Configuring an application which allows online booking and purchase of travel tickets for railway and road transport - Unified Modeling Language

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Abstract—**The purpose of this paper is to configure an application which will allow the online reservation and purchase of travel tickets for rail transport and road system. This application aims to connect the reservation and payment systems of the Romanian rail transport operators and those that ensure the transport of passengers by coaches, on the internal routes. The purpose of the application is to create a software product which will help as many users as possible. They will thus be able to plan their trip, including purchasing online a single ticket to travel by different means of transport, at an early stage train and bus, using the mobile phone. The online system for booking and purchasing tickets responds to the current needs of the society, one of them being the need to travel and encourages the use of public transport which leads to the reduction of pollution.**

Keywords—integrated ticketing and payment system, eticketing passenger, passenger mobility, multimodal passenger transport, door to door journey, MaaS

I. INTRODUCTION

The necessity of such web application starts from the idea that, at the moment, in Romania there is no common information system, which allows the reservation and online purchase of travel tickets for rail and road transport. Moreover, at present, in Romania there is not even a common system for issuing travel tickets, which will connect all the rail passenger transport operators. However, in the near future, creation of this system becomes mandatory. Amendment of Law no. 202/2016[1], by transposing Directive (EU) 2016/2370[2], provides for the introduction of a common system of information on rail passenger transport and an integrated ticketing system, direct tickets and reservations. Participation in these systems is part of the public service obligation regarding rail passenger transport.

The integrated ticketing system, direct tickets and reservations is manage by Romanian Railway Reform Authority, a public legal entity independent of any railway operator or of an association of all railway operators, which operates passenger rail services [R7]. The construction of these two systems, the one proposed by the theme of this paper, and the one that will be introduced to meet the requirements that have arisen as a result of the transposition of Directive (EU) 2016/2370, may represent the starting point for the creation of a common system for multimodal

transport (road, rail, naval and air transport), integrated ticketing, direct tickets and reservations. Online booking and purchasing a travel ticket offers a lot of benefits, not only for passengers, but also for passenger transport companies. For example, those who want to travel using several modes of transport will save time, being able to get their transport ticket from anywhere, using their mobile phone. Moreover, online booking of the ticket allows customers to view all the information regarding the working timetable of the railway undertakings and road passenger transport operators, the connections between them, as well as the prices of the travel tickets. Also, the customer can check the correctness of the data he has entered so that he can get the best travel option. Also, passenger transport operators can increase their sales with minimal costs (there are no costs related to renting spaces for ticket sales, utilities and staff costs). Eticketing is definitely one of the important future directions of transport ticketing. Public transport ridership represents one of the key performance indicators of sustainability in the sense of balancing the economic, social and environmental aspects of public transport [D3].

II. EUROPEAN INITIATIVES

A. Abbreviations and Acronyms

Identifier – ID
Intelligent Transport Systems - ITS
European Commission – EC
European Union - EU
Mobility as a Service - MaaS
Romanian Railway Reform Authority – RRRA
Unified Modeling Language – UML.

B. Solutions for multimodal passenger transports

In other EU Member States, such online platforms have been operating successfully for several years, facilitating the booking and purchase of tickets for multimodal passenger transport. For example, Ferrovie dello Stato Italiane, the Italian railway infrastructure manager, has recently launched an application for multimodal transport. Named Nugo, the application is valid for both Apple and Android users [F5]. Nugo allows you to plan a door-to-door trip to Italy, but also to purchase a single ticket for all the types of transport you need to get to your destination. Initially, the application included 50 transport companies, but it is expected to be extended to 400 members. The 50 transport companies include companies operating local and interurban transport services, ferry, rail, including high-speed trains, metro, taxi

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[1] regarding the integration of the Romanian railway system into the single European railway area
[2] of the European Parliament and of the Council of 14 December 2016 amending Directive 2012/34 / EU as regards the opening of the market for inland rail passenger transport services and the governance of railway infrastructure

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and car-sharing companies, as well as bicycles rental companies. Also, users can utilize the application to book parking spaces at railway stations throughout Italy.

Earlier, in 2015, in Helsinki, on the occasion of the ITS World Congress, the MaaS-Mobility Alliance was launched, a public-private partnership, which laid the groundwork for a common approach to multimodal transport services for travelers, both in Europe and outside the continent [A1]. The members of the alliance include European municipalities, such as Vienna, Copenhagen, Antwerp, Helsinki, Milan etc., the Metropolitan Transport Authority of Barcelona, the Dutch Ministry of Infrastructure and Water Management, but also private companies: Siemens, Alstom, Uber etc. Mobility as a service is characterized by: door-to-door comfort, using multimodal, integrated transport and ease in terms of travel payment [G6].

Although several European countries have developed such integrated systems, so far, at EU level there has not been created a single system for online booking and purchasing travel tickets for multimodal transport. During this time, China is preparing for the next level: multimodal interactive payment based on biometrics [S8]. Although mobile payment has gradually become an integral part of Chinese life in the "Internet +" era, they are increasingly demanding when it comes to the security and ease of making these payments. The solution is provided by biometrics. The next steep is to analise the possibilities for introducing the biometric payment system for public transport services. But, eticketing is not a solution used only for the transport system, but it has an extended application. At present, China is vigorously promoting the construction of eticketing network system. The introduction of big data integrated marketing concept has a positive reference value for the transformation and upgrading of traditional eticketing network platform and the cultivation of performance industry market [J7].

C. European Commission studies: barriers and challenges

In June and July 2019, the EC published two studies targeting multimodal passenger transport [E4]. The first study refers to the rights of passengers using multimodal transport and the second to the challenges that exist in the EU regarding the implementation of the integrated payment and ticketing system. Studies have shown what are the challenges and barriers to developing, at EU level, an integrated system of booking and issuing travel tickets for multimodal passenger transport: lack of trust between the operators, high competition, lack of experience or expertise and missing legal framework. For example, the availability of access to fare data varies between the public and private transport providers. Public operators are in most cases obliged to share their fare data in a national database, where such database exists. But this does not usually apply to private operators. They share their fare data mostly on voluntary basis or based on agreements with other private operators and/or the national authorities. In the distribution/sales market, some respondents in the consultation have mentioned transport operators refusals to enter into distribution agreements, in certain cases coupled with the market power of the providers of transport services. Control of sales interfaces by incumbents as a means of controlling the relationship with the customer has been mentioned as the reason why such refusals may occur. On the other hand, the absence of a common EU legislative framework on integrated ticketing and the large number of different local and regional transport operators, each one developing their own programme, may lead to higher transaction costs for each part of integrated ticketing transport chain.

III. UNIFIED MODELING LANGUAGE

In order to create the web application, with the help of which the unique travel ticket for rail and road transport can be online booked and purchased, it is necessary to model the process, using the UML language. The next step after UML modeling is database generation. It stores all the information about the schedule (departures/arrivals) for the railway passenger transport undertakings and road transport companies, operated routes, stops/connections etc. In this paper will be presented the activity diagram and the class diagram for an application which allows online booking and purchase of travel tickets for railway and road transport.

A. Activity diagram

Activity diagrams are used to model the dynamic aspects of a system. They play a decomposed activity in actions that can be performed sequentially or in parallel [A2].

In order to draw up the activity diagram of a computer application, which allows the online booking and purchase of travel tickets for rail transport and road system in Romania, the actors are presented, at an initial stage: buyer creates an account on the online platform/downloads the application on the mobil phone, authenticates itself, requests information, enters the travel information and enters the necessary information for the payment of the travel ticket, takes the ticket; online travel booking and ticketing platform request travel information, process travel information, request ticket payment, process ticket payment, issue ticket; bank authorizes or rejects the payment by card of the travel ticket. The activity diagram represents the flow from one action to another (Fig.1).
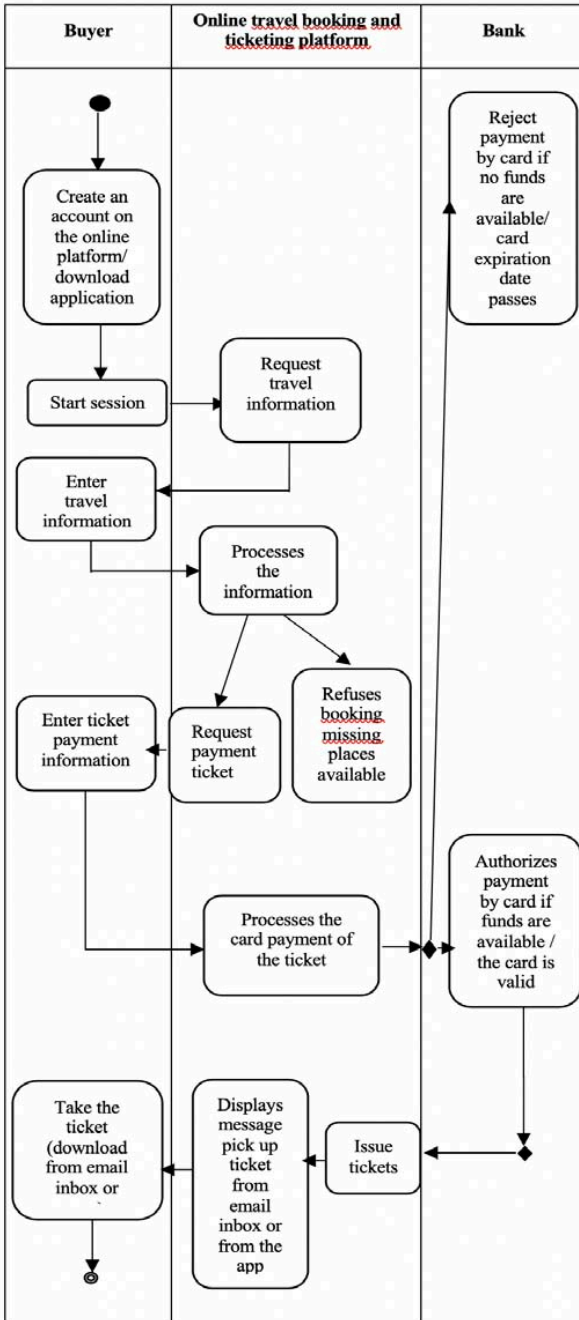
Fig. 1. Activity Diagram

The activity diagram in UML describes the process of purchasing a ticket from an online ticket booking and ticketing platform. The online ticket booking and ticketing platform generates and sells tickets according to the needs of the buyers and is only a part of the entire ticketing system, which includes the buyer, the online ticketing platform and the bank. In this case, the online platform is a subsystem of the entire system, which performs a dual function, interacting with both actors: the client and the bank.

The activity is started by a buyer, who, in this case, is the person who wants to buy a ticket. The online ticket booking

and ticketing platform will request travel information from the buyer. This information includes: date and time of departure; the date and time of the return; destination (place of departure/place of destination); number of persons traveling; type of tickets: round-trip tickets, tickets needed to travel with several transport operators (rail and road transport) and class/type of wagon (Ist or II nd class or wagon-lit). Based on the information provided by the buyer, the online platform will calculate the best multimodal transport options and the total amount related to the travel ticket. The bank will participate in the activity, authorizing or not authorizing the payment, depending on the available balance and the expiry date of the card. After the payment is made, the ticket is issued electronically, through the buyer's email address, an address that was mentioned when he created his account on the online platform, or directly in the application downloaded on the mobile phone.

B. Class diagram

A class UML diagram is used to represent the classes (group of objects that have similar properties, common behavior, common relations with other objects and the same semantics), interfaces and links between them, in order to design a system. Class diagrams are the most commonly used models in object oriented software design (Fig.2).
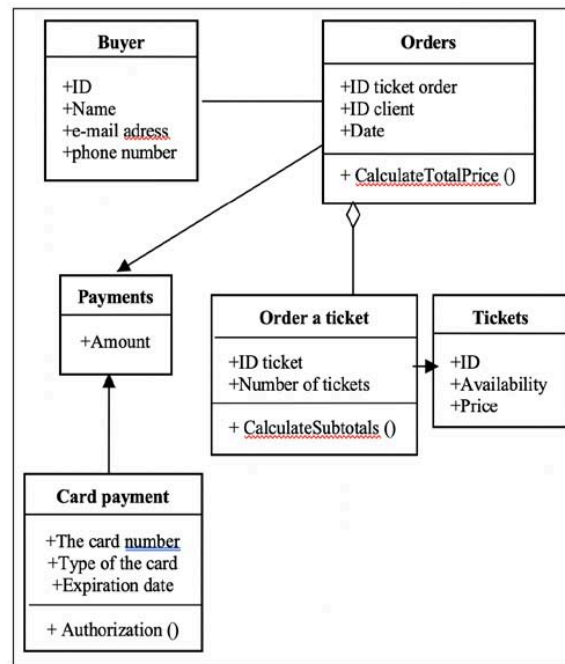

Fig. 2. Class diagram

Steps to be followed:

a) The buyer who wishes to book and purchase online a travel ticket, after accessing his account created on the web page, entering his name and surname, email address and/or telephone number and/or downloading his application on the mobile phone, with a user ID, places an order on the platform, which allows online booking and purchase of travel tickets for rail transport and road system;

b) The order will generate an ID of the ticket/tickets ordered, but also one of the user (the person who wants to

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book and buy online the travel ticket), including the date on which the order was placed, the ticket price/prices being calculated;

c) The availability of the ticket/tickets ordered is/are searched in the online application database;

d) If the ticket/tickets is/are available, it is required the payment, being required to enter the card number, the type of card and the expiry date;

e) Depending on the correctness of the entered data, which were listed above, and the expiry date of the card, the transaction is authorized or not.

V. Conclusion

• The online system for booking and purchasing tickets responds to the current needs of the society, one of them being the need to travel and encourages the use of public transport which leads to the reduction of pollution;

• Online booking and purchasing a travel ticket offers a lot of benefits, not only for passengers, but also for passenger transport companies;

• The study published by the EC, shows that the main barriers regarding the implementation of the integrated payment and ticketing system in EU are: price integration, legal uncertainties, technological challenges, lack of cooperation etc.;

• Mobility as a service is characterized by: door-to-door comfort, using multimodal, integrated transport and ease in terms of travel payment;

• Although several European countries have developed integrated ticketing system, so far, at EU level there has not been created a single system for online booking and purchasing travel tickets for multimodal transport. During this time, China is preparing for the next level: multimodal interactive payment based on biometric;

• It is necessary to model the process, using e.g. the UML language, in order to create the web application who support

the online reservation and purchase of the single travel ticket for rail and road passenger transport;

• Database generation is the next step after system modeling. It stores all the information about the schedule (departures/arrivals) for the railway and passenger transport operators, operated routes, stops/connections etc.

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