Integrated e-ticketing: Solution to make public transport more attractive than personal cars

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Abstract: - Integrated e-ticketing has been long on the agenda of European Union transport policy. Although several European countries have developed such integrated systems, so far, at European Union level there has not been created a single system for online booking and purchasing travel tickets for multimodal transport. Several studies have shown what are the challenges and barriers to developing, at European Union 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. Nevertheless, e-ticketing is definitely one of the important future directions of transport ticketing. Online booking and purchasing a travel ticket offers a lot of benefits, not only for passengers, but also for passenger transport companies and responds to the current needs of the society, one of them being the need to travel.

Key-Words: - integrated ticketing and payment system, e-ticketing, passenger transport, passenger mobility, multimodal passenger transport, door to door journey, MaaS

1 Introduction

Multimodal transport is one of the solutions for decongesting traffic and for reducing pollution and carbon dioxide emissions. More than a decade, the integrated e-ticketing system for multimodal transport was one of the objectives of the European Union transport policy. Thus, in 2011, the objective of integrating the different systems within an European information, management and payment system for multimodal passenger transport, before 2020, was declared to be part of the 10 objectives of the transport policy [15].

A few years before, The International Association of Public Transport proposed the vision to enable citizens "to travel within, between and through different cities, regions and borders without the need to change the ticketing media they use" (International Association of Public Transport, 2007, p.1). This is supposed to contribute to more customer convenience and efficiency of public transport, as the combination of modes is said to be facilitated and thus the transfer between them easier. Main aim of integrated ticketing is to improve service quality for (potential) public transport users and therefore to encourage the use of alternatives to the car [10].

In 2015, in Helsinki, on the occasion of the Intelligent Transport Systems World Congress, the Mobility as a Service (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 [9]. Among the members of the alliance are 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 [7].

The European Commission (EU) declared 2018 the "Year of Multimodality", and one year later, in 2019, European Commission published two studies targeting multimodal passenger transport [5]. The first study refers to the rights of passengers using multimodal transport and the second to the challenges that exist in the European Union regarding the implementation of the integrated payment and ticketing system. Studies have shown what are the challenges and barriers to developing, at European Union 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.

Although several European countries have developed such integrated systems, so far, at European Union level there has not been created a

single system for online booking and purchasing travel tickets for multimodal transport. For example, Ferrovie dello Stato Italiane, the Italian railway infrastructure manager, recently launched an application for multimodal transport. Named "Nugo", the application is valid for both Apple and Android users [6]. "Nugo" allows 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 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. 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 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 by an association of all railway operators [13].

While Europe is looking for solutions, China is preparing for the next level: multimodal interactive payment based on biometrics [14]. 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, e-ticketing 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 e-ticketing network system. The introduction of big data integrated marketing concept has a positive reference value for the transformation and upgrading of traditional e-ticketing network platform and the cultivation of performance industry market [8].

2 Solutions for multimodal passenger transport

The purpose of this paper is to configure an application which will allows the online reservation and purchase of travel tickets for rail transport and road system in Romania. This application aims to connect the reservation and payment systems of the Romanian railway transport undertakings and of the road transport operators that provide the transport of passengers by coaches on internal routes. The purpose of the application is to create a software product which will help as many users as possible. They will 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 or a computer. 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.

An integrated system of booking and issuing travel tickets for multimodal passenger transport will improve service quality for public transport users and therefore to encourage the use of alternatives to the personal cars [4]. The modal distribution shows that in Romania land transport has a quota that exceeds 90%. The majority of the population travels by personal car (80%) and only a small percentage chooses the public road transport (15%) and railway transport (5%) [3].

3 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, for example, the Unified Modeling Language (UML).

The next step after the modeling is database generation. It stores all the information about the schedule (departures/arrivals) for the railway

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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

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 for online booking and purchase of travel tickets.

3.1 Activity diagram

Activity diagrams are used to model the dynamic aspects of a system. They represent an activity decomposed into actions that can be performed sequentially or in parallel [1].

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, the actors are presented, at an initial stage: buyer, online travel booking and ticketing platform and the bank.

The activity diagram represents the flow from one action to another (Fig.1).

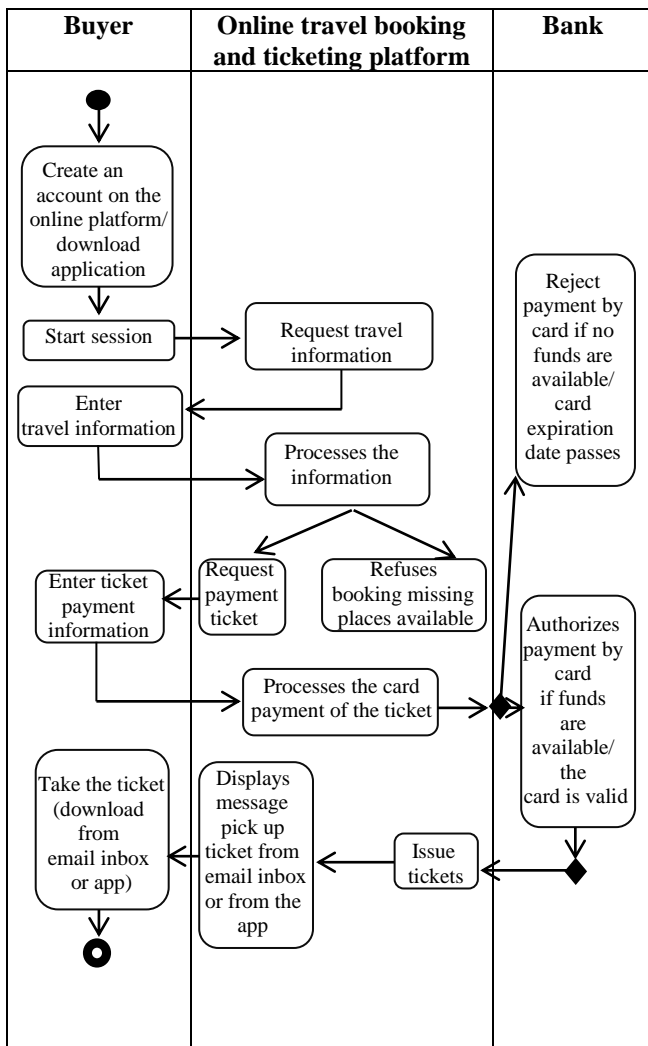| Buyer	Online travel booking and ticketing platform	Bank

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 booking and purchase of travel tickets 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 buyer 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 travel 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 passengers; 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 the payment, depending on the available balance and the expiry date of the card.

After the payment is made, the ticket is issued through the buyer`s email address, at the address that was mentioned when the account was created on the online platform, or directly in the application downloaded on the mobile phone.

3.2 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 [1].

The UML class diagram is a so-called "bridge" between software specification at the user side and software realization at the developer side [12].

In the diagram, classes are represented as boxes that contain three compartments: the top compartment (contains the name of the class), the middle compartment (contains the attributes of the class) and the bottom compartment (contains the operations the class can execute).

Class diagrams are the most commonly used models in object oriented software design (Fig.2).
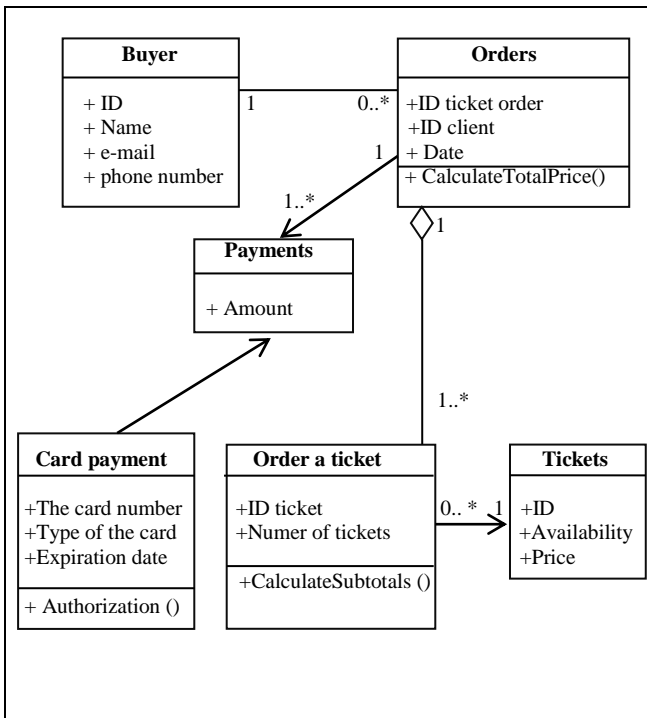
Fig. 2.   Class Diagram

Steps to be followed:

a) The buyer, after accessing the account created on the web page, entering the name and surname, email address and/or telephone number and/or downloading the application on the mobile phone, with a user identifier (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 an ID of the user (the person who wants to 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 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.

4 BPMN Modeling

Business Process Model and Notation (BPMN) is, together with the Unified Modeling Language, one of the best known standards for modeling and managing business processes, being extremely useful in the definition and alignment stages of software products. BPMN`s goal is to provide a unified set of elements and notations that are easy to understand and use by everyone involved in developing a business, including business analysts,

IT specialists and managers [11]. BPMN is a graphical representation focused on activity flows for defining business processes [2]. When we use BPMN, we graphically represent a business process in the form of a Business Process Diagram (Fig.3).
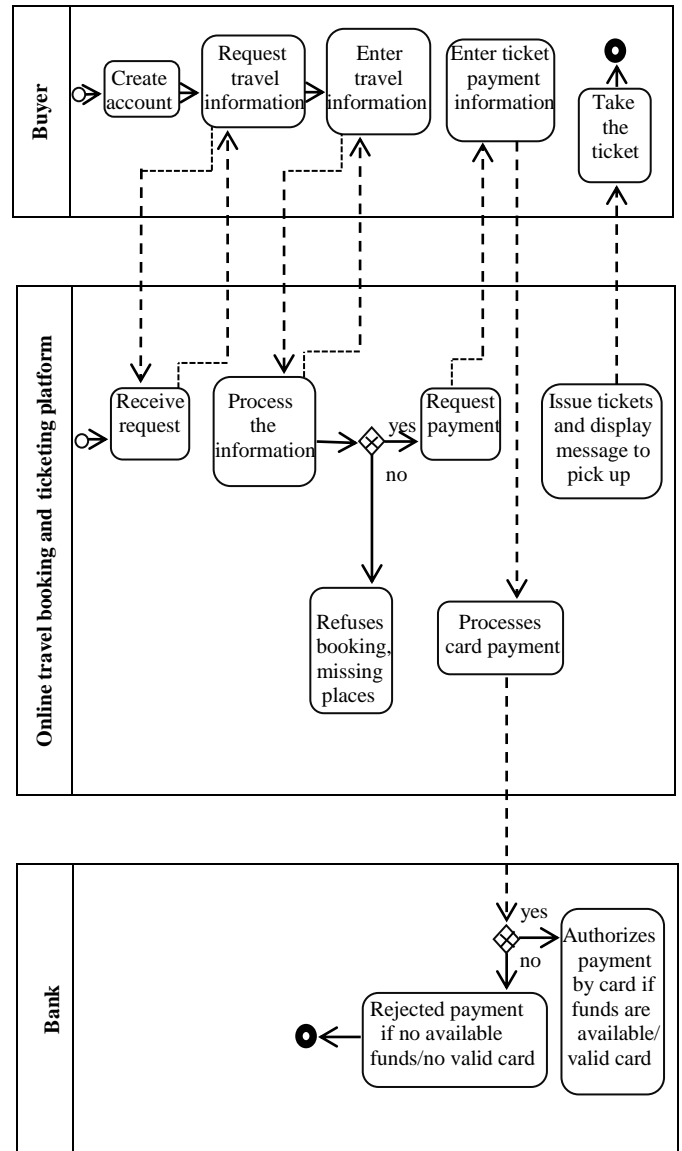

Fig. 3.   Diagram for modeling the process of online booking and purchasing tickets using BPMN

Steps to be followed:

a) The buyer who wants to book and purchase a travel ticket online, creates an account on the website, entering her/his name and surname, e-mail address and/or phone number and/or downloads the application on mobile phone;

b) Request the travel information to the online platform (departure and arrival times, depending on the point of embarkation and the debarkation point);

c) The online platform receives the request and displays the information requested by the buyer, and requests the buyer to enter the travel information (departure and arrival time, depending on the point

of embarkation and the one of debarkation; number of places; class and type of wagon; type of tickets: round-trip tickets, tickets needed to travel with several transport operators (railway and road transport);

d) The buyer enters the requested information;

e) The online platform processes the information and, in the absence of available places, rejects the reservation. If there are available seats, requests the payment of the ticket/tickets;

f) If there are available places, the buyer enters the necessary information for payment of the ticket/ tickets (card number, expiration date of the card, name of card holder, cvc);

g) The online platform processes the card payment of the ticket/ tickets and sends the information to the bank;

h) In case there are no available funds or if the card expiration date has passed, the bank will reject the card payment of the ticket/tickets. If funds are available and the term of validity of the card has not expired, the bank authorizes payment by card of the ticket/tickets;

i) If the bank authorizes the payment by card, the online platform issues the ticket/tickets and and displays the message for receiving the ticket/tickets from the email inbox or from the application.

4 Conclusion

Multimodal transport is one of the solutions for decongesting traffic and for reducing pollution and carbon dioxide emissions. More than a decade, the integrated e-ticketing system for multimodal transport was one of the objectives of the European Union transport policy. Although several European countries have developed such integrated systems, so far, at European Union level there has not been created a single system for online booking and purchasing travel tickets for multimodal transport. The study published by the European Union shows that the main barriers regarding the implementation of the integrated payment and ticketing system in European Union are: price integration, legal uncertainties, technological challenges, lack of cooperation etc.

Despite all these obstacles, e-ticketing is definitely one of the important future directions of transport ticketing, that offers a lot of benefits, not only for passengers, but also for passenger transport companies and responds to the current needs of the society, one of them being the need to travel.

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 for example, Unified Modeling Language or Business Process Model and Notation. 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.

The purpose of the application is to create a software product which will help as many users as possible. They will be able to plan their trip, including purchasing online a single ticket to travel by different means of transport, using the mobile phone or a computer. Also, an integrated system of booking and issuing travel tickets for multimodal passenger transport will improve service quality for public transport users and therefore to encourage the use of alternatives to the personal cars.

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