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Economic evaluation of a technological leap in the sector of train control and signalling: the case of German regional lines

Giuseppe Siciliano [a,]*, Dario Musolino [a]

[a]*Certet – Bocconi University, via Rontgen, 1, Milan 20136, Italy.*

Abstract

This paper addresses the question of the economic benefits deriving from the application of satellite-based technologies in the rail sector, in particular in regional lines. The introduction of these technologies can generate a re-design of the control systems in the rail sector, reducing investments and operating costs, and increasing the capacity of railway lines, especially in the regional and local market. Therefore, it can be a source of efficiency for involved operators, increasing competitiveness and economic returns.
The objective of this paper then is to present and discuss the results of the economic evaluation of the potential benefits deriving from the introduction of technologies based on the Global Navigation Satellite Systems (GNSS) on the ERTMS/ETCS level 2 systems, adapted for regional lines, focusing on the German case study.
The results presented in the paper come from a study of the wide program of researches promoted by ESA for the development of satellite technologies in the rail sector; in particular, it is part of the 3inSat "Train Integrated Safety Satellite System" Demonstration project". The study has been realized with the close collaboration of Ansaldo STS, ESA, Deutche Bahn Netz and DLR (German Aerospace Agency).

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Keywords: Cost-Benefit Analysis; transport systems; rail transport; train control and signaling

* Corresponding author:
E-mail address: giuseppe.siciliano@unibocconi.it

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1. Introduction

This paper is aimed at illustrating the evaluation of the introduction of satellite-based technologies in control and signaling in the regional rail network, focusing on the case of German regional railways.

The satellite-based solution for train control and signaling is based on the "virtual balise" concenpt and aims at providing a solution complying with ERTMS Level 2 standards. In fact, the purpose and approach of the evaluation is that of a comparison with alternative ERTMS Level 2 solutions based on fixed balises.

The virtual balise concept involves the use of the enhanced positioning service provided by the satellite sector in order to locate the train, instead of the fixed balises between the tracks; and it is coupled with the use of a public GSM network for the radio communications between trains and the central control (Radio Block Center) rather than the GSM-R (GSM dedicated to rail).

The main impact of the virtual balise concept as compared to fix-balises is the removal of the track-side equipment and its connected costs. Obvisouly the introduction of satellite-based ERTMS generates a relevant number of upfront and operating costs. However, the complexity of Train Control Systems and their evolution in European countries (cfr. Vincze 2006) suggests to focus on cost elements which are remarkably different from one ERTMS solution to another.

The aim of the analysis is to investigate the economic impact for the rail transport system in general, however it also addresses impacts for specific operators, as this is particularly relevant for the future deployment of the satellite-based system.

2. Methodology

2.1. Approach

The evaluation of the introduction of the GNSS-based control system in the German regional network uses the following approach:

1) Division of the German regional network into a (limited) set of homogenous parts, according to the following line standards.
    a. R120 (4971 km)
    b. R80 (4639 km)
    c. G50 (287 km)
2) Derivation of unit figures with the contribution of DLR in a theoretical 100 km lines (by line standard)
3) Application of a Cost-Benefit Analysis, using the above mentioned unit figures, to the whole parts (by line standard)
4) Sum up the results by part into the overall network (some 12000 km line)

It is to be taken into account that the current solutions for train control and signaling in the German network consist of conventional signalling system (Ks-System) with line-side signals and intermittent automatic train protection (PZB); the alternative solutions accounted for in this evaluation, called ETCSL2oS, consists of a balise-based system complying with ERTMS Level 2, without line signals.

2.2. Cost-Benefit Analysis

Cost Benefit Analysis (CBA) is a tool for identifying and monetizing the impacts of an investment decision in order to determine the project costs and benefits; the aggregated results can support conclusions on whether the project is desirable and worth implementing.

The difference with a Financial Analysis is that the latter considers the "private" point of view of the subjects who run the project/operations (and/or make it feasible); whereas CBA uses the "public" point of view, in that it compares differential costs and benefits that may include non-market elements (e.g. externalities), and which are borne or taken by the community. As a result, the cost benefit analysis evaluates the contribution to the economic