account to login to the system, user logs in. If user is valid, access profile, else return access login page.

5.3.2. Train Monitoring Activity Diagram

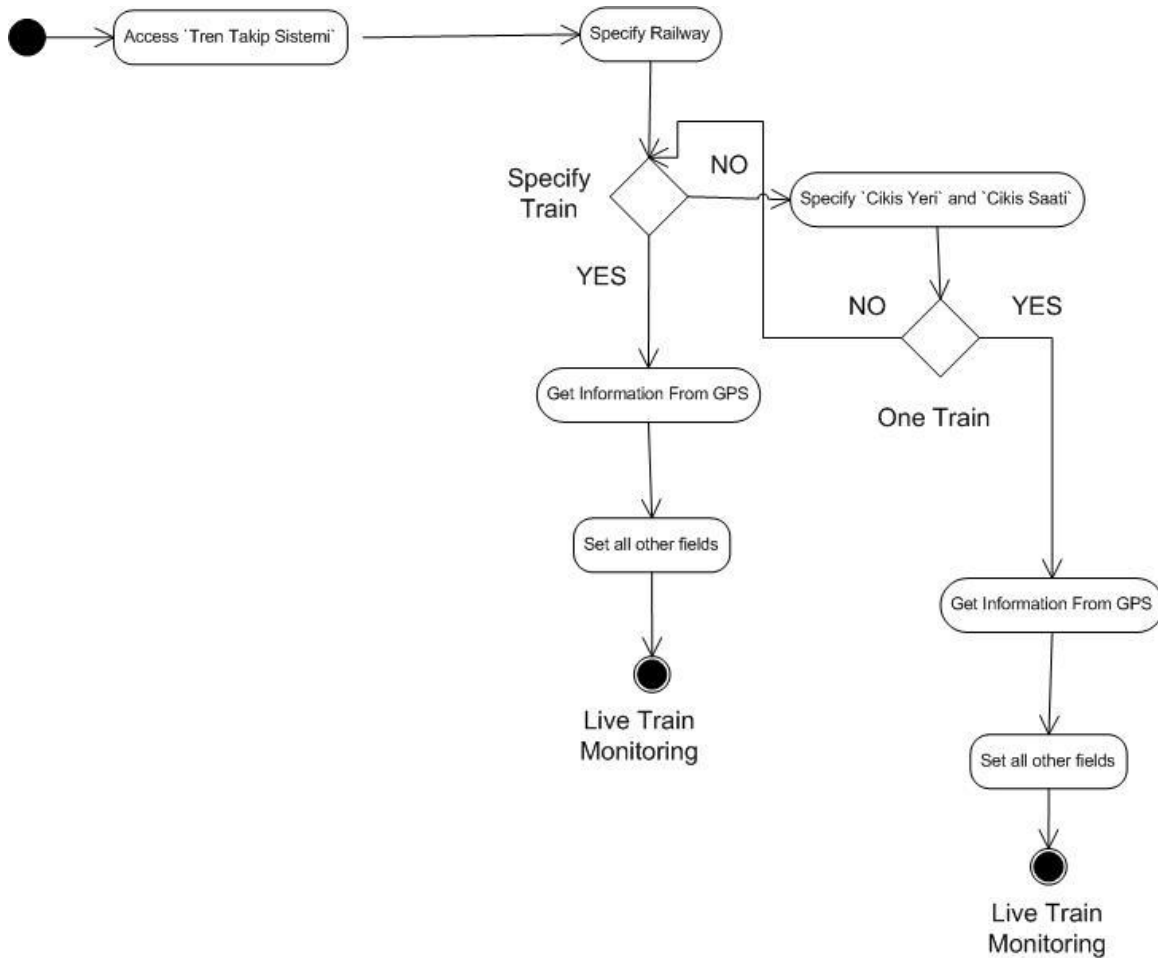


Figure 16 - Train monitoring activity diagram

The first activity in Figure 16 is to access 'Tren Takip Sistemi' page. Then specify railway. A decision then has to be made, depending on specifying train.

If a train is specified, system get information from GPS device and set all train fields.

If no train is specified, user specifies 'cikis yeri' and 'cikis saati'. After listing the trains according to 'cikis yeri' and 'cikis saati', check there is one or more train.

If there is one train, system get information from GPS device and set all train fields.

If there are more than one train, you pass again 'specify train' decision.

5.3.3. Adding New Question Activity Diagram

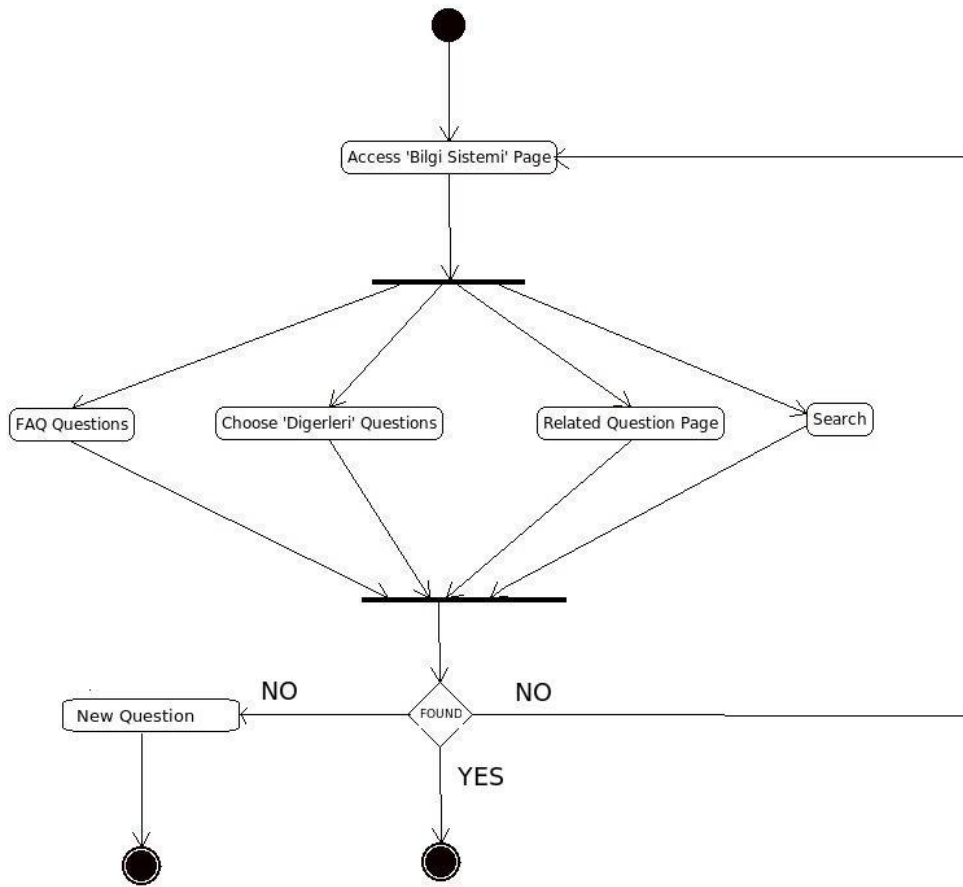


Figure 17 - Adding new question activity diagram

The first activity in Figure 17 is to select 'Sorun Gönderme'. Then access 'Bilgi Sistemi' page. After accessing page, user can choose one of the four options(FAQ Questions, Related Question Page, Diğerleri Page, Search). If user does not found, he/she adds new question or return to 'Bilgi Sistemi' page.

5.3.4. Best Path Activity Diagram

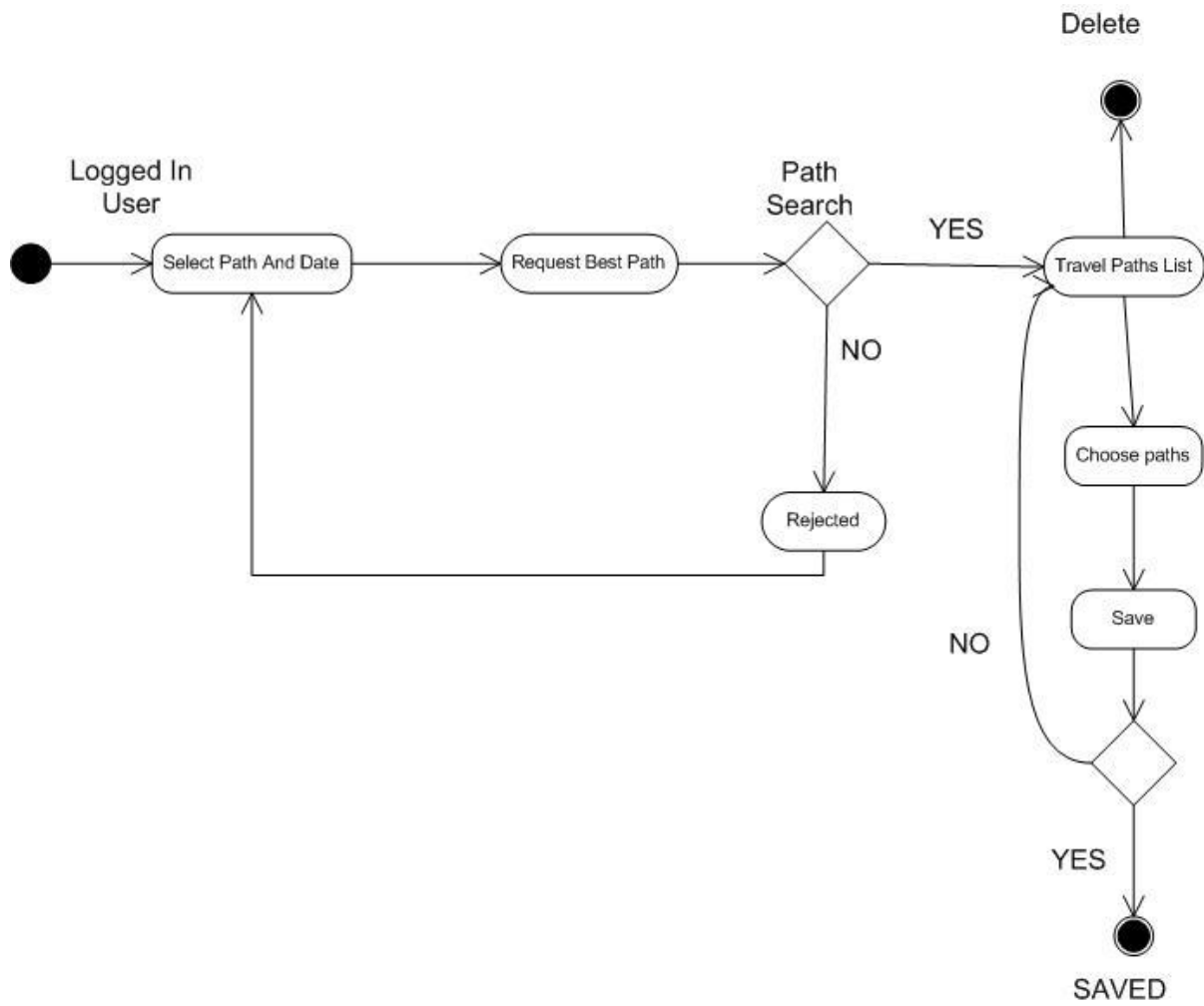


Figure 18 - Best path activity diagram

The first activity in Figure 18 is selects path and date. Then request best paths.

If there is no path, user returns selection path and date; else user chooses the desired paths and saves.

5.4. Class Diagram

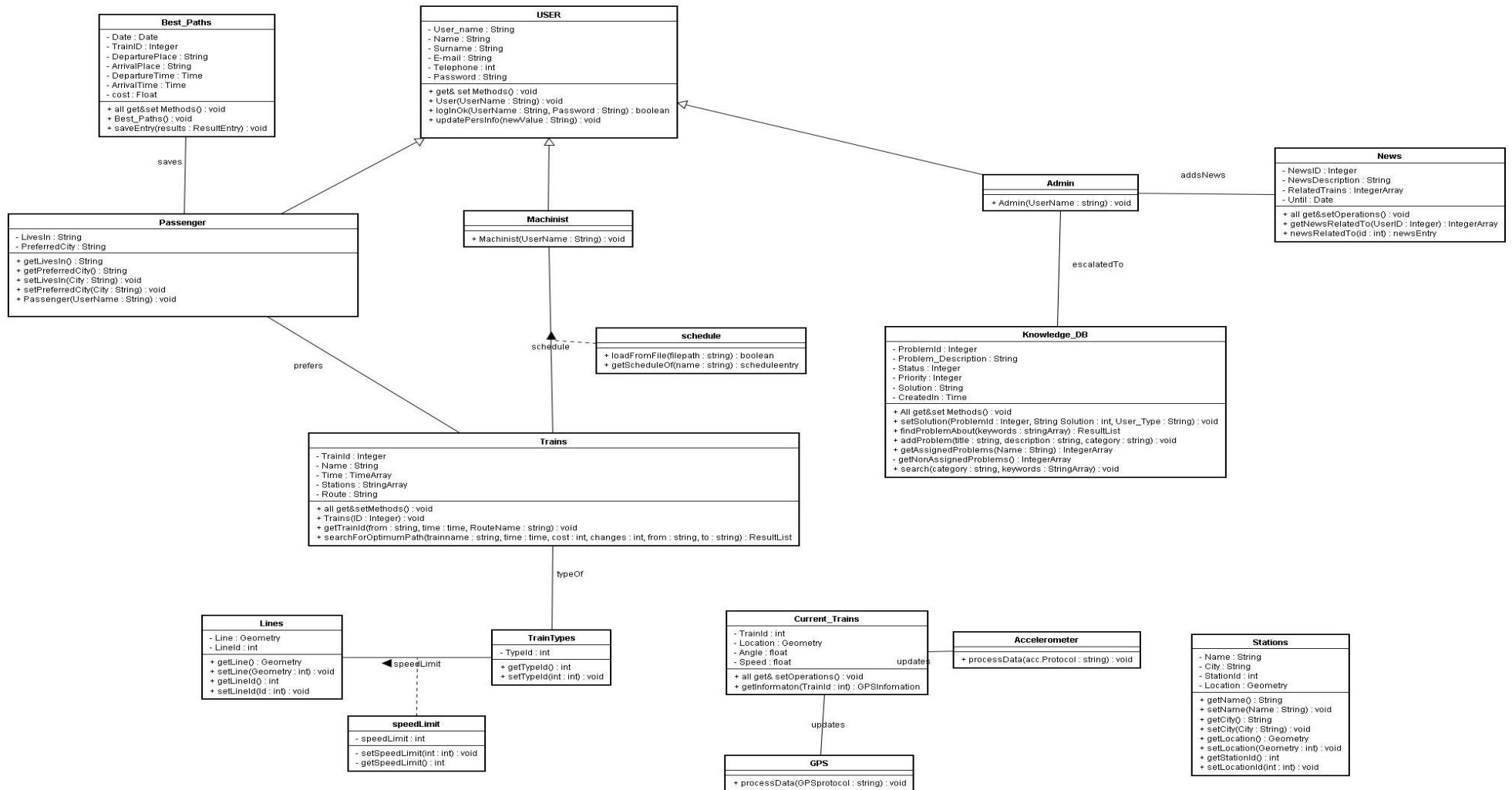


Figure 19 - Class Diagram

- User class is located in the user module. It is the parent class of the individual user classes: passenger, machinist and administrator. It stores all user members and provides get methods to access them. This class also provides set methods to update user information received from update form in the update information page. As pictured in the activity diagrams Figure 2 and Figure 3, the methods updatePersInfo() and LoginOk() are called and the database is updated accordingly.
- Only passenger class has a private member apart from the other derived classes administrator and machinist from base class user. It holds a "lives_in" member in order to provide the information needed by newsRelatedTo() function in the news class. Passenger class has a relation with the trains, called prefers. This relation also provides information for the NewsRelatedTo() method. After passenger logs into the system, home page of the passenger will call this method and load the related news for the passenger.
- Machinist class does not hold any separate private member. This class has a relation with trains class, called schedule. Schedule relation enables the system to show the daily schedule of the machinist. After machinist logs in, the related schedule entries in the database is shown in the home page of the machinist. This is accomplished by getSchedule() method in the associated class of schedule.
- Schedules class is in the journey module. Administrators of the system loads the daily schedule of all machinists everyday with a function "loadFromFile(string)" in the associated class of schedule. The administrators give a path to the schedules file in the "load schedule page". This file is required to be a comma separated values (csv) file. The function reads from the file and parses the data, then it drops the table "schedules" if it exists. Then it creates the "schedules" table again and adds new entries from the parsed data. In this way, the schedules table is updated as illustrated in Figure 13.
- News class is in the news module and provides methods to manage the news table. Only the administrator of the system will be able to call the set methods of this class. News class saves the news entities which are not out of date. There will be an interface for the administrators to manage the news table. The administrators will call clearNews() method daily and this method checks the news which are out of date and deletes them from the news table. Administrator will also add new entries via this interface.
- Stations class will provide methods to manage the stations in the database. Stations table will only be used to hold the station names to show them on the train monitoring and best path searching pages.

- Lines class provides methods to get the lineId of the line segment which the train is being on by supplying the position information of the train. Geometry data type holds the line segment's coordinate informations.
- TrainTypes class provides a method to get the locomotive type information of a train. It also provides a set method which will be called only by an administrator.
- Trains class is one of the most important classes in the journey module. This class provides an interface for the trains database. SearchForOptimumPath method will be implemented in this class and via this method, users will be able to query the trains and schedules table as pictured in Figure 7. The required informations for this method are hold as the members of the class. This method will first find all options from the departure place to the destination place with a maximum number of 3 train changes. To accomplish this, the function will trace the stations array, hold by stations member, and find the matched entries for the departure place. First the paths with no train changes will be found. Then for 1 change the current train will be changed and the stations of that train will be traced. After all trains are traversed, the function will return. The result list will be modified according to the cost. After that the result list will be shown on the home page of the user.
- Current_Trains class provides two methods to set the class members and to get them. When an object is initialized tThe members hold the information which is fed from the GPS and accelerometer devices: the speed, location and angle.
- Knowledge database will provide users an interface to find related problems about an issue, to add new problems (create a ticket) and to add a solution to the system. setsolution() method will only be available to the system administrators. All users will be able to use search() funciton to find a related problem in a specific category. Another option for searching will also be provided by findProblem() method, which finds any related problem in the system without a category constraint. By addProblem() method, users will be able to add a problem to the database. The problems in the database will be assigned to the administrators by creating an escalatedTo object. Then the administrators will be able to see them on their home page. The sequence diagrams related to knowledge database are shown in Figure 10, Figure 11, and Figure 12.

6. Data Design

6.1. Entity – Relationship Diagram

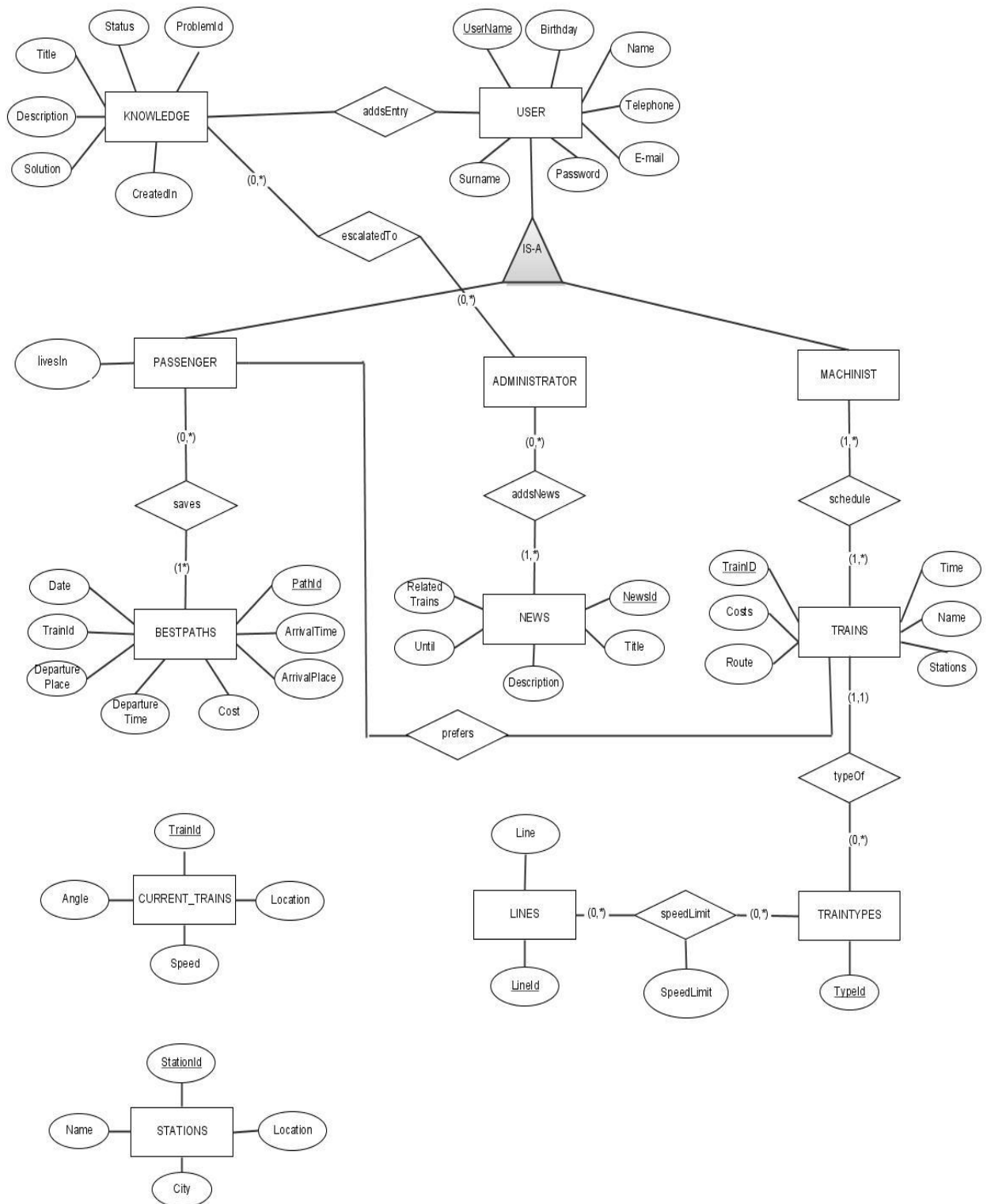


Figure 20 - ER Diagram

6.2. Database Schemas

6.2.1. USER table

Field	Type	Null	Foreign Key	References
<u>UserName (p.k.)</u>	Varchar(20)	no	no	-
Name	Varchar(20)	no	no	-
Surname	Varchar(20)	no	no	-
Password	Varchar(20)	no	no	-
E-mail	Varchar(30)	no	no	-
Telephone	Varchar(20)	no	no	-
Birthday	Date	no	no	-

This table holds user information. Every user has to supply name, surname, password, e-mail, and telephone information and select a username. Three tables (passengers, administrators, machinists) extends from this table.

6.2.2. Passenger table

Field	Type	Null	Foreign Key	References
livesIn	Varchar(20)	no	no	-
User_name (p.k.)	Varchar(20)	No	Yes	USER

This table extended from USER table and every passenger has to supply the city he lives.

6.2.3. Best_Paths table

Field	Type	Null	Foreign Key	References
<u>PathID (p.k.)</u>	Integer	no	no	-
Date	Date	no	no	-
TrainID	Integer	no	yes	Trains
DeparturePlace	Varchar(20)	no	no	-
DepartureTime	Time	no	no	-
ArrivalPlace	Varchar(20)	no	no	-
ArrivalTime	Time	no	no	-
Cost	Float	no	no	-
UserID	Varchar(20)	no	yes	USER

This table contains information about a passenger's best path searches. After a user searches some path, it is kept on that database and users may retrieve their past searches

6.2.4. Trains table

Field	Type	Null	Foreign Key	References
<u>TrainID (p.k.)</u>	Integer	no	no	-
Name	Varchar(20)	no	no	-
Time	Date array	no	no	-
Costs	Integer array	no	no	-
Station	Integer array	no	yes	Stations
Routes	Varchar(20)	no	no	-

All the trains are kept in that table. The train's paths are stored in Station array and the costs to stations are stored in costs fields respectively. Also the departure times are stored in time array.

6.2.5. Stations table

Field	Type	Null	Foreign Key	References
<u>StationID (p.k.)</u>	Integer	no	no	-
City	Varchar(20)	no	no	-
Name	Varchar(20)	No	No	-
Location	Geometry	no	no	-

On that table, every station is given a unique id. The city, station name and location information of the station is kept.

6.2.6. Knowledge_DB table

Field	Type	Null	Foreign Key	References
<u>ProblemId (p.k.)</u>	Integer	no	no	-
Problem_Description	Varchar(1000)	no	no	-
Status	Integer	no	no	-
Priority	Integer	no	no	-
Solution	Varchar(2000)	yes	no	-
CreatedIn	Timestamp	no	no	-

That table keeps the problems reported and the solutions to that problems as soon as administrators edits the entries and add solutions. Status field indicates whether the problem waits for an answer or it is solved. High priority problems will be handled firstly.

6.2.7. News table

Field	Type	Null	Foreign Key	References
<u>NewsID (p.k.)</u>	Integer	no	no	-
RelatedTrains	Integer array	yes	yes	Trains
Title	Varchar(200)	no	no	-
News_Description	Varchar(2000)	no	no	-
Until	Timestamp	yes	no	-

This table holds data about some special offers such as a cut on ticket prices. They will be showed to passengers as advertisements. Also in that table, the delay or cancellation information will be hold.

6.2.8. Traintypes table

Field	Type	Null	Foreign Key	References
TypeID	char	no	no	-

This table contains typeIDs and will be joined with trains database.

6.2.9. Lines table

Field	Type	Null	Foreign Key	References
LineID (p.k.)	Integer	no	no	-
Line	Geometry	no	no	-

The geospatial data will be hold on that table line by line. Every line will be given a unique id number to decrease the processing load while querying.

6.2.10. Currenttrains table

Field	Type	Null	Foreign Key	References
TrainID	Integer	no	yes	Trains
Location	Geometry	no	no	-
Speed	Integer	no	no	-
Angle	Integer	no	no	-

The moving trains will be hold on that database. The location, speed and horizontal angle information will also be stored.

7. Interface Design

7.1. User Interfaces

7.1.1. Registration Interface

Lütfen Kullanıcı Bilgilerinizi Giriniz

*Kullanıcı Adınız: Emre_Bilgin

*Şifreniz: *****

*Şifrenizi Tekrar Giriniz: *****

*Adınız-Soyadınız: Emre Bilgin

*E-Posta Adresiniz: eposta@eposta.com

*Telefonunuz: 0123456567

Doğum Yeriniz: İstanbul

Yaşadığımız şehir: Ankara

En çok seyahat ettiğimiz şehir: İstanbul

Bizen Haber Almak İster misiniz?

Tamam İptal Temizle

* ile işaretli alanların doldurulması zorunludur.

On registration page, the user will be asked to supply some personal information and also he will be asked to supply a username – password combination. If the users marks the checkbox, he will receive e-mails about promotion news.

7.1.2. Login Interface

Tren Bilgi Sistemi

Kullanıcı Girişi

Kullanıcı Adı: []

Şifre: []

Kullanıcı Tipi: Yönetici

Yönetici

Personel

Uye

Tamam

Yeni Kullanıcı >>

On login page, user types his username and password, and then selects the user type from the combo box. When user clicks the “Tamam” button, the supplied information is checked and the user will be given authorization if they are correct. Also on that page, not registered users may follow the “Yeni Kullanıcı” link to register to the system.

7.1.3. Update Information Interface

Lütfen Kullanıcı Bilgilerinizi Güncelleyiniz

*Kullanıcı Adınız: Emre Bilgin

*Şifreniz: *****

*Şifrenizi Tekrar Giriniz: *****

*Adınız-Soyadınız: Emre Bilgin

*E-Posta Adresiniz: eposta@eposta.com

*Telefonunuz: 0123456567

Doğum Yeriniz: İstanbul

Yaşadığınız şehir: Ankara

En çok seyahat ettiğiniz şehir: İstanbul

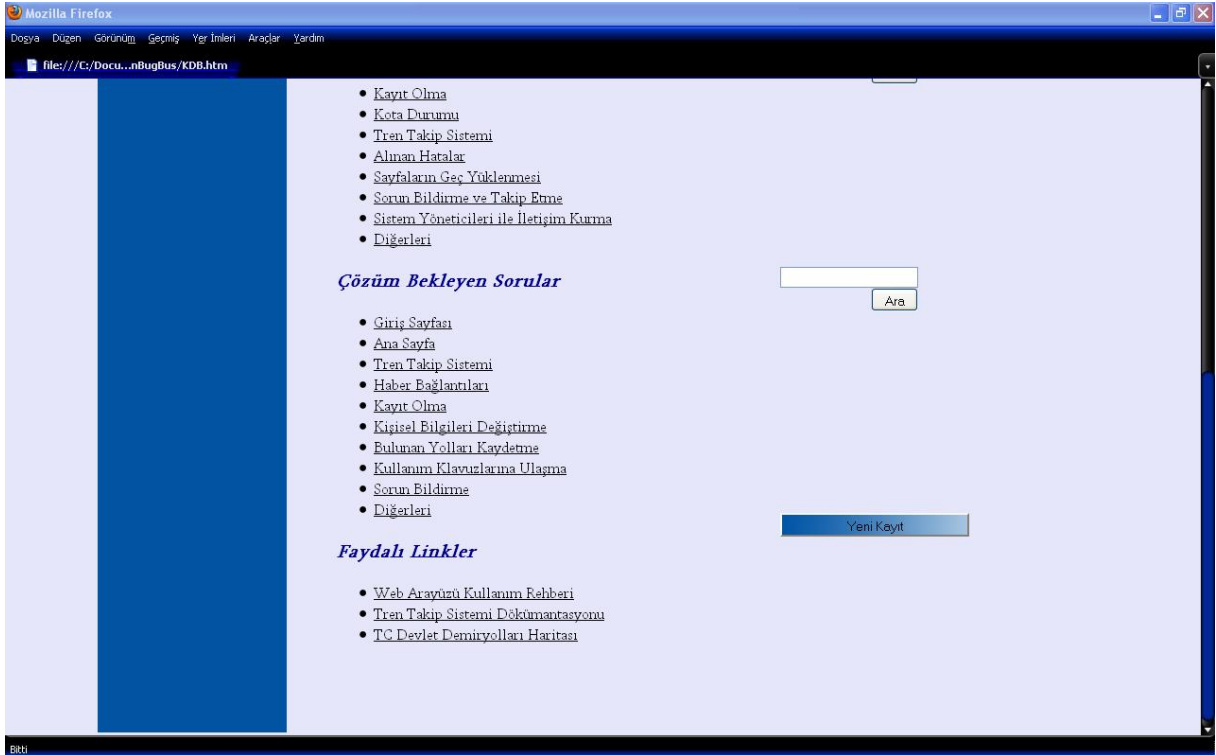
Bizden Haber Almak İster misiniz?

Kaydet İptal

* ile işaretli alanların doldurulması zorunludur.

On that page users will be able to edit the personal information they supplied while registering to the system. Also users may change password on that page. If user clicks the “Kaydet” button, the personal information will be updated with the information on the form. If user click “İptal” button, there will no change on personal information.

7.1.4. Knowledge Database Interface



On knowledge database and help page, there are many links grouped under four sections:

- Frequently Asked Questions
- General Questions & Answers
- Questions Waiting Answers
- Useful Links

A user may use the search boxes to search some keywords on help pages. Also a user may create a new problem entry by clicking the “Yeni Kayıt” button.

Mozilla Firefox
file:///C:/Docu...s/P_newQues.htm

Ana Sayfa

Yeni Soru Oluşturma

Tren Takip Sistemi
Kişisel Bilgiler
Sevir Defteri
Sorun Giderme
Bize Ulaşın

Problemin Başlığı: Kaydedilen Tablolara ulaşamama

Problemin Kategorisi: Giriş Sayfası

Problemin Açıklaması: Sayfalar kaydedildi mesajı gelmesine rağmen tablolara ulaşamıyorum.

Gönder Temizle İptal

Mozilla Firefox
file:///C:/Docu...s/P_newQues.htm

Ana Sayfa

Yeni Soru Oluşturma

Tren Takip Sistemi
Kişisel Bilgiler
Sevir Defteri
Sorun Giderme
Bize Ulaşın

Problemin Başlığı: Kaydedilen Tablolara ulaşamama

Problemin Kategorisi: Tren Takip Sistemi
Giriş Sayfası
Ana Sayfa
Tren Takip Sistemi
Haber Bağlantıları
Kayıt Olma
Kişisel Bilgileri Değiştirme
Bulunan Yolları Kaydetme
Kullanım Klavuzlarına Ulaşma
Sorun Bildirme
Diğerleri

Problemin Açıklaması: Sayfalar kaydedildi mesajı gelmesine rağmen tablolara ulaşamıyorum.

Gönder Temizle İptal

When the user clicks the “Yeni Kayıt” button, a form page displayed. User is required to type a problem title and description and also select the problem category.

7.1.5. Optimum Cost / Optimum Time Search Interface

Ana Sayfa

Ana Sayfaya Hoşgeldiniz!
Aşağıdaki Yolculuk Planlama Sistemi'ni kullanarak kendinize en uygun tren yolculuğunu seçebilirsiniz. Listele tuşuna bastıktan sonra aşağıda çıkacak olan tablodan size en uygun olan yolu işaretleyiniz. Sonucu kendi sayfanıza kaydedebilir daha sonra bu sonucu tekrar kullanabilirsiniz. İyi Yolculuklar Dileriz!

Yolculuk Planlama Sistemi

Kalkış yeri: **Ankara**
Varış Yeri: **Istanbul**
Tarih Aralığı: **16/03/09** 'den **16/03/09** 'e
Zaman Aralığı: **16 : 30** 'den **23 : 30** 'e
Maximum Ücret: **100** TL
Maksimum Aktarma : **2**
Maksimum Süre: **6** Saat

[Listele](#) [Temizle](#)

Bizden Haberler
[Ankara-Istanbul Hattı'nda Kaza](#)
[Etilcek-Istanbul Hattı Biletlerde Promosyon](#)
[Ankara-Eskişehir Hattı'nda Sefer İptali](#)

Varış Yeri: **Istanbul**
Tarih Aralığı: **16/03/2009** 'den **16/03/2009** 'e
Zaman Aralığı: **17 : 35** 'den **22 : 30** 'e
Maximum Ücret: **75** TL
Maksimum Aktarma : **3**
Maksimum Süre: **6** Saat

[Listele](#) [Temizle](#)

Seçenek	Tarih	Tren No	Kalkış Yeri	Kalkış Saati	Varış Yeri	Varış Saati	Yolculuk Süresi	Ücret	Aktarma
1	16.03.09	TR001	Ankara	17:40	Eskişehir	18:40	01:00	10 TL	
	16.03.09	TR002	Eskişehir	18:50	Bilecik	21:00	02:10	12 TL	2
	16.03.09	TR003	Bilecik	21:10	Istanbul	22:10	01:00	10 TL	
<input checked="" type="checkbox"/> Toplam	16.03.09		Ankara	17.40	Istanbul	22.10	04.30	42 TL	2
2	16.03.09	TR004	Ankara	17:30	Istanbul	21:30	04:00	72 TL	0
<input checked="" type="checkbox"/> Toplam	16.03.09	TR004	Ankara	17.30	Istanbul	21.30	04.00	72 TL	0
	16.03.09	TR005	Ankara	18:30	Bilecik	21:30	03:00	27 TL	
3	16.03.09	TR006	Bilecik	21:50	Istanbul	23:40	01:50	20 TL	
<input checked="" type="checkbox"/> Toplam	16.03.09		Ankara	18.30	Istanbul	23.40	05.10	47 TL	1

[Keydet](#) [Sil](#)

A user may search for an optimum cost / optimum time train. User may choose the destination place, arrival place, date and time interval, maximum price, maximum number of train changes and maximum journey time and system shows the corresponding trains.

Mozilla Firefox

file:///C:/Docum...seyirdefteri.htm

Seyir Defteri

Seyir Defteri

17/03/09

Seçenek	Tarih	Tren No	Kalkış Yeri	Kalkış Saati	Variş Yeri	Variş Saati	Yolculuk Süresi	Ücret	Aktarma
1	16.03.09	TR001	Ankara	17:40	Eskişehir	18:40	01.00	10 TL	
	16.03.09	TR002	Eskişehir	18:50	Bilecik	21:00	02.10	12 TL	2
	16.03.09	TR003	Bilecik	21:10	İstanbul	22:10	01.00	10 TL	
Toplam	16.03.09		Ankara	17:40	İstanbul	22:10	04:30	42 TL	2
2	16.03.09	TR004	Ankara	17:30	İstanbul	21:30	04.00	72 TL	0
Toplam	16.03.09	TR004	Ankara	17:30	İstanbul	21:30	04.00	72 TL	0

Sil

19/03/09

Seçenek	Tarih	Tren No	Kalkış Yeri	Kalkış Saati	Variş Yeri	Variş Saati	Yolculuk Süresi	Ücret	Aktarma
3	16.03.09	TR005	Ankara	18:30	Bilecik	21:30	03.00	27 TL	
	16.03.09	TR006	Bilecik	21:50	İstanbul	23:40	01.50	20 TL	
Toplam	16.03.09		Ankara	18:30	İstanbul	23:40	05.10	47 TL	1

Also the user's search histories are kept and a user may see his search histories anytime he wants.

7.1.6. Passenger Tracking Interface

C:\Documents and Settings\İşıl Özge Pekel\Desktop\UserMonitor.htm - Windows Internet Explorer

C:\Documents and Settings\İşıl Özge Pekel\Desktop\UserMonitor.htm

Sık Kullanılanlar C:\Documents and Settings\İşıl Özge Pekel\Desktop\U...

Tren Takip Sistemi

Seçilen Trenin Konumu:

Seçilen Trenin Bilgileri

Seçtiğiniz Hat: **Ankara - İstanbul Hattı**

Seçtiğiniz Tren: **Anadolu Ekspresi**

Çıkış Yeri: **Ankara**

Çıkış Saati: **12.00.00**

Konum: **Fenerbahçe-Söğütöçesme 870 metre**

Hız: **100 km/sn**

Sonraki Durak: **Söğütöçesme**

Beklenen Variş Saati: **17.55.00**

Son Durak: **Haydarpaşa**

Beklenen Variş Saati: **18.10.00**

On the left side of that page, a passenger may see the position of a train he selects on the map. On the right, the details about selected train are displayed.

7.1.7. Machinist Tracking Interface

Mozilla Firefox
file:///C:/Docum...nistmonitor.htm

Tren Takip Sistemi

Tren Konumu

Anlık Durum

Konumunuz:	Bayramiç - Yenice arası 60 km
Sonraki Durak:	Bayramiç
Uzaklık:	40 km
Beklenen Varış Saati:	18 30 00
Bekleme Süresi:	05 00 00
Beklenen Kalkış Saati:	18 35 00
Hızınız:	87 km /s
Maksimum Hız Sınırı:	90 km/s
Sonraki Işık:	100 km ileride

UYARI!

Tren Bilgileri

Bulduğunuz Hat:	Balıkesir - Çanakkale Hattı
Trenin Numarası:	ID-126478
Çıkış Yeri:	Balıkesir

A machinist may see only the positions of the trains on the same railway route. On the right half of the page, the position, next station, distance to next station, expected arrival time, expected remaining time to arrival, expected departure time, current speed, the speed limit and the distance to the next light are displayed. Also the current railway route, train id, departure city information will be on the interface. In some cases, if there is a warning, it is displayed on the middle frame of the right half of the page.

Mozilla Firefox
file:///C:/Docum...nistmonitor.htm

Tren Konumu

Anlık Durum

Konumunuz:	Bayramiç - Yenice arası 60 km
Sonraki Durak:	Bayramiç
Uzaklık:	40 km
Beklenen Varış Saati:	18 30 00
Bekleme Süresi:	05 00 00
Beklenen Kalkış Saati:	18 35 00
Hızınız:	87 km /s
Maksimum Hız Sınırı:	90 km/s
Sonraki Işık:	100 km ileride

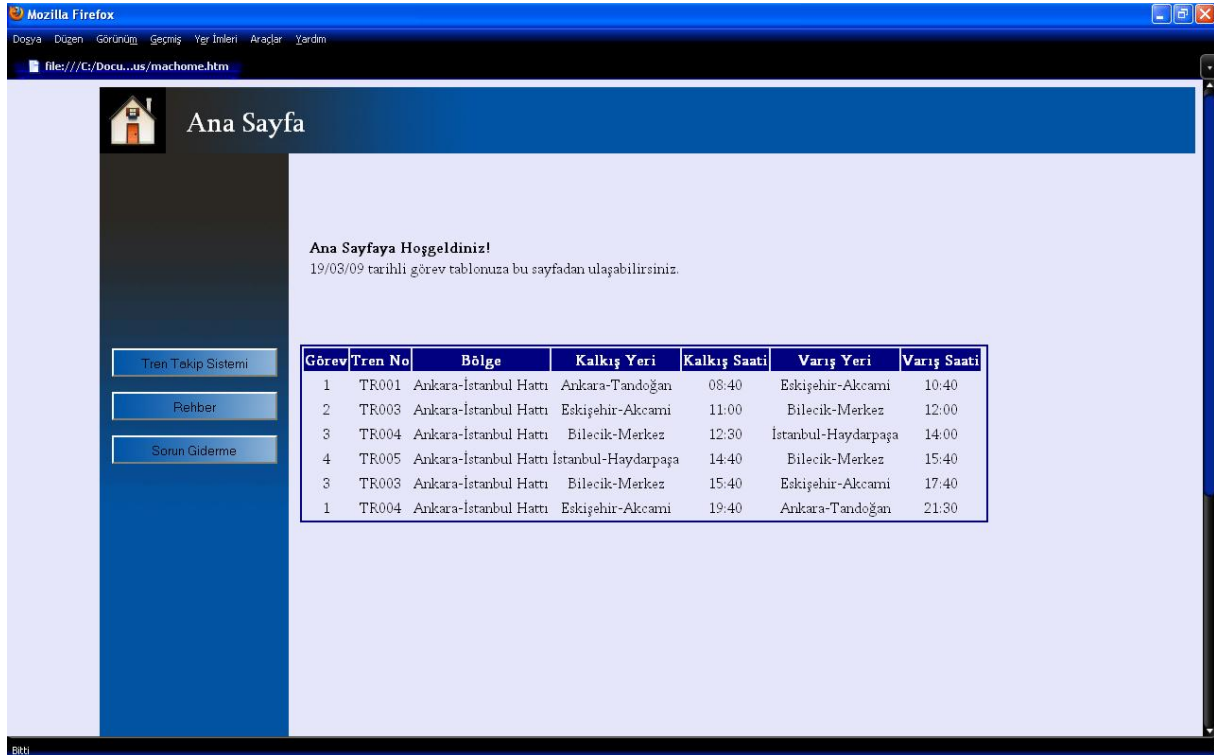
UYARI!
MAKSİMUM HIZ SINIRINI GEÇTİNİZ!
LÜTFEN YAVAŞLAYINIZ!

Tren Bilgileri

Bulduğunuz Hat:	Balıkesir - Çanakkale Hattı
Trenin Numarası:	ID-126478
Çıkış Yeri:	Balıkesir
Çıkış Saati:	16 17 32
Varış Yeri:	Çanakkale
Beklenen Varış Saati:	19 35 00

If a machinist exceeds the speed limit, an appropriate warning will be displayed and it will be written with red color to get the attention of the machinist. This frame will also be used when departure time comes and warns the machinist to move. Another use of that warning frame is while getting nearer to a station or control point, telling the machinist to slow.

7.1.8. Machinist Task Interface



Ana Sayfa

Ana Sayfaya Hoşgeldiniz!
19/03/09 tarihli görev tablonuza bu sayfadan ulaşabilirsiniz.

Görev	Tren No	Bölge	Kalkış Yeri	Kalkış Saati	Varış Yeri	Varış Saati
1	TR001	Ankara-Istanbul Hattı	Ankara-Tandoğan	08:40	Eskişehir-Akcami	10:40
2	TR003	Ankara-Istanbul Hattı	Eskişehir-Akcami	11:00	Bilecik-Merkez	12:00
3	TR004	Ankara-Istanbul Hattı	Bilecik-Merkez	12:30	İstanbul-Haydarpaşa	14:00
4	TR005	Ankara-Istanbul Hattı	İstanbul-Haydarpaşa	14:40	Bilecik-Merkez	15:40
3	TR003	Ankara-Istanbul Hattı	Bilecik-Merkez	15:40	Eskişehir-Akcami	17:40
1	TR004	Ankara-Istanbul Hattı	Eskişehir-Akcami	19:40	Ankara-Tandoğan	21:30

Tren Takip Sistemi
Rehber
Sorun Giderme

Machinists can see their task schedules on that page. On the list, the train ids, regions, departure and arrival cities and times are displayed.

8. System Design

8.1. User Information Security

In the Login Page the users will enter their username and password. The system will check the username and password from the database. The passwords of the users will be kept in the database in an encrypted form. Login Page and the other pages of the system will be implemented using PHP technology ^[13]. The passwords of the users will be encrypted and then kept in the database to ensure security. PHP provides its own built-in hashing functions for encryption. The different interfaces for different users will be provided by PHP. After the user logs in, the system will check the user type and display the corresponding interface.

User passwords must be stored safely in the database. So, we must store password encrypted in database. We use MD5 function. "The MD5 message-digest algorithm takes as input a message of arbitrary length and produces as output a 128-bit "fingerprint" or "message digest" of the input. The MD5 algorithm is intended for digital signature applications, where a large file must be "compressed" in a secure manner before being encrypted with a private (secret) key under a public-key cryptosystem such as RSA.

The MD5 algorithm is designed to be quite fast on 32-bit machines. In addition, the MD5 algorithm does not require any large substitution tables; the algorithm can be coded quite compactly. MD5 function ^[14] is also defined in PHP.

8.2. Optimum Train Suggestion System

In the Home Page the passengers will plan their travels. They will search for the possible paths for their desired destination stations, departure stations and date. After selecting the departure and destination stations, 3 more drop down menus will appear. The user will choose the date and the train type. After the stations chosen, the system will show new drop down menus with the help of JavaScript ^[14] technology. The OTTS (Optimum Train Suggestion System) will determine the most suitable selections with the help of a minimum time/cost finding algorithm. The user will be able to sort the results according to travel time, cost, train type or number of changes. The system will do this by adding a final database query to sort these results according to the given entity. The result can be saved by the users to the personal page. The result appears as a link on the personal page. It will be kept in the user table of the database.

8.3. Intelligent Machinist Assignment

The machinists will check their daily schedule from Home Page. Intelligent Machinist Assignment will assign machinist to appropriate machines. The Brevets of machinists will be kept in the database. The system will match the machines with the machinist having the desired brevet and then choose one machinist to assign that machine.

8.4. Personal Information

In the Personal Page the users will be able to update their personal information. The system will fetch the information of the users from the database and fill the form with corresponding information. After editing, the system will update the information of

users in the database. And also travel history of users will be kept in the database and can be shown from this page.

8.5. Live Train Monitoring

In the Live Train Monitoring Page the users will be able to keep track of the trains on the map of the railways. This page will be implemented by using JSP technology ^[15]. It ensures to use Java functions and facilities in the web page. Since the main system functions will be implemented in Java, JSP is a better solution and more suitable for us to use. The map for the Live Train Monitoring will be drawn using Autocad Map 3D and then it will be processed by some Java functions with GPS data. Java program will mark the positions of the trains on the map looking at the GPS data. The resulting map will have the positions of the trains and stations and it will be shown in the Live Train Monitoring Page. All of the users will be able to see the positions of the trains and also some information about the trains. The position and the other information will be updated periodically. The system will take the new coordinates and other information from GPS and update the result.

The machinists will also see the information and position of their own train and the other trains on the same line. On the machinist panel, the speed limit and the distance to the next station will also be shown. The speed limits for specific areas will be stored in the database. The system will check the current speed limit from the database with the position information and it will calculate the distance to the next station.

8.6. Emergency Situations

If an emergency situation occurs, the machinists will be able to push a button to warn the admin about the situation and send critical information to the admin. If a signal is received from the accelerometer, an emergency signal will be sent to admin and nearest control point automatically. The system on the machinist panel will process the signal coming from the accelerometer and send emergency signal.

8.7. Railway Map

The reason a new railway map is drawn with Autocad Map 3D is to see the system features and test the system more effectively enough on a suitable map. The railways in Turkey are not very complex and complicated. For every travel between cities there is only one possible path. We want our system to be useful in the future and it will be adaptable to any railway system. So, the current railway map of Turkey is not enough for our project. With this map the OTSS (Optimum Train Suggestion System) becomes useless. So, we will draw our own railway map and simulate the system on this map. Autocad Map 3D will be used to draw a new railway map. The map will only cover some part of Turkey and it will have many connections. It will be possible to select at least two different options from one city to another. Smaller stations will be connected to big cities with one railway and slower trains will be used.

8.8. Contact Information

In the Contact Page the users will be able to see the addresses, e-mails, phone number of stations, points to buy tickets, call centers. The user will be able to see the position of these places on a map. Google Maps ^[16] gadget will be used at this point.

Google Maps is a basic web mapping service application and technology provided by Google. It offers street maps, a route planner for traveling by foot, car, or public transport and an urban business locator for numerous countries around the world. There is only one problem with Google Maps. Since Google Maps is only free of charge for non-commercial use, it limits the number of requests in a certain time interval for a user. But since the gadget is not directly system related, the limit will only apply to the system users.

The users will be able to send e-mail directly by clicking on the e-mail addresses. For this purpose there is no need to use any extra application. With some simple HTML code this can be done.

8.9. Knowledge Database

In the Help Page the users will be able to search in a database of topics from database called Knowledge Database. It's mainly an issue tracking system. An issue tracking system is a computer software package that manages and maintains lists of issues, as needed by an organization. Issue tracking systems are commonly used in an organization's customer support call center to create, update, and resolve reported customer issues, or even issues reported by that organization's other employees. An issue tracking system often also contains a knowledge base containing information on each customer, resolutions to common problems, and other such data.

Our system will provide passengers a knowledge database which allows them to solve their problem without calling the TCDD staff or sending a mail to them. If they can't find any solution, they will create a ticket. These tickets must be managed in a professional way.

For this purpose we want to use an issue tracking system. With this system the administrators will be able to get new tickets from the passengers, assign them to the related persons and escalate them to the more experienced administrators. In this system they will also have a time restriction. All tickets will be solved in a particular time interval.

Instead of implementing such a complicated issue tracking system, we will integrate the application "JTrac"^[17] to our system. JTrac is an open source and highly customizable issue-tracking web-application written in Java. JTrac has many of the features of a standard issue-tracking application such as support for file-attachments and e-mail integration that we would like to integrate to our system. JTrac offers many customization options, especially in the areas of workflow and field-level permissions. We will take its most useful and basic parts and let them work in our background environment.

8.10. Database

As Database Management System, MySQL will be used. It's an open source software licensed under the terms of GNU GPL.

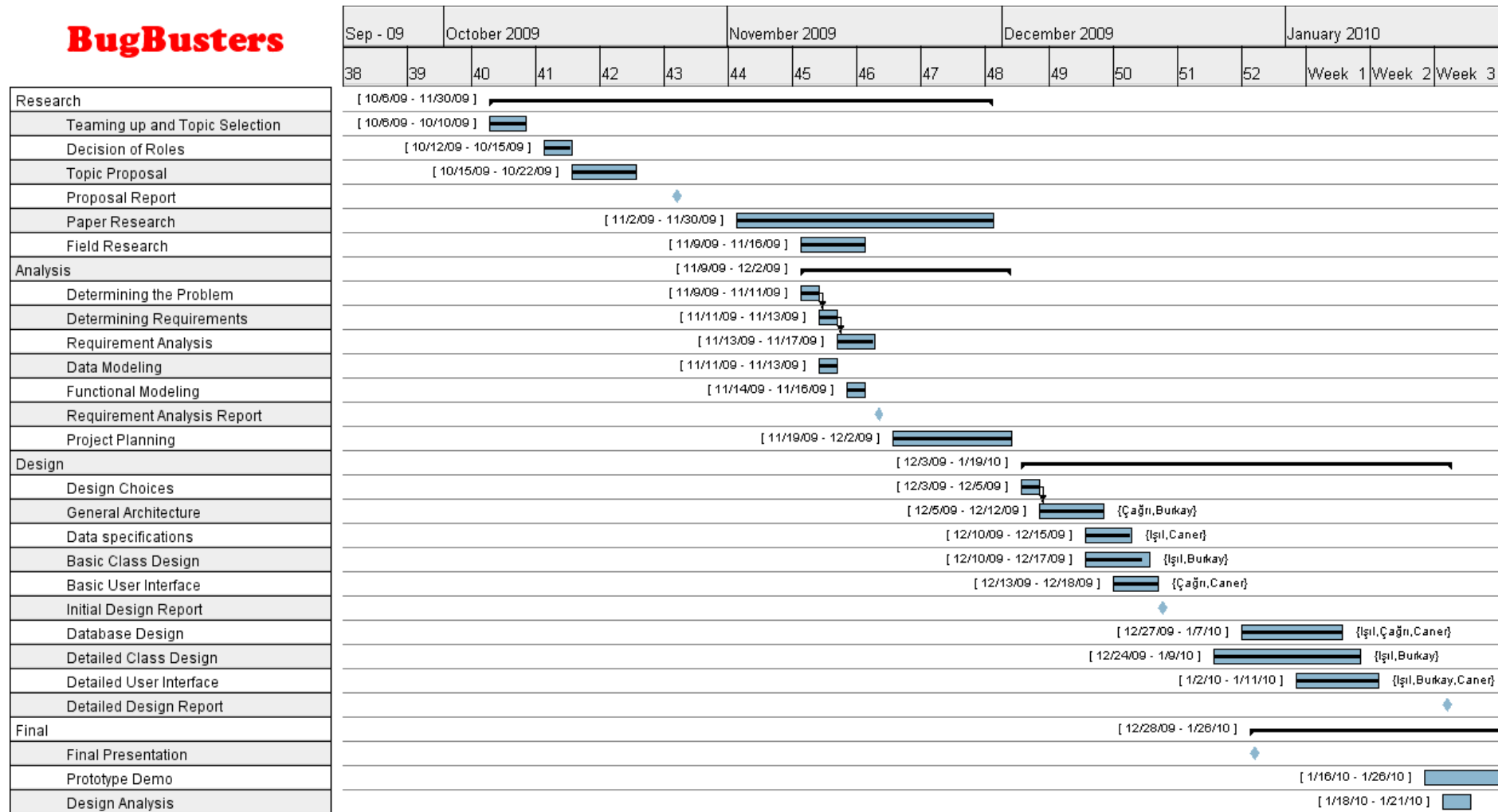
8.11. Webpage Design

We will need Apache Tomcat as a servlet container to work with JSP pages. This is an open source software developed by Apache Software Foundation. Apache Tomcat provides a pure Java HTTP web server environment for Java code to run.

For the search in the web site we will use Google search. With some HTML code ^[18], the search string is sent to Google from the web page and the search scope is minimized to the current web site only.

9. Project Schedule

The project schedule is illustrated on the following Gantt chart [19].



BugBusters

	February 2010	March 2010	April 2010	May 2010	June 2010													
	Week 6	Week 7	Week 8	Week 9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Implementation	8/10 - 5/27/10																	
Database Implementation	8/10 - 2/26/10		{Bukay, İşil, Çağın, Caner}															
Map Integration	[2/25/10 - 4/6/10]			{Bukay, Çağın}														
Improvement on Interfaces	[3/11/10 - 3/15/10]			{İşil}														
User Authentication	[3/13/10 - 3/18/10]			{Çağın}														
Security	[3/16/10 - 3/27/10]			{Caner}														
GPS Simulation Module	[3/14/10 - 4/8/10]			{İşil, Caner}														
Registration Module	[4/10/10 - 4/13/10]			{Bukay}														
Login Module	[4/14/10 - 4/17/10]			{İşil}														
Update Module	[4/18/10 - 4/22/10]			{Caner}														
Scheduling Module	[4/23/10 - 4/27/10]			{Çağın}														
Best Path Module	[4/5/10 - 4/22/10]			{Çağın}														
News Module	[4/26/10 - 4/29/10]			{Caner}														
Accelerometer Module	[4/30/10 - 5/1/10]			{Bukay}														
Journey Module	[5/2/10 - 5/6/10]			{İşil}														
Optimization	[5/8/10 - 5/24/10]			{İşil, Çağın}														
Test and Debugging	[3/27/10 - 5/25/10]																	
Documentation	[5/21/10 - 5/25/10]																	
Final Release																		

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