# THE ECONOMIC IMPACT OF INTRODUCING OF THE INFORMATION AND COMMUNICATION TECHNOLOGY UPON THE RAILWAY TRANSPORT IN ROMANIA

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**Abstract.** *The technological progress over the past decades allowed for the emergence of new multimedia services and telematic applications. The development of new means of communication and information technology is an important factor for increasing the economic agents' competitiveness, opening new perspectives for a better organization of work and for creating new jobs. Transports are a key of success in achieving the single market in the European Union, because they contribute to concretize two of its fundamental objectives: free movement of persons and free movement of goods. Among the existing transport modes, the railway transport is still of great interest due to certain benefits arising from the fact that it is the least polluting and the most environmentally friendly.*

*The Intelligent Transport Systems require the application of information and communication technologies (ICT) in transport. The railway networks are gradually introducing the European system of railway traffic management (European Rail Traffic Management System – ERTMS) and telematic applications for freight transport (Telematic Applications for Freight – TAF). The aims of implementing the ERTMS are to replace the national command and control systems for trains, to create a unitary European railway system and to increase the competitiveness of the European railways.*

*The paper proposes a brief analysis of the economic implications of implementing the information and telecommunications technology in the Romanian railway transport. It analyzes the economic benefits arising from the capacity and performance improvement, but also from the reduction in re-signaling costs. The increase in the number of passengers carried by railway will require increase in the number of trains, and in train service costs, but they are assumed in estimating the benefits of ERTMS deployment. Economic benefits from ERTMS implementation are also arising for the railway users by cutting the crowding and delays, as well as for the road users by taking over a part of the passenger/freight transported by road.*

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## 1. Introduction

Transport is one of the keys for achieving success in the EU Single Market, as it contributes to the realization of two of its fundamental objectives: the free movement of persons and free movement of goods.

Among today's existing transport modes, rail transportation remains of great interest because of certain advantages which derive from the fact that it is the least polluting and more environmentally friendly. These are just some of the reasons why, in recent years by the European Union try to develop strategies and implement programs to revive rail transport in the Community and to attract increased traffic to this type of transport.

The European Union advocates the exploitation of existing infrastructure and transport more environmentally friendly. Ensuring environmental sustainability of European transport and energy is a goal that can not be attained only by combining several policies that support and complement each other and involving a growing number of actors, representatives of the transport sector, the government and public citizens.

Since transport is a complex system that depends on multiple factors, including patterns of human settlements and consumption, the organization of production and facilities available for intervention in this sector must be based on a long term vision on mobility sustainable for people and property.

European Economic and Social Committee believes that competitive transport, reliable, cost-effective fluid and a prerequisite for economic prosperity of Europe and the free movement of persons and goods is one of the fundamental freedoms of the European Union. In this context, transport should contribute greatly to achieving the objectives of Strategy 2020.

Advanced information and communication technologies can contribute significantly to achieving competitive and reliable transport, improving infrastructure, traffic and fleet, by facilitating better monitoring and traceability of assets along the transmission and print better networking of enterprises and administrations.

## 2. Rail transport in the European Union

Transport is an essential component of the European economy, generating about 7% of GDP and more than 5% of total employments in the EU. European Transport Policy (ETP) has contributed to a comparable mobility system, the efficiency and effectiveness with those of the regions most economically advanced in the world. Also, ETP has stimulated

economic and social cohesion and promoting competitiveness of European industry, thus contributing to a significant extent, the implementation of the Lisbon Agenda for growth and jobs [11-12].

European Community is seeking to create conditions for improving the railway sector and its adaptation to the requirements of the Single Market. In this respect, proposed the introduction of an operating license to provide uniform access to infrastructure and established a system for the allocation of infrastructure capacity on a non-discriminatory basis, users paying the actual cost of the facilities they use.

Rail transport in Europe registered an alarming decline in recent decades, particularly in freight transportation. The share of rail freight declined from 32.6% in 1970 (EU-15) to 10.7% in 2007 in the EU-27. In absolute terms, taking into account the quantity of goods carried and distance flown, rail freight activity (EU-15) fell between 1970 and 2006, about 1%, while road freight grew by more than three times in the same period.

As regard the passenger rail traffic, it also decreased, but not as dramatically (in 1970 (EU-15), the share of passenger rail travel was over 10%, but decreased to 6.1 % in 2007 in the EU-27). The main cause of this situation is that the rail sector is not as competitive as a road.

Rail transport is less safe than the road in terms of delivery, which are less predictable for railways. In the recent years, one some international routes, terms of delivery (very important for many sectors) have doubled or even tripled. This is mainly caused by very long stops along the way, because other trains (especially passenger service) have priority and border procedures are complicated (train crews and locomotives must be changed due to differences in signaling and traction systems from one country to another etc.).

However, Railways have unique advantages: a safe and clean transport's mode and a train can carry the load of 50-60 trucks. Rail infrastructure cover much territory and is generally in good condition, but no longer matches with the customer requirements.

In the last fifteen years, the European Community has developed a rail policy designed to create a new dynamics for this sector and halting the decline of rail freight transport in relation to the road, to build a solid single market, based on a sustainable transport system. In this context and actions are part of the freight market opening from 2007 and identification of priority axes eligible for Community support, both in financial terms (was created a budget for achieving trans-European Transport Network (TEN-T) 8 billion for 2007-2013, much of this amount being for rail infrastructure)

and in terms of coordination among the various Member States crossed by each axis.

Internationally, the rail freight faces three major difficulties:

i) the slowing of traffic on the bottlenecks (generally near urban agglomerations);

ii) loss of time at border crossings due to administrative or technical duties;

iii) the terms of access to rail services (terminals, sorting stations). These difficulties significantly affect the average commercial speed and can be considered the same constraints that are affecting the infrastructure, limited capacity and reliability of freight.

### *2.1. Intelligent Transport Systems in rail transport*

Technological innovation will be a major contributor to the solution of the transport problems. Rail traffic management systems can optimize network utilization and improve safety [4].

"Intelligent Transport Systems" require the application of TIC in transport. These applications are developed for different modes of transport, but also to promote interaction between them (including hubs).

If air transport, SESAR will be the framework for implementation of a new generation air traffic management systems, and hinterland waterways are the River information services are available (RIS) for managing the use of waterways and freight and passengers transport, inside the railway network is gradually introducing the European Rail Traffic Management System (European Rail Traffic Management System – ERTMS) and telematics applications for freight (Telematic Applications for Freight-TAF).

The European rail transport management ERTMS is a major industrial project developed by six members of the association UNIFEM (the Association of the European Rail Industry): Alstom Transport, Ansaldo STS, Bombardier Transportation, Invensys Rail Group, Siemens Mobility and Thales, in close cooperation with EU bodies concerned with rail and GSM-R industry.

ERTMS system has two basic components (ETCS + GSM-R = ERTMS);

ETCS – European Train Control System, which is the system of automatic train protection (ATP Automatic Train Protection System), used to replace existing national ATP systems;

GSM-R – radio system for providing voice and data communications between rail and train based on the GSM standard that uses special frequencies reserved for railway applications, with specific and advanced functions.

The purpose of the ERTMS system implementing is to replace the national command and control systems for trains and creating a single European rail system that leads to increased competitiveness of European railway.

Currently, in the European Union there are more than 20 train control systems. Each train used by the national railway company must be equipped with at least one system, but sometimes more, so that traffic can be safely held in that country.

Each system is independently and non-interoperable, and thus require extensive integration, engineering effort and increasing total cost of delivery for cross-border traffic. This is but an obstacle to the competitiveness of European rail compared with road transport, creating technical barriers to international travel. For example, Thalys speed trains running between Paris-Brussels-Cologne and Amsterdam, must be equipped with seven different types of train control systems, which involve significant costs.

As a unique European Train Control System, ERTMS is designed to replace the existing systems compatible throughout Europe. This will bring considerable benefits for the rail sector, which will lead to the strengthening of international freight and passengers transport.

Also, ERTMS is the most powerful train control system existing in the world and brings significant advantages in terms of maintenance costs, safety, reliability, punctuality and traffic capacity. This explains the fact that ERTMS is increasingly used outside of Europe and becomes the train control system in countries like China, India, Taiwan, South Korea and Saudi Arabia.

ERTMS contribute, thus increasing the competitiveness of rail, which makes this system can compete with other modes of transport such as road.

ERTMS system will enable interoperability across the European railway network.

Compatible across Europe, ERTMS allows the creation of a single rail system, allowing, for example, trains running from Barcelona to Warsaw would no longer be faced with technical problems related to specific signals that go through each area.

ERTMS also presents other advantages. Designed to implement the trains with the best control systems in the world, so the system brings considerable benefits in addition to interoperability, including:

- increase capacity of existing lines through strict management of the intervals between trains and the ability to cope with rising demand for transport;
- achieve higher speeds: ERTMS allows a maximum movement speed to 500 km/h;
- achieve higher reliability rates: ERTMS can significantly increase the reliability and punctuality, which are essential both for passengers and for freight transport;
- reducing production costs: as a harmonized system is easier to install and maintain and manufacture of railway systems become more competitive;
- obtaining low maintenance costs;
- creating an open market offer: customers will be able to purchase equipments for installation anywhere in Europe and all providers will be able to bid for any opportunity. Railway lines and equipment on board can be purchased from any of the six ERTMS suppliers, which makes the supply market become more competitive;
- reduced supply contracts as a result of significant reduction in process engineering;
- simplifying the approval and certification process in Europe, which has greatly reduced the costs associated, traditionally, to the introduction of new systems;
- improve the safety of passengers, employees and freight.

Economic considerations for the implementation of ERTMS system derives from three main reasons:

- increase rail capacity and performance by taking a volume of passenger and freight transport by road, thus eliminating bottlenecks, reducing at the same time, the complexity of track systems and costs caused by road accidents and traffic delays ;
- Interoperability, which will allow trains to operate safely and effectively in control systems supplied in part or whole by different companies. This leads to greater mobility for trains across Europe and beyond, the competitive procurement;
- Safety-ERTMS is a system that provides automatic train protection, reduce the incidence and consequences of signals passed at

danger (SPADs). Even if the installation of Protection and Prevention System for trains (Train Protection and Warning System-TPWS) significantly mitigates risk by implementing ERTMS system to, it provides an additional signal in the train cab, which is an important step forward for train drivers, especially at high speeds in bad weather. ERTMS is actually a requirement for trains to travel at 200 km/h. This is a safety requirement, but ERTMS also allows obtain commercial benefits in this area. Higher levels of ERTMS will facilitate better management of "possession" for track work and track requires less infrastructure, leading to reduced risks for workers in this sector.

The assessment of the investment required to implement ERTMS, requires consideration of the following objectives:

● economical – to identify the optimal solution for the implementation of ERTMS, cost-benefit analysis and, especially the economic benefits of the capacity and improve performance and reduce costs by re-flashing. Increasing the number of passengers transported by train will require increase in number of trains, with train service costs, but they are assumed in estimating the benefits of ERTMS implementation. Economic benefits through the implementation of ERTMS are for rail users by cutting settlement time (crowding) and delays, and benefits to road users by taking on the part of rail passengers/cargo to be transported by road [6-8].

● compliance with EC directives on interoperability [2-3];

● Safety – a means of providing more ATP to reduce the incidence and consequences of signals passed at danger (SPADs).

## 3. Rail transport in Romania

Romania now has a national transport system (infrastructure, vehicles, carriers etc.) situated largely in terms of both functional structure and the services rendered to media standards conventional transport systems in Europe, able to cope the current needs of domestic and international users.

Overall, the network of public transport infrastructure (roads, railways, waterways, fairways, sea and river ports, airports) ensure achievement of all localities in the country connected to the national transport and international transport systems.

Although major changes made so far, the transport system in Romania is still indebted "the old" system has been designed and built. Restructuring it in a manner required by the principles of the common

transport policy takes time, resources and "amputations" sometimes very painful.

Romania's location at the intersection of numerous roads connecting Western and Eastern Europe as the North and South Europe and transit country location on routes between Europe and Asia, is a benchmark for determining transport policy.

Romanian Railways have a duty to integrate national railway infrastructure in the technical and operational parameters of European standard to be compatible and interoperable part of the future Trans-European railway network.

Interoperability of the conventional rail network (TEN-T and TEN-T out) with the European rail network will be achieved by placing in the track and rolling stock engine board the elements necessary surveillance system ETCS, upgrading of railway stations centralization through the introduction of electronic railway interlocking, developing the information system for all railway stations located on interoperable rail network in Romania, the development of the telecommunications network to provide data transmission support and implementation of railway information systems in all railway stations located on the interoperable railway infrastructure in Romania, the implementation of the National Center for centralized control of rail traffic in Romania, retrofitting energy-supply facilities of the contact line.

These actions will lead to better market coverage and better transport accessibility to major transportation routes for passengers through their interconnection to the regional services and increased passenger wagon's load on the main and regional routes.

### *3.1. Implementation of ERTMS / ETCS in Romania and the economic effects generated by this*

Develop national plan for implementation in Romania of the system ERTMS / ETCS started from the strategy in signaling, based on current features and future upgrades, the allocated funds for this area [1].

Thus, for large stations was considered necessary to introduce electronic interlocking installations (W-SIEMENS SIMIS types and L90 ESTW EN-ALCATEL compatible for connecting in the system ERTMS / ETCS), and for small stations have developed two variants of computerization of operating stations of the electrodynamics centralized facilities (CED).

Because the equipment developments is more spectacular, and the pressure to reduce maintenance costs is more powerful, National Railway Company CFR SA has included in its strategy an project of an electronic interlocking equipment for small and medium-sized stations [9]. Through this project are kept outside upgraded equipment (point machine, signals, track circuits, installation of automatic signaling level crossings), relays interfaces for external elements and other subsystems, respectively automatic line block (BLA), barrier automatic level crossing (BAT), signal level crossing without automatic half-barriers (SAT) etc., but they replaced the logic of the contact safety relay with safety logic based computing. In this way, performing a hybrid system that benefits facilities for electronic interlocking equipment, but kept outside equipments of the station, reducing in turn the large proportion that the number of relays and maintenance costs.

Implementation of ERTMS/ETCS is based on a range of specific requirements of each railway administration, for Romania requirements can be classified as:

- higher requirements, covering essential needs for the ERTMS / ETCS system;
- operational requirements, which describe the necessity of ERTMS / ETCS in terms of operations that are performed on the railway;
- functional requirements of the system ERTMS / ETCS system;
- Among the requirements imposed centralize facilities in Romania may be mentioned:
- general requirements: the facility must ensure interlocking/locked the reciprocal of points and signals;
- particular requirements of the electronic interlocking plant: are those governing the safety philosophy of the Romanian railways.

Regarding the introduction of ETCS train protection type, Romania has opted for ETCS Level 1 on the Bucharest Nord-Ploiesti West, ETCS Level 2 on the Bucharest Nord-Constanta facility while maintaining point control of train speed (INDUSI).

Within the concept of transition from national INDUSI to ETCS level 1, the system keeps in track and INDUSI for freight and passenger trains that are not equipped with ETCS.

For reasons of cost and given the size of railway stations, in Romania shall be equipped with ETCS, the first stage, only the direct lines stations and the BLA blocks.

The introduction of ETCS Level 1 provides a number of important advantages: interoperability, increase safety, increases the comfort of the

passenger transport by optimizing braking, power consumption reduction of specific thrust, reducing brake wear.

The selected configuration option must be a balance between costs and increased safety performance and availability.

Modular design of the system hardware and software, combined with the media through standardized protocols, allows economic adaptation to changing circumstances, so that modules can be placed next to each other to form an integrated solution.

The system allows the integration of new features by adding software or hardware modules, thus allowing the extension in line with growing needs, without sacrificing the original investment.

Important advantages related to the implementation of electronic interlocking installations are:

- achievement of all possible paths of movement and maneuver for a given configuration of the station, which gives greater flexibility traffic management;
- providing opportunities for changes and adjustments during operation, without requiring significant time period in which the system is turned off;
- increase the safety of rail traffic;
- ensure a maximum level of the installation reliability, to allow, thus reducing maintenance activity and costs;
- effective preventive and corrective maintenance activities by assisting computer, including the functions of diagnosis and fault location;
- decrease in operating costs by reducing the system components that require periodic adjustments, such as relays;
- technical support for the development of rail traffic management by incorporating centralized facility as a subsystem in ERTMS / ETCS.

### *3.2. Other's implementation of TIC in the Romanian railway transport and economic implications arising from this*

As a result of the project "Modernization of the SNCFR telecommunications systems", financed from BIRD loan (36.7 million USD), and in addition the state budget through the Ministry of Transport (21.9 million USD) were made:

i) installation in the cadastral area of railway of 3530 km of 20 single-mode optical fiber cables and extensions;
ii) synchronous digital transmission network, structurally organized in five rings and seven branches;

iii) the provision to users, large data transmission capacity ranging from 155 Mbit/s and 2.5 Gbit/s and lower transport capacity data between 64 kbit/s and 34 Mbit/s, on the 550 access points in railway stations;
iv) integrated service network that includes 224 digital telephone exchanges, 40 knots international switching and switching node;
v) asynchronous digital transmission network based on ATM switches, with data transmission speeds of 622 Mbit/s network backbone providing railway information systems;
vi) network synchronization, which is based on a clock generated by the cesium atomic clock and 8 GPS points located in major railway hubs;
vii) videoconference network that connects the eight regional offices, located in the Palace CFR and conference room complex Snagov.

Offer variety of railway telecommunications services allows user's easy access to new communications technologies found in constant development in asynchronous transmission network (ATM) and network synchronization, which is, technically speaking, among the most successful networks in Europe.

The upgrading of rail communications program has included and integrated project of information technology for operations management in Romanian Railways-IRIS [5].

The IRIS (Integrated Railway Information System) is a component of the Railway Rehabilitation Program funded by the BIRD, the latter wishing to increase the competitiveness of the Romanian railways system in the context of free access to European railways.

The main objectives of the project were to optimize and automate a number of key activities in rail and construction of an information infrastructure capable to supporting further development. The first phase of the IRIS project, designed to cover the applications and information systems vital activities of the entire railway system was completed in 2003 and included four major components: the application of railway infrastructure management, application management of railway vehicles; application freight transport management, application for monitoring the movement of trains.

Thus, IRIS provides an integrated solution for information technology, including advanced hardware for databases and software applications, connected into a national network with two levels – WAN and LAN.

In Romania, IRIS-RSMA –Rolling Stock Management application is already implemented in 14 pilot locations in the area, and of these, it is

only operational in seven locations SNTF Passengers and three locations C.F.R. Freight.

For timetable planning it use solution IRIS-ATLAS. This allows you to create train paths and a program of movement. Existing paths are shown, as highlighted opportunities for the rapid creation of some additional paths for special trains.

Application for passenger and freight transport management IRIS-ARGUS contains records for all freight and passenger wagons, locomotives stationed, or which are in circulation on the track, including foreign cars entering/leaving the border stations.

For commercial freight subsystem was carried IRIS MERCURY application that allows creation and use of consignment notes for calculating tariffs and accessories due to transportation charges. It maintains constant data files on the stations, customers, costs, distances, etc. and the percentage of VAT applicable, that the amount of charges to be fully and correctly calculated in accordance with the conditions of transport.

XSELL project is an upgrade of the electronic sale of travel tickets and booking of seats on passenger trains. Implementation of the solution made by S.C. Railway Information S.A. offers a series of economic and procedural advantages for customers: it's cheaper than an imported solution, is already proven in service, specific requirements in Romania and works for any passenger rail carriers.

Among the advantages of implementing this system can be listed: the doubling of passenger ship, high quality service to passengers, fair pricing, secure booking, ticket issuing standardized on the European level, with clear information, financial management, safe and quick, a major reduction manual effort, to obtain various statistics that support effective decision making, modeling processes specific CFR, comfortable use, 100% availability, ensure security and confidentiality of data in the system.

Pilot system, installed in Bucharest North Station (SELL) since 1993, is an improved response to real business needs and existing technology processes developed with latest technology in the field. Hardware and software architecture provides an availability of over 99.3% of the system, over 80% of tickets issued in Bucharest complex requiring an average serving time of an application for 40 seconds.

Since 2008, S.N.T.F. C.F.R. Travel S.A. started more purchasing programs for the coaches or the service of upgrading the fleet of cars to comply with the limits imposed by current transport requirements and Regulation (EC) no. 1371/2007 of the European Parliament on the rights and obligations of rail passengers transport [10].

## 4. Conclusions

Romanian railway system began to revive shy steps after the start of accession of Romania to the European Union, a process that continued more intensely after accession in order to align it with the standards of European railways. From the actual moment started the rehabilitation of the Romanian railway infrastructure.

As investment in infrastructure, the implementation of the EURO – Interlocking project was intended mainly to reduce costs of procuring, installing and commissioning related facilities.

Putting into use of three electronic interlocking systems in the Bucharest-Constanta section (implemented Dorobanțu, Saligny and Borcea stations) will bring CFR benefits of proven technologies, in accordance with international safety standards. The implemented solution allows C.F.R. to increase transport efficiency and to reduce transmission costs.

Implementation of ETCS – Level 1 in Romania decrease in operating costs by reducing the system components that require periodic adjustment, gives greater flexibility traffic management, increase safety of railway traffic, ensuring the highest level of reliability of the plant thus enabling reduction maintenance activity, but also preventive and corrective maintenance efficiency by assisting the computer, including the diagnosis functions and fault location;

All telecommunications networks and computer systems were expanded in 2004 with 1200 km, and in 2007 all railway lines, and thus interoperable rail network is Romanian.

Current dimensioning of telecommunications networks services digital railway but does not provide the necessary infrastructure entirely domestic rail operators and economic operators working in the railway field.

Development of transport infrastructure will play an important role in integrating the internal market and will help enhance the geographical position of Romania as a transit area, located at the intersection of Pan-European Transport Corridor IV and Pan-European Transport Corridor IX. Romania's location at the intersection of numerous roads connecting Western Europe with the East, and North with the South, and location of the axes of transit country between Europe and Asia, is a benchmark for determining the strategic options development and modernization of transport infrastructure, the opportunity created by the Danube-Black Sea channel and the Danube, can play a key role in attracting international flows of goods, the relations between Europe and other continents.

Romanian Railways have a duty to integrate national railway infrastructure on the technical and operational parameters of European standard, to be compatible and interoperable part of the future Trans-European railway network.

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