ANALYSIS OF PUBLIC-PRIVATE PARTNERSHIP MODELS IN HIGH-SPEED RAILWAY TRANSPORT IN PORTUGAL

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ABSTRACT

European railway transportation is not as efficient as it could be. Several factors contribute to this absence of efficiency, including a lack of private investment and exclusively public railway administrators and enterprises. Public-private partnerships can yield higher efficiency in railway transport. Within the high-speed railway sector there are a few implemented infrastructures through public-private partnerships and, in many of them, the result has not been the expected one. Hence, the purpose of this research is to develop a list of recommendations and good practices that allow governments, private investors, and railway stakeholders to take better and more efficient decisions on the implementation of new high-speed rail lines. Consequently, this research has analysed the Portuguese high-speed rail network called Rede Ferroviária de Alta Velocidade (RAVE) designed through public-private partnership. The research methodology is based on exploratory case study and on the identification of critical success factors. This article has made it possible to develop the following list of recommendations and good practices, cross-border cooperation for international sections, unique contracts for substructure and superstructure and an independent contract for signalling and communication systems.

1. INTRODUCTION

Exclusively public railway managers and operators, an absence of cost-reducing competition, and a lack of private investment can be classified as the historical factors that have not allowed railway transport to be as efficient as it might be (European Parliament, 2016). The European Union initiated railway transport liberalisation in 2006 with international freight transport, in 2007 with domestic freight transport, continued in 2010 with international passenger transport, and finished the 14th December 2020 with domestic passenger services (Diario Oficial de la Unión Europea, 2004b, 2007, 2016). These measures represent the initial actions taken toward an efficient railway system in Europe.

The most efficient railway transport management and development can be obtained through public–private partnership (PPP) contracts. PPP offers a reduction in public financing, mobilises private investment, and grants access to advantages connected with the private sector like skilled project management and innovation. Public services such as road transport have implemented this partnership successfully, but it is not a common model in high-speed railway transport. A limited number of high-speed railway lines have been constructed using PPP contracts. However, in many cases, the result has not been optimal. The following situations illustrate these facts (European PPP Expertise Centre 2020; World Bank, 2017, 2020).

Since 2007, a high-speed railway line has connected the Channel Tunnel with London. Formerly known as the Channel Tunnel Rail Link, this line is currently called High Speed 1. The PPP contract had to be restructured during the construction period due to two obstacles: difficulties in obtaining private financing and the British Government's opposition to augmenting the direct grants. High Speed 1's income came from the track access payments of Eurostar, the international railway enterprise that operates passenger rail services between France and the United Kingdom through the Channel Tunnel. The concession contract included the purchase of British public participation in Eurostar. Nevertheless, the Eurostar services were merely a third of what was forecasted, and the concessionaire had to sell its participation in Eurostar (Butcher, 2011; National Audit Office, 2001, 2005, 2012, 2015).
Since 2010, a cross-border high-speed line has connected the towns of Figueras (Spain) and Perpignan (France) through the Pyrenees. The PPP contract was awarded to the company TP Ferro. The Figueras-Perpignan line should receive traffic from the Spanish Barcelona-Figueras high-speed line. However, when the cross-border line was ready to begin operation, the Barcelona-Figueras line was under construction and the Figueras-Perpignan line had no rail traffic. The concession period was extended to solve this inconvenience, but ultimately, the PPP contract was terminated early. Currently, the Spanish and French national railway managers are operating this Spanish-French international section (Boletín Oficial del Estado, 2004, 2016; Eiffage 2013; Ministerio de Fomento, 2009, 2011; Sanz Gandásegui, 2005; Secretario de Estado de Relaciones con las Cortes, 2015).

These experiences reveal the need for a deep study of the reasons that high-speed railway PPP contracts fail, so that such failures can be avoided. In both cases, the failures proceeded from the decisions of public administrators and private investors. Hence, this article examines the RAVE Portuguese high-speed railway line which was designed through PPP contracts. Through this high-speed rail network, Portugal not only connected their capital with that of the neighboring country, but also connected with the European high-speed rail network. The RAVE Portuguese high-speed railway network was designed through six PPP contracts in 2004. However, it was only awarded the contract for the Poceirão and Caia section. Because of the 2008-2010 international financial crisis, which deeply affected Portugal, the PPP contract for the Poceirão-Caia section was rescinded during the design phase and the project for the whole network was discarded (Diário da República, 2011; Direcção-Geral do Tesouro e Finanças, 2010; Rede Ferroviária de Alta Velocidade, 2007; Tribunal de Contas, 2014).

In the general context of PPPs for high-speed railways, several economic aspects have already been studied. First, Bonnafous (1987) concluded that the first European high-speed railway line, which connected Paris and Lyon, generated direct economic benefits in the tourism and industry sectors. An extended article on railway PPPs was published by Dehornoy (2012), who deduced that the most successful concessions were those focussing on integrated traffic (for airport links) and availability traffic (for high-speed infrastructure). Moreover, Crozet (2016) concluded that PPPs permit the construction and opening of new high-speed lines in a timely fashion; however, public financial rescues are needed to solve financial problems. The relationship between investment and social benefits of high-speed rail transportation experiences in Europe (and worldwide) has been investigated by multiple researchers (De Rus, 2009; De Rus and Nash, 2009; Campos, de Rus and Barrón, 2009). They concluded that it was better than alternative modes of transport in terms of time savings, reliability, comfort, safety, and reduced pollution. Koppenjan and Leijten (2005, 2007) and Priemus (2011a, 2011b) analysed the Dutch sector in detail – the Hogesnelheidslijn Zuid (HSL-Zuid) high-speed line in particular – to assess the participation of private investors in railway infrastructure. They established that the Dutch government was not able to implement innovative contracts successfully due to its limited knowledge about PPP.

The RAVE Portuguese high-speed railway network has been developed in consideration of the interests of the Republic, politicians, private investors, and construction companies. De Azevedo Isidoro, Marat-Mendes, and Regina Tângari (2018) realised that the network's layout has not suffered from large changes from 1845 to 2015 and that developments were successfully made during social and economics transformations. Despite its limited budget, Portugal has led the European Union in development new transport infrastructure through PPP. However, Macário, Ribeiro and Duarte Costa (2015) found several pitfalls related to PPP regulation. Through a huge study on Portuguese road and railway PPPs, Pereira (2016) explains that most of the projects overestimated the demand forecast. On the contrary, while exploring the advantages of PPP, Rolland Sobral and Neves Cruz (2011) noted the success of private financing, adherence to a budget and deadlines, and the know-how of private investors in Portugal.

The Portuguese public-private high-speed rail model has been analysed by many authors. Besanko and Tenreiro Gonçalves (2013) concluded that the state-owned company RAVE should have described how the social and economic benefits were higher than the infrastructures costs. Pedro, De Abreu e Silva and Brookes (2015) described the influence of the external stakeholders. Oliveira Cruz, Kokkaew, and Cunha Marques (2017) issued recommendations to reduce risks (e.g., construct initially only one line to test the PPP model, split the infrastructure and operation management, or re-bid the operation contract within 5 to 10 years). Regarding the financial implementation and management of the Portuguese high-speed railway network, De Abreu e Silva, Silva and Sussman (2011) also determined that PPPs must be adapted to each project and it is necessary to pay attention to the interface generated from the split between substructure and superstructure works.

The failures that appeared during implementation (as previously described) could be repeated, even if the conclusions of the studies reviewed were applied to new high-speed rail lines contracted by PPPs. Therefore, the present research aims to develop a list of recommendations and good practices that can serve as a tool for governments, private investors, and railway stakeholders to make the best decisions before the construction of a new line. For that reason, this study analyses the RAVE Portuguese high-speed railway network.

2. RESEARCH METHODOLOGY

Case study theory was applied to this research in accordance with Stake (1995) and Yin (2009), the most relevant authors in this area. A case study was defined by Stake (1995) as a “study of the particularity and complexity of a single case, coming to understand its activity within important circumstances” (p. 7) and by Yin (2009) as “an empirical inquiry that investigates a contemporary phenomenon in depth and within its real-life context, especially when the boundaries between phenomenon and context are not clearly evidence” (p. 9). These authors identified two groups of three case study types. According to the reason for selecting a case study, Stake (2003) identified intrinsic, instrumental and collective case studies, and according to the purpose of the research, Yin (2009) identified explanatory, descriptive and exploratory case studies. This research is classified as exploratory case study due to the novelty of the RAVE Portuguese high-speed network examination. This case study is analysed to identify the critical success factors (CSFs) in high-speed railway infrastructure contracted by PPPs. Rockart (1982) defined CSFs as “the few key areas of activity in which favourable results are necessary for a particular manager to reach his or her goals” (p. 4).

This methodology was proven in research related with PPP transport infrastructures (Koppenjan, 2005; Liyanage and Roumboutsos, 2016; Liyanage and Villalba-Romero, 2015; Liyanage, Njuangang and Villalba-Romero, 2016; Ribeiro, Couchinho, Macário and Liyanange, 2016; Voordijk, Liyanage and Temeljotov Salaj, 2016; Macário et al., 2015).
The research methodology steps applied to this article consisted of five sequential actions: (a) collection of a wide range of data for the RAVE Portuguese high-speed railway network from the railway infrastructure concessionaire, railway infrastructure manager, railway undertaking, public administrations and railway-specific publications; (b) classification of the data into six areas: project, infrastructure, transport service, contract, corporate structure and investment; (c) identification and analysis of the CSFs; (d); discussion of the CSFs and (e) development of a list of recommendations and good practices for governments, private investors, and railway stakeholders.

3. DESCRIPTION OF THE CASE STUDY

In 1988, Portugal launched the construction of a high-speed rail network in coordination with Spain; they agreed to design the lines with Union Internationale de Chemins de Fer (UIC)-gauge (1,435 mm) (Diário da República, 1988). RAVE was established as a company in 2000. This company was comprised of the Portuguese State (60%) and Rede Ferroviária Nacional (REFER) (40%), the Portuguese national railway infrastructure manager, whose aim was to analyse and prepare for implementation of the RAVE Portuguese high-speed railway network. In 2001, Portugal and Spain created a European economic interest group called Spain-Portugal high-speed—or, in Portuguese and Spanish, Alta Velocidade Espanha-Portugal and Alta Velocidad España-Portugal. Both nations were responsible for the cross-border sections. This group was made up of RAVE and Administrador de Infraestructuras Ferroviarias (ADIF), the Spanish national railway infrastructure management organization (Rede Ferroviária de Alta Velocidade, 2004; Tribunal de Contas, 2014).

In a binational summit between Portugal and Spain in 2003, the following cross-border sections were defined: Porto-Vigo, Lisbon-Madrid, Aveiro-Salamanca, and Faro-Huelva. In 2004, Portugal unveiled its high-speed railway network, which comprised the agreed-upon sections with Spain and a domestic section between Lisbon and Porto. The European Union included the Lisbon-Porto, Lisbon-Madrid, and Aveiro-Salamanca sections in the high-speed railway axis of its southwestern Europe priority project; and the Porto-Vigo section in the Iberian Peninsula priority project. The Lisbon-Madrid section was classified as one of the five highest-priority axes for the European Union (Diário da República, 2004; Diario Oficial de la Unión Europea, 2004a; Rede Ferroviária de Alta Velocidade, 2004; Tribunal de Contas, 2014).
Following various Portuguese-Spanish summits up to 2009, the Portuguese high-speed rail network was designed with the features described in Table 1:

Axis	Journey time	Traffic	Length	Maximum speed	Stations
Lisbon-Madrid	2 hours and 45 minutes	Passengers and freight	206 km	350 km/h	Lisbon, Évora and Elvas/Badajoz
Lisbon-Porto	1 hour and 15 minutes	Passengers	314 km	300 km/h	Lisbon, Ota, Leiria, Coímbra, Aveiro and Porto
Porto-Vigo	60 minutes	Passengers and freight	100 km	250 km/h	Porto, Sá Carnerio Airport, Braga and Valença/Tuy
Aveiro-Salamanca	2 hours and 45 minutes	Passengers and freight	70 km	250 km/h	Aveiro, Viseu and Guarda
Évora-Faro-Huelva	Lisboa-Faro 1 hour and 30 minutes Faro-Huelva 30 minutes	Passengers	200 km	300 km/h	Évora and Faro

Note: Data from Rede Ferroviária de Alta Velocidade (2006, 2008, 2009).

Table 1 – Portuguese high-speed rail network.

There is a high cross-border mobility between Portugal and Spain due to cultural, linguistic, economic and cultural relations. However, it exists an important deficit in public transport. The new high-speed railway axis benefits to Portugal and Spain, and specially to the Spanish regions of Galicia, Castilla y León, Extremadura and Andalucía, due to its geographical location (Gutiérrez Gallego, Naranjo Gómez, Jaraíz-Cabanillas, Ruiz Labrador, and Su Jeong, 2015; Chen, Correia and de Abreu e Silva, 2015; Carvalho, Partidario and Sheate, 2017; Varela Cornado, 2018).

The Portuguese government decided to start contracting only for the axes considered to be a priority for Portugal. Theses axes were Lisbon-Madrid, Lisbon-Porto, and Porto-Vigo's 1st Phase, which was designed with polyvalent sleepers in 1,668 mm Iberian gauge. These sections are summarised in Table 2.

Axis	Journey time	Traffic	Length	Maximum speed	Stations
Lisbon-Madrid	2 hours and 45 minutes	Passengers and freight	206 km	350 km/h	Lisboa, Évora and Elvas/Badajoz
Lisbon-Porto	1 hour and 15 minutes	Passengers	314 km	300 km/h	Lisboa, Ota, Leiria, Coímbra, Aveiro and Oporto
Porto-Vigo 1st Phase Braga-Valença	60 minutes	Passengers and freight	55 km	250 km/h	Braga and Valença/Tuy

Note: Data from RAVE (2006, 2007, 2008, 2009).

Table 2 – Portuguese high-speed rail network priority axes

The Portuguese government justified the construction of these three Portuguese high-speed rail priority axes mainly through the socioeconomic benefits introduced by the connection with the Spanish and European passenger and freight railway networks (Diário da República, 2010).

In 2010, due to the international financial crisis that affected Portugal in 2008 and especially in 2009, an economic program dedicated to stability and growth was established. This program included a delay on the contracting for the Lisbon-Porto and Porto-Vigo axes (Ministério das Finanças e da Administração Pública, 2010). In 2011, the Portuguese government published a strategic transport plan for the 2011-2015 period in which the Lisbon-Madrid high-speed railway line project was abandoned (Diário da República, 2011). That year, the RAVE society was extinguished and integrated into REFER, which assumed the role of RAVE in the Spain-Portugal high-speed European economic interest group (Tribunal de Contas, 2014).

4. ANALYSIS AND DISCUSSION OF THE CSFs

This research examines the PPP model developed for the RAVE Portuguese high-speed network. In this section are analysed and discussed the CSFs.

4.1. Cross-border cooperation for international sections

For the RAVE Portuguese high-speed network cooperation between Portugal and Spain is ongoing through the various binational summit meetings and involved the creation of a European economic interest group, in which both countries were responsible for the cross-border connection of the Lisbon-Madrid axis (Diário da República, 1988; Tribunal de Contas, 2014). Spain has experience in this type of cross-border cooperation, since the international high-speed rail section between Figueras and Perpignan that links the high-speed rail networks of Spain and France was built through a public-private collaboration model involving a joint agreement between the two countries. As with the connection between Portugal and Spain, these two countries principally made their decisions in bilateral summits to define the characteristics of the international section between Figueras and Perpignan. On October 10th, 1995, as a result of the Spanish-French summit meeting held in Madrid, Spain and France signed the so-called Madrid Agreement, the purpose of which was to establish the grounds for the construction and operation of a high-speed connection between Spain and France through Figueras and Perpignan. Subsequently, in the same way as Portugal and Spain, a European economic interest group was also set up between Spain and France to control and enable the development of the project (Boletín Oficial del Estado, 1998; López Pita, s.f.; Ministère de l'écologie, du développement durable, des transports et du logement, 2011). Another infrastructure that should be highlighted in terms of cross-border railway cooperation is the Channel Tunnel between France and the United Kingdom. This infrastructure was also developed through public-private collaboration, in a joint project between France and the United Kingdom enacted by the Treaty of Canterbury on February

12th, 1986 (Secretary of State for Foreign and Commonwealth, 1986). All these cross-border agreements and cooperation accords between different countries contrast with the case of the HSL-Zuid line where the Netherlands had to pay compensation to Belgium to agree and finalise the route for the cross-border connection (Omega Centre, 2011).

Currently in Europe, cross-border cooperation is an undeniable reality since it contributes to cohesion, sustainable social development, and facilitates increased economic activity in cross-border territories. Transport infrastructures play a fundamental role in cross-border cooperation and common planning policies are increasing in Europe. To provide cross-border projects with continuity and durability, it is necessary to create an alliance between cross-border territories, which must be institutionalised through an agreement. For this alliance to be robust, it is necessary to ensure the participation of interest groups, guarantee a coherent objective for all participants, and ensure that the results of the cooperation involve similar benefits on both sides of the border (Galko and Volodin, 2016; Castanho, Vulevic, Fernández, Fernández-Pozo, Gómez and Loures, 2017; Kurowska-Pysz, Castanho and Loures, 2018).

4.2. Unique contracts for substructure and superstructure

The infrastructure works were divided into the six PPP contracts displayed in Table 3:

Axis	Section	PPP Contract	Scope
Lisbon-Madrid	Poceirão-Caia	PPP1	Substructure and superstructure. Évora station. Conventional freight railway line between Évora and Caia.
	Lisbon-Poceirão	PPP2	Substructure and superstructure. Tejo new bridge, Terceira Travessia do Tejo (TTT).
Lisbon-Porto	Lisbon-Pombal	PPP3	Substructure and superstructure. Leiria station.
	Pombal-Porto	PPP4	Substructure and superstructure. Aveiro station.
Porto-Vigo	Braga-Valença	PPP5	Substructure and superstructure.
All axes	All sections	PPP6	Signalling and communications systems.

Note: Data from Rede Ferroviária de Alta Velocidade (2007) and Tribunal de Contas (2014).

Table 3 – PPP contract scope for the Portuguese high-speed rail network

Substructure and superstructure works were included in the same PPP contracts. The PPP1, PPP2, PPP3, PPP4, and PPP5 contracts had the following scope: design, construction, finance and maintenance for 40 years; during operation, the payments were based on availability, traffic, and maintenance. The PPP6 contract was for the signalling and

communications systems on the whole high-speed railway network. For the Lisbon-Madrid axis, Portugal was responsible for the connection between Lisbon, Poceirão and Caia, which was divided into 2 contracts. The first (contract PPP1) included the high-speed section between Poceirão and Caia. Contract PPP1 also included the construction and operation of Évora station and a conventional freight railway line between Évora and Caia. Contract PPP2 included the high-speed section between Lisbon and Poceirão and a new bridge in Lisbon called Terceira Travessia do Tejo. Contract PPP1 was signed in 2010 with ELOS–Ligações de Alta Velocidade. Contract PPP2, which connected Lisboa and Poceirão in the second Portuguese section of the Lisbon-Madrid axis, was launched in 2009. The consortiums called ELOS–Ligações de Alta Velocidade, ALTAVIA ALENTEJO–Infraestruturas de Alta Velocidade, and TAVE TEJO presented bids. In 2010, due to the financial crisis, the Portuguese government discarded this construction (Direcção-Geral do Tesouro e Finanças, 2008, 2009, 2010; Rede Ferroviária de Alta Velocidade, 2007; Tribunal de Contas, 2014).
For the RAVE Portuguese high-speed network, both the substructure and superstructure were included within the same contract (Rede Ferroviária de Alta Velocidade, 2007; Tribunal de Contas, 2014). This is also the case of the other high-speed lines contracted through public-private partnerships in Europe, namely, the High Speed 1 line, connecting the Channel Tunnel with London, in the United Kingdom, the French Bretagne-Pays de la Loire line, which links the towns of Le Mans and Rennes, the Sud-Europe Atlantique line, which links the towns of Tours and Bordeaux, the Contournement Nîmes-Montpellier bypass, and the international Figueras-Perpignan section between Spain and France (Boletín Oficial del Estado, 2016; ERE Eiffage Rail Express and Réseau Ferré de France, 2013; LISEA and SNCF Réseau, 2017; National Audit Office, 2001; OC'VIA and Réseau Ferré de France, 2012).

It is not a coincidence that all these lines, except for the Dutch HSL-Zuid line, combined the substructure and superstructure activities into a single contract. This need is justified by the following technical reasons. Firstly, it is necessary to indicate that the substructure supports the superstructure and transmits the loads to the foundation. Secondly, the superstructure is the area above ground level that receives the loads from the trains which are then transferred to the substructure. It is clear, therefore, that there is an interaction between the substructure and superstructure; for this reason, it is necessary for the design to take into account the factors that influence the dimensioning, such as stresses and deformations, in order to obtain a better performance from both the substructure and superstructure as well as vehicle dynamics (Alamaa, 2016; Byun, Hong and Lee, 2015; Giannakos, 2010; Li, Hyslip, Sussmann and Chrismer, 2015; Ministry of Housing and Urban Affairs, 2018; Selig and Waters, 1994).

4.3. An independent contract for signalling and communications systems

Portugal decided to equip its infrastructure with the following signalling and communication systems European Rail Traffic Management System (ERTMS) Level 2 and Global System for Mobile Communications-Railway (GSM-R). The implementation of these systems transpired through an independent PPP contract called PPP6. The scope of this contract was for the whole high-speed railway network. The contractor awarded was responsible for design, supply, installation, finance, and maintenance for 20 years, with a public payment based on availability (Rede Ferroviária de Alta Velocidade, 2004, 2007; Tribunal de Contas, 2014).

An independent contract for signalling and communications systems has the following advantages. Due to the reduced number of ERTMS suppliers, if they were integrated into consortiums with the rest of the infrastructure system companies, the number of bidders would decrease, the high technological risk during operation would be minimized, and a unique contract would increase the competitivity in the sector.

Analysing all the European high-speed railway lines constructed through public-private collaboration, Portugal was the only example involving this type of separate agreement for signalling and communication systems (Rede Ferroviária de Alta Velocidade, 2007; Boletín Oficial del Estado, 2016; ERE Eiffage Rail Express and Réseau Ferré de France, 2013; Geluk, 2007; LISEA and SNCF Réseau, 2017; National Audit Office, 2001; OC'VIA and Réseau Ferré de France , 2012; Tribunal de Contas, 2014; Tweede Kamer, 2008) .

Almost every country in the European Union had its own Automatic Train Protection (ATP) system, which were not compatible with one another in most cases. With the increase in international services, it was therefore necessary for the vehicles to possess all the ATP systems of the countries though which they were going to pass. Because of this, in 1989, the European Union launched the development of a single signalling system for the entire network that would facilitate transit between countries. This system was referred to as ERTMS and, in 2000, the first technical specification was published (European Union, 2021). In parallel to the development of the ERTMS system, it was necessary to implement a communication system between the railways and the trains. Thus, it was decided to adapt the existing communication system to the Global System for Mobile Communications (GSM) for railways, which led to the creation of the GSM-R communication system (UIC, 2021b).

Since the first technical specification of the ERTMS system in 2000, 12 new versions of this document have been published (European Union, 2021). The GSM-R communication system will now be replaced by a new development, known as the Future Railway Mobile Communication System (FRMCS) (UIC, 2021a). It is clear that this technology is constantly evolving, representing a significant investment for technologists, infrastructure managers, and railway companies. For this reason, the European Union, aware of the large outlay involved in implementing a single railway signalling system, supported the roll-out of this technology with a subsidy of 3.9 billion euros between 2007 and 2019. (European Commission, 2020). A peculiar fact about this continuous technological evolution is that in Spain, through a public-private collaboration contract, awarded to the technologist Alstom, the ERTMS signalling and GSM-R communication systems have been implemented in the Albacete-Alicante high-speed section, whereas the substructure and superstructure were implemented through a traditional contract (European Commission, 2014).

5. CONCLUSION

This research analysed RAVE high-speed rail network project. This project enabled Portugal to link to the European high-speed network.

This research has required the application of an exploratory approach and the identification of critical success factors (CSFs). The purpose of this research was to develop a list of recommendations and good practices that can serve as a tool for governments, private investors, and railway stakeholders to help them make the best and most efficient decisions in terms of new high-speed rail line construction.

To that end, we present the following recommendations and good practices. Cross-border cooperation for international sections must be established through an agreement between the countries involved, including stakeholders, to guarantee a common objective and the development of similar benefits for all countries. Single contracts should be awarded for a combination of substructure and superstructure, as the design must be implemented jointly by one group of engineers, since any modifications of the substructure affect the superstructure and vice versa, due to the load transmission relationship between these two elements. An independent contract for signalling and communication systems should also be awarded due to the enormous technological risk involved in implementing the ERTMS signalling and GSM-R communications systems, which are constantly evolving in terms of technical specifications. In addition, greater competitiveness must be allowed in this area due to the reduced number of existing technologists. With this list of recommendations and good practices, it is expected that the implementation efficiency of new high-speed rail infrastructures will improve. In addition, this project could be applied not only to the field of public-private collaborations but also to the railway environment as a whole.

LIST OF ABBREVIATIONS

ADIF: Administrador de Infraestructuras Ferroviarias
ATP: Automatic Train Protection
CSF : Critical Success Factor
ERTMS: European Rail Traffic Management System
FRMCS: Future Railway Mobile Communication System
GSM-R: Global System for Mobile Communications-Railway
HSL-Zuid: Hogesnelheidslijn Zuid
PPP: Public–Private Partnership
RAVE: Rede Ferroviária de Alta Velocidade

REFER: Rede Ferrovíaria Nacional
TTT: Terceira Travessia do Tejo
UIC: Union Internationale de Chemins de Fer

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