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# Planning transport infrastructures in an uncertain context. Analysis and limits to contemporary planning in France

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## Abstract

**Introduction** The planning of transport infrastructures in France has been marked by three major developments: the European reform concerning the opening of rail transport to competition, the privatisation of semi-public motorway concession-holding companies, and the use of public-private partnership contracts. This article proposes examining the following research question: how to plan a series of infrastructure projects within an uncertain context?

**The methodology** (i) analyses whether the objectives (traffic, travel time, safety, cost, socio-economic profitability, financial profitability) of the 12 motorway and HSL projects built since the 1990s have been attained with the new planning procedure (such as risk management methods, financial risk assessment, impact assessment, public consultation) (ii) compares the additional costs and delays for three HSL projects according to their type of financing and whether or not they have used these planning procedures.

**Results** The analysis shows that traffic levels are lower than forecasts for 8 projects. The cost is greater than the forecasts for all infrastructures. The socio-economic profitability and the financial profitability are also lower than forecasts for approximately two-thirds of the projects.

**Conclusion** The social, political, institutional and environmental risks are generally well identified and treated by the client, no matter whether public or private.. The risk of additional cost is less well covered. The traffic risk remains a

topical issue. Anticipating risks is liable to produce other risks, such as overcosts or opposition. It seems necessary to deepen the traffic forecast studies and to develop the multi criteria analysis method that can take account of the different points of view from the consultation.

**Keywords** Motorways · HSL · Planning · Risks · Uncertainty · France

## 1 Introduction

The decision-making and planning process for large transport infrastructures (high speed railway lines, motorways, tunnels, bridges, etc.) falls within an uncertain context. By definition, these projects are highly capital intensive and characterised by a long planning and operational period [1].

The current economic crisis results in public financing no longer being so easy to obtain. There is also an increased use of private financing for projects that is managed by banks determined to see a return on their investments. This is being accompanied by a growing awareness of the need to respect the human and natural environment of projects and changes in regulations. These place the issue of risks and uncertainties at the heart of the process governing the decision-making, planning and operating of infrastructure projects. In addition, the multitude of occasionally contradictory objectives developed by the players (State, elected representatives, neighbours, association, etc) can result in the project decision-making and planning process being particularly long and difficult.

The need to justify public action with regards civil society is, generally speaking, increasingly important for all decisions as well as, more particularly, transport infrastructure projects. The latter are in fact very expensive and subject to cost overruns [2] or are liable to have an impact on the human and natural environment. These

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standpoints and their consequences cannot always be envisaged by the public and private clients, despite territorial context studies and the continuous consultations that take place from the beginning of the project through to its commissioning.

The life of a project can easily attain 20 to 30 years between the political decision idea and the DUP (declaration of public utility). The commissioning process can also require several years. As a result, the socio-economic planning context permitting the definition of the project characteristics (method, capacity, on site development or new construction, route) is liable to change between the preliminary studies, the preliminary design file, the final draft design file and the commissioning. It is difficult for planners to provide a detailed forecast of lifestyles, demographic developments, growth of GDP and other variables that might influence traffic flows over 10, 15, 20 years or more. It should also be underlined that currently, mobility is characterised by a certain unpredictability because mobility practices change rapidly. Literature in the sector underlines this difficulty in predicting the future and, in particular, the creation of reliable traffic forecasts [3].

The definition of uncertainty and risk which is used in this paper is the following: « *Risk is the possibility that events, their resulting impacts and their dynamic interactions will turn out differently than anticipated. Risk is typically viewed as something that can be described in statistical terms, while uncertainty is viewed as something that applies to situations in which potential outcomes and causal forces are not fully understood (...)* » [4, p 148]. The risk is defined as an event which can represent a threat. Its frequency, gravity and occurrence can be measured. Uncertainty can be defined as a possible event, of which causes and consequences are not known. Uncertainty is not measurable [5].

Different uncertainties and risks have been studied [2, 4]. They can be political (in the case of occasionally unexpected disagreements between the communities and the client financing the project), social (in the case of the project being challenged by associations or the public), institutional (in the case of changes to regulations impacting the project), financial (in the case of delays generating an added cost), or technical. The traffic risk is particularly important in transport projects as it can generate a commercial risk for the operator.

The planning of transport infrastructures in France has been marked by three major developments: the European reform concerning the opening of rail transport to competition, the privatisation of semi-public motorway concession-holding companies, and decree no. 2004–559 dated 17 June 2004 authorising the use of public-private partnership contracts.

This article proposes analysing how planning practises have evolved within this context.

We define planning as a long-term process that covers the political idea of the project, its incorporation into the national scheme, through to its commissioning once it has been defined. Planning in the form of plans can be superimposed over time with the

implementation of the transport project. The implementation of projects and their progress in terms of design and construction depends on the socio-economic context, their acceptability, the quality of the studies, the obtaining of administrative authorisations and their profitability. It frequently occurs that a project is launched and the plan modified to integrate the project once its characteristics have been defined in terms of the context. The planning integrates a number of different practices such as the detailing of a master plan, the socio-economic evaluation, the environmental evaluation, the level of consultation, the project design, the project management, etc.

The first part defines the European reform for the opening of rail transport to competition that took place in the 1990s, the privatisation of semi-public motorway concession-holding companies in 2002 and decree no. 2004–559 dated 17 June 2004 authorising the use of public-private partnership contracts. It specifies how these three events placed risk at the heart of planning practices.

The second part analyses the developments having taken place in planning practices (socio-economic evaluation, environmental evaluation, consultation, project design, project management, etc.). It explains how the practices of public and private stakeholders increasingly take risks into consideration.

The third part provides an assessment of these planning practices. It analyses whether or not traffic forecasts, socio-economic profitability and the financial profitability of projects financed using public funds and financed by public-private partnership contracts since 1991 have been respected. An assessment of the risks that could or could not be handled by these new practices is also provided. Finally, this part analyses whether new risks are emerging.

## **2 The European reform concerning competition in the rail transport sector, the privatisation of semi-public motorway concession-holding companies and the use of public-private partnership contracts place risk at the heart of the planning process**

The 1991 European reform concerning the competition of rail transport, the beginning of the privatisation of semi-public motorway concession-holding companies in 2002 and the increasing use of concessions and partnership contracts for new motorways and high speed railway lines (LGV) in 2004 led professionals in the sector to integrate the concept of risk in several reference texts concerning the socio-economic evaluation and make greater use of a formalised risk management (even though this already existed in the 1980s and 1990s but in a different form).

First, the infrastructures planning by a master plan is shortly presented (see Table 1). These three developments (competition, privatisation, PPP) are then detailed.

**Table 1** Short description of national planning of transport infrastructures

Planning infrastructures on a national level is translated by the production of a master plan and a planning doctrine. The master plan provides a diagnostic of the network's current situation (traffic fluidity, safety level, maintenance level, increasing mobility, accessibility of the territory, continuity of the service during the winter). It specifies the environmental challenges as well as the economic and financial constraints linked to the management and development of the networks. It establishes transport policy objectives, lists projects and establishes an order of priority for their completion (based on a socio-economic evaluation or a multi-criteria analysis) but without specifying completion times.

The 2011 SNIT (Schéma National des Infrastructures de Transport-National Master Plan for Transport Infrastructures) was the first multimodal scheme. The 2013 *Mobilité 21* [6] report presented a doctrine that was different from the one provided by the 2011 National Master Plan for Transport Infrastructures. Like the 2011 Master Plan, it was oriented towards ecological and energy transition, but it reduced investments into new projects (Figs. 1 and 2).

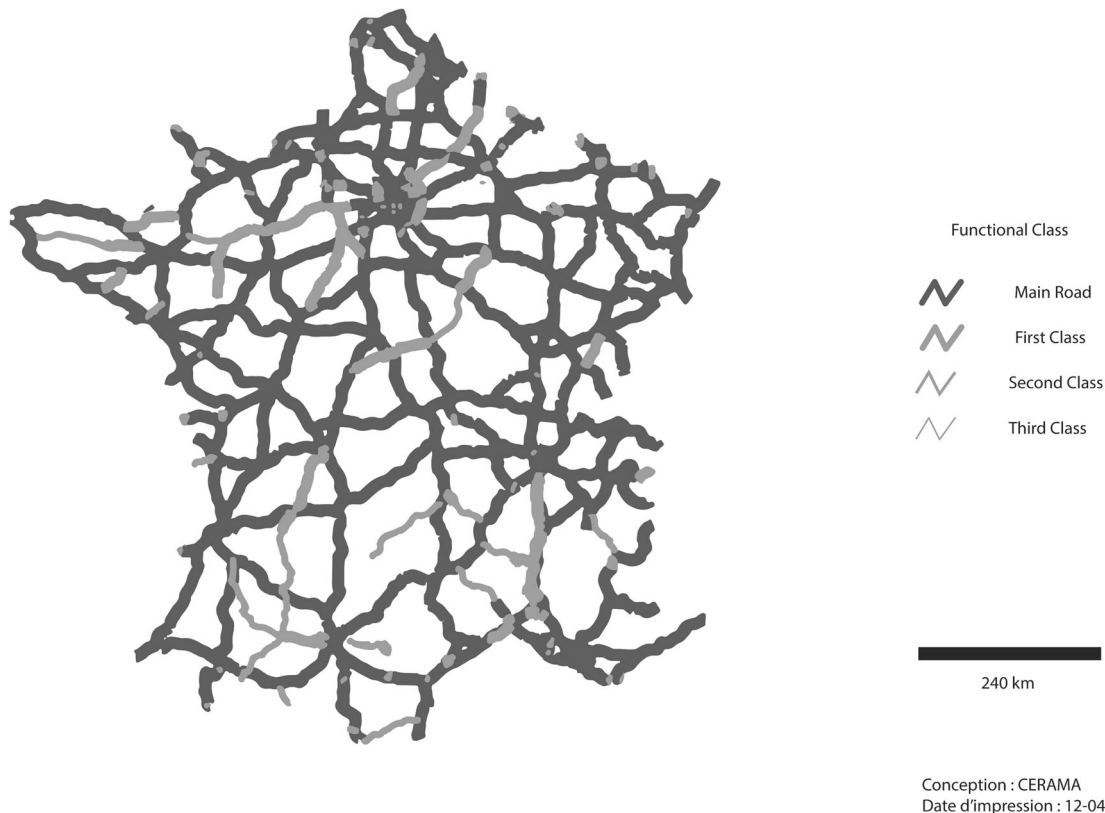
## 2.1 The European reform concerning competition between railway operators

As from the 1990s, the European Union encouraged the progressive opening to competition of waterway, road

and rail transport to give concrete form to the principle of free movement between European countries and the single market rules, and to increase the efficiency of the various modes of transport. For the railway mode, this approach was translated by the 91–440 EEC directive issued in 1991 concerning the development of the Community's railways. This directive had several objectives:

- guarantee independence in the management of railway companies which are often dependent on States,
- assure the separation between the management of railway infrastructures and transport services. The organic or institutional separation was optional. The accounting separation was obligatory,
- clean up the financial structure of the railway companies, which were highly indebted,
- guarantee the rights of access to railway networks of member States for the international grouping of railway companies carrying out combined international freight transport operations.

The French State applied this directive by creating SNCF Réseau (Société Nationale des Chemins de Fer



**Fig. 1** Map of the motorway and road networks currently in service or undergoing construction. Source: Ministère de l'Écologie <http://www.developpement-durable.gouv.fr/Consistance-et-cartes-du-reseau.html>. Map of the road network Conception: CEREMA. Map published with

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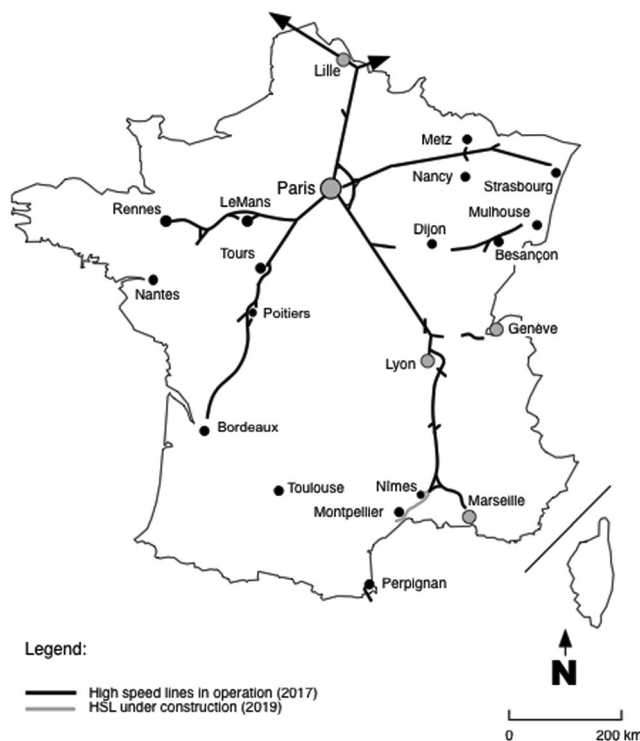


Fig. 2 Map of the HSL network currently in service or undergoing construction. Source: G. Zembri

Français-Réseau). SNCF Réseau is responsible for the development and maintenance of the railway network. SNCF-Mobilité is responsible for the operation of the network (see Table 2). Article 4 of decree no. 97-444 dated 5 May 1997 concerning SNCF Réseau assignments and statutes forbids this establishment from investing beyond its financial capacity.

Article 4 of the SNCF Réseau statutes states that the company “can only accept an investment project on the national railway network forming part of a programme on request from the State, a local authority or a local or national public body, on condition that it is subject to the requesting party providing financial assistance able to avoid any negative consequences on SNCF Réseau accounts over the depreciation period of this investment”. This article aims to avoid the creation of a non-depreciable debt. It was introduced following the 200

billion franc debt that marked the SNCF (French national railways company) in the 1990s. SNCF Réseau in fact took over ownership of the railway network at the moment of its creation in 1997 and assumed responsibility for ensuring its maintenance, improvement and extension.

SNCF Réseau cannot finance loss-making railway projects. It is therefore interested in risk analysis. There is a dual objective: on the one hand evaluate the financial sturdiness of projects to avoid overly high investments and, on the other hand, make a choice between complete funding by the public through concessions or through the use of partnership contracts. The concession and the partnership contract are the two types of public-private partnership contracts that exist in French law. They are defined below.

**2.2 The privatisation of semi-public motorway concession-holding companies**

At the end of the 1990s, the European Community noted that semi-public motorway concession-holding companies in France did not respect European competition rules. These companies systematically became the concession-holders of new motorways (calls for bids were not preceded by the usual advertising) and profited from the balance of toll revenues between profitable and amortised sections and non-profitable sections to finance the construction or the maintenance of new motorways.

Advertising became obligatory prior to any call for bids and balancing forbidden. Decree no. 2001-273 dated 28 March 2001 made the accounting regimes of the SEMCA

Table 2 Division of railway activities between SNCF Réseau and SNCF Mobilités

SNCF (management, support)	
SNCF Réseau	SNCF Mobilités (operation)
Network development, maintenance and cleaning Distribution of railway capacities and pricing	Organises rail transport for freight and passengers



(semi-private companies holding motorway concessions) compatible with those of private sector companies. Each motorway concession had to be subject to an independent contract. The SEMCA had to apply strict profitability rules for each motorway construction and operation contract as all State subsidies or balances through another concession were forbidden.

Within this context, the privatisation of the SEMCA took place between 2003 and 2006. These motorway companies were bought up by banks and institutional investors (pension funds, insurance companies, etc.) that were often majority shareholders in their capital.

The capital of the nine private motorway concession companies is mainly held by institutional investors (between 26 and 71% of the capital), by other concession-holding companies (from 8 to 50% of the capital) and finally by building and public works contractors (between 15 and 65% of the capital). The capital of these building and public works contractors is also largely held by institutional investors.

The capital of the three concession-holding companies or companies having a high speed railway line partnership contract is essentially held by institutional investors (between 20 and 50% of the capital) and by building and public works contractors (between 33 and 50% of the capital).

These institutional investors are pension funds, insurance companies and undertakings for collective investments in transferable securities (UCITS). In comparison with other investment funds that bet on a high risk level (hedge funds), they respect the profitability levels of funds invested for their clients and try to limit the risk level. The companies that these institutional investors invest in have to maximise the share value and reduce the risk to which the investor is exposed.

These companies therefore need to develop risk identification, analysis and treatment tools. We underline that these tools are just one among other project monitoring and management methods within concession-holding companies and companies having signed partnership contracts. Management experience, detailed studies and the anticipation of situations also make it possible to avoid events able to generate risk or uncertainty.

### 2.3 Use of public-private partnerships

The financing of transport infrastructures in France can be provided by public funds within the framework of a public works sector contract or through a public-private partnership contract. The public-private partnership contract includes the concession-holding contract and the partnership contract.

Public works contracts are contracts drawn up between the State, local authorities or public establishments and public or private providers. Their intention is to design and construct a structure or carry out works. The provider is remunerated by

the public authority (decree relative to public contracts dated 23 July 2015).

Public-private partnership contracts were introduced in France by decree no. 2004–559 dated 17 June 2004. They allow the State or a dependent public establishment to give a third party a global mission for a period determined according to the duration of the investment amortisation period or the chosen means of financing. This can consist in the financing of works or equipment necessary for the public service, the construction or transformation of works, cleaning, maintenance, operation and management, as well as other service provisions contributing to the public service mission (such as traffic management).

These public-private partnership contracts can take the form of a concession-holding contract or a partnership contract.

The public-private partnership system goes back in time in France. In particular, the concession system was used for the construction of the first railway lines and then for the construction of the motorway network. More recently, in application of the law dated 17 June 2004, partnership contracts and concession-holding contracts have been signed with the Eiffage, Vinci and Bouygues public works groups. These contracts particularly concern the Sud Europe Atlantique, Bretagne Pays de Loire, Perpignan – Figueras high speed railway lines as well as the A65 Langon – Pau motorway.

Public works concession contracts “*are administrative contracts whose aim is to have all building or civil engineering works carried out by a concession-holder whose remuneration consists in either the right to operate the structure or to operate the structure as well as receive a payment*” (decree no. 2009–864 dated 15 July 2009). The concession-holder receives toll revenues. The contract period can be as long as 20 to 30 years.

The partnership contract, created by decree no. 2004–559 dated 17 June 2004, is an “*administrative contract by which a public entity gives a global assignment to a third party concerning the financing, construction or transformation, and maintenance, operation or management of structures or equipment, particularly where these are necessary to provide a public service*”. The contract can concern all or part of the structure’s design. It is drawn up for a determined period. This definition was completed by the decree dated 23 July 2015 relative to public contracts. The contract period can be as long as 20 to 30 years. The partnership contract “*results in the holder of the partnership contract being remunerated by the public entity over the entire period of the contract. This remuneration can be linked to performance objectives*” (article 1st of decree no. 2009–864 dated 15 July 2009 modified). The latter can also participate in the financing of the project.

The identification, analysis and treatment of risks are vital for private providers as they are obliged to respect

**Table 3** Description of the types of financing for transport infrastructures and risk sharing

	Public financing (public client)	Partnership contract	Concession-holding contract
Provider's remuneration	Financing by the public authority	Rent paid by the public authority, calculated in accordance with the level to which performance criteria are respected.	Collection of tolls paid by the user Revenues linked to traffic.
Contracts	Separated short term contracts with different providers for the design, construction, maintenance and operation. The public authority manages the contracts	The provider is generally responsible for the design, construction, operation, maintenance and cleaning of the infrastructure.	The concession-holder is generally responsible for the design, construction, operation, maintenance and cleaning of the infrastructure.
Risks assumed by the public authority		Risk of force majeure Commercial risk	Risk of force majeure
Risks assumed by the private provider		Political risk Social risk Financial risk Regulatory risk (depending on the contract) Technical risk Geological risk Operational risk Maintenance risk Etc	Traffic risk Commercial risk Political risk Social risk Financial risk Regulatory risk (depending on the contract) Technical risk Geological risk Operational risk Maintenance risk
Penalties (delay, lack of respect of contract clauses or performance criteria)	yes	yes	yes
Bonus should the contract objectives be exceeded	yes	yes	yes
Performance criteria (service quality, etc.)	yes	yes	yes

the clauses of the concession-holding contract or partnership contract. These particularly concern the forecast cost, completion times for works phases, and commissioning and service quality objectives. The private providers must assume the financial responsibility for the large number of risks provided for in the concession-holding contract or the partnership contract, as shown in the Table 3. It should be noted that the distribution of risks developed in this table can vary from one contract to another depending on the results of negotiations. For example, it is in the interest of the private provider to resolve a conflict situation with neighbours as this can delay works, lead to additional costs and postpone commissioning.

The contracts provide for the payment of penalties to the public authority should contract clauses not be respected. For example, the penalty reached €800,000 for every day of delay for the Sud Europe Atlantique high speed railway line conceded to Vinci. These penalties are in addition to toll revenue losses or charges linked to a delay in commissioning.

The banks lending part of the capital to the private providers exercise a control over the latter that aims to check that the works planning phases for the construction – completion of the deck, earthworks, etc. – are on schedule with regards the programme concerning the financing agreement and that the commissioning generating revenues – from the toll or from rent – and the beginning of the return on investment begins by the agreed date.

This inspection allows the bank to free the loan money necessary for the progress of the works and for the completion of each contractual stage. Should this schedule not be respected, the banks can suspend or reduce the payment of capital.

### 3 Taking the social, political, regulatory, financial, environmental and technical risks into account when planning projects

The first part showed that the use of competitive procedures for rail transport, the privatisation of semi-public motorway

concession-holding companies and the use of private-public partnership contracts have pushed both the public and private sectors to reinforce their analysis of all types of risks when planning projects. SNCF Réseau, a public establishment responsible for extending the railway network, has developed socio-economic risk evaluation, risk management, etc. Private companies with concession and partnership contracts have also developed these practices.

These various practices are analysed in this second part. They concern consultation, impact assessments, risk management and the socio-economic and financial evaluation of projects.

### 3.1 The incorporation of social uncertainty by a progressive opening of the decision-making process to the public

Cases of the public disagreeing with projects multiplied over the 1980s, 1990s and 2000s (HSL Méditerranée, A 400 motorway, etc.) [7–9]. These occasionally harsh disputes successfully blocked the projects for months on end, forcing the client to review the project, and introduced a certain uncertainty in the decision-making and planning processes for major projects that until then had been restricted to experts and elected representatives. Professional practices evolved as from the 1980s to try to facilitate the social acceptability of projects. However, the clients retained control over the decision-making process.

Continuing disputes led the State to begin consultations with a public debate that took place after the preliminary design phase (Bianco circular dated 15 December 1992). The debate involved the public, elected representatives and experts. As well as being interpreted as an opening of the decision-making process to the public, it can also be seen as an opportunity for the State to channel controversies without undermining the projects. The text was completed by the Barnier law dated 2 February 1995 that created the French national commission for public debate (Commission nationale de débat public - CNDP) which was responsible for organising debates concerning the relevance of constructing large development projects and examining their characteristics. Public debate also meant that there was a possibility that a project might not be built, as had occasionally been the case in the past (such as the A24 motorway between Amiens and Lille).

In addition, the public inquiry procedure became more flexible. Since the publishing of decree no. 2011–2018 dated 29 December 2011, the public inquiry report was held to include the remarks made by the public during the inquiry and an analysis of the counter-proposals made by the public. These remarks and requests for modifications had to be completed by a technical response provide by the client. If necessary, the public inquiry could be suspended for up to 6 months

in order to make substantial modifications to the project file submitted during the inquiry. An additional public inquiry could be authorised by the State representative should the changes modify the project's overall architecture. The project could therefore be modified in function of the deliberative process. This new type of public inquiry could be seen by clients as a final phase providing information concerning local issues and an optimisation of the project in accordance with observations made by the public. The client was permitted to refuse certain requests on condition of providing technical or financial justification (Table 4).

### 3.2 Impact assessment and risks to the natural and human environment

The impact assessment and the client's obligation to compensate for the impact of the project on the environment have existed since 1976. Since the beginning of the century, these two procedures have taken greater account of the concept of risk. Decree no. 2011–2019 which became effective in 2011 made it necessary to carry out “*an analysis of ecological issues and the potential risks linked to land and forestry development resulting from the project, in terms of the anticipated scope of works and the sensitivity of the concerned environments*” as part of the transport infrastructures impact assessment.

The public's assurance that the impacts of the project that it considers as negative can be subject to compensatory measures and that the latter are followed up by action form part of the elements used for the negotiation of a project's characteristics and can serve to reduce the risk of conflict or controversy. However, it is difficult for the impact assessment to establish relevant conclusions on the environmental effect of the project as it is not possible to have detailed information concerning the route of a project lying within a 1000 m wide corridor at the time that the public debate takes place.

The application of the compensatory measures procedure remained limited in the years from 1970 to 2000 [10]. These measures were used to reduce, avoid or compensate the effects

**Table 4** Studies and consultation process

- 
- 1- Inscription of the project on the Master Plan
  - 2- Preliminary studies (impact assessment, route studies, cost-benefit analysis, multicriteria analysis, etc).
  - 3- Public debate (State, owner, local elected representatives, local companies, local residents, associations, etc).
  - 4- Schematic and preliminary design (impact assessment, route studies, cost-benefit analysis, multicriteria analysis, etc).
  - 5- Final draft design file (which can be sometimes modified while the public inquiry)
  - 6-Public Inquiry
  - 7- Public Utility Statement
-



of a project on wetlands. Law no. 2009–967 passed in 2009 and law no. 2010–788 passed in 2010 reinforced the regulations and established a control over their application. Clients had to introduce measures that would generate ecological benefits at least equal to the ecological loss that had not been avoided or reduced.

The quality of the impact assessments and the appropriateness of the compensatory measures now represent a major factor in the decision-making process for public or private clients. Clients place great importance on the quality of the impact assessments and the detailing of species inventories. In the case of the A 65 Langon – Pau motorway, the State had to compensate the concession-holder with 90 millions euros because a nature protection association has claimed a legal recourse against the project. This recourse has delayed the commissioning and the collect of toll receipts of 6 months for the concession-holder.

### 3.3 Risk management linked to project planning and completion

SNCF Réseau and clients with concessions and partnership contracts have developed two project management assistance tools over the last decade.

The first tool is a risk matrix. The method consists in identifying the project constraints and the potential impacts of these constraints on the cost, the commissioning and the global performance of the project over its working life. Risks must be prioritised in accordance with their potential impact, gravity and probability and, if found to be unacceptable, must be treated in one of three different ways: reducing them by acting on their causes or consequences, transferring them to an insurer or via a contract, and covering them by anticipating a financial provision.

Knowing that it is difficult to develop statistics concerning the risks inherent in major projects due to the fact that there are very few projects of this kind and because of the highly variable context of each project, the opinions of experts are fairly often used to identify, analyse and treat the risk.

The value of identifying, analysing and continuously treating all types of risks from the outset of the project generally makes it possible for them to be anticipated. This systemic approach to risks also results in increasing the global performance of the project with regards cost, completion and quality criteria. This method is used by public and private clients as from the preliminary studies through to either the DUP (French declaration of public utility) or the commissioning, depending on the chosen mode of financing. It is in addition to the studies provided for by the official consultation and project management procedure (outline proposals, impact assessment, public debate, public enquiry, final design, etc.).

The second tool is a context assessment. While it is not explicitly intended to identify risks, it can nevertheless

contribute to their identification. During this study, SNCF Réseau carried out a territorial analysis to better understand the socio-economic context and the players in the sectors concerned by the rail route. This analysis particularly consists in listing the concerned players (associations, elected representatives, etc.) and their positions with regards the project. This diagnostic makes it possible to identify potential blockages in the decision-making process that could subsequently generate a risk of controversy around the project, its territorial impacts or risk of delay. The client then tries to optimise its infrastructure project by integrating demands or explaining to residents why these cannot be taken into account. This approach can increase the acceptability of the project by local residents.

### 3.4 Socio-economic evaluation of the projects

SNCF Réseau, which needs to limit its investments and the financial risk, has developed an all-inclusive financial evaluation method intended to evaluate the financial strength of all projects in the preliminary design and outline proposals phases and a probabilistic evaluation method for large projects (high speed railways, new lines) in outline proposal and final design phases.

The all-inclusive method (used for example for the Rhine-Rhone high speed railway line project) includes a risk margin in the all-inclusive inflation discount rate. The method consists in analysing the revenues and investment costs with and without the project over a 20 years period for a small railway project and over 50 years for a high speed railway line project. The ratio between revenues and costs is updated through to the date of commissioning. It makes it possible to establish the proportion of financing to be provided by SNCF Réseau, on condition that this financing does not constitute a loss. The risk is integrated into this method by adding a 3% risk margin (risks of all types) to the 5% debt discount rate. The calculation of this discount rate is based on the distribution of past rates and already incorporates a risk margin.

The probabilistic method simultaneously concerns risks and uncertainties. The uncertainties are first modelled on the basis of earlier statistical series. They are defined as cyclical, applicable to all projects and concern the cost of construction, the quality of the studies, the cost of manpower, the cost of transport, etc. The method then distinguishes between risks. These are specific to each high speed railway line project.

The risks taken into account could be: the risk of the private partner not being able to obtain a loan, the risk of increasing interest rates, a delay in the period needed to obtain financing from the co-financers, the risk of the private partner defaulting, the traffic risk, the pricing level, the risk of changes in regulations, the environmental risk (archaeological or other), or the risk of objections.

Within the framework of this financial analysis, a provision for each incorporated risk is evaluated in the cost of the project

if the risk probability is high and if it has an important financial impact. In the opposite case, the event is included in the risk of delay.

SNCF Réseau calculates a probability for each uncertainty or incorporated risk (for which reliable data exist) and the probability incidence of this risk or this uncertainty on the global cost and revenues derived from the project.

The choice of a concession system for the Sud Europe Atlantique high speed line and a partnership contract for the Bretagne Pays de la Loire high speed line obliged SNCF Réseau to integrate the risks specific to other projects into the probabilistic method as well as the risks generated by other lines that could impact the Bretagne Pays de Loire and Sud Europe Atlantique high speed lines.

A political will to limit social uncertainty and reduce the financial risk of projects through an adapted socio-economic analysis was developed at the beginning of the twenty-first century. The framework instruction dated 27 May 2005 provided for the expert to be able to take into consideration data resulting from the consultation in his socio-economic calculation and, consequently, modify the reference situation, find ways to compensate for nuisances and enhance criteria that had not been taken into consideration. The socio-economic evaluation also had to be presented in a way that could be understood by the public. An evaluation of the financial risks taking the constraints of public financing into account also needed to be made. The risks specific to each project needed to be taken into consideration and determined according to the uncertainties concerning the investment and operation costs alongside the envisaged income-generating traffic.

The circular dated 9 December 2008 issued by the Ministry of Ecology and concerning the creation of an evaluation quality charter had two objectives. On the one hand, it recommended an analysis of the risks associated with each studied impact through a multi-criteria study. The text formulated an evaluation of the projects and their variants. It was based on a comparison between their social impacts (employment, vulnerable groups, accessibility, social mix, etc.), environmental impacts (climate, pollution, noise, etc.) and economic impacts (on households and companies, cost, competitiveness, etc.). However, for the time being there is no standard method able to evaluate all these impacts. Nor does the circular specify how to evaluate the risks.

In addition, the text gave a more important role to the multi-criteria analysis than it did to the cost-benefits analysis in the a priori evaluation of the projects.

The cost-benefit analysis only provided a single figure for each project variant while the multicriteria analysis permitted an evaluation and a comparison between the multiple impacts for each variant. The multicriteria analysis separated the performances of each criteria for each variant and, where necessary, developed a variant based on one or more specific criteria.

Finally, the analysis of the financial risk was integrated into the socio-economic calculation [11]. The method used to

analyse the risk was specified. It needed to take into consideration the uncertainty that threatened economic growth as the profitability of a project often depended on this growth. This approach made it possible to battle against the occasionally overly optimistic forecasts that sometimes characterised certain projects. It was recommended that the risks linked to inadequate forecasting methods, missing data or external project variables (complex and uncertain economic growth forecasts, variations in oil prices having an effect on traffic levels) be better analysed. The scenario methods employed by private operators should be used to this end. Finally, the evaluation analysis period should concern the service life of projects (which can sometimes be as long as a century) to integrate current transitions such as ecology, global warming and the development of digital technology.

#### 4 Critical analysis of planning methods for transport infrastructures

The third part establishes a critical assessment of the previously developed planning practices. This part analyses whether the forecasts concerning travel times, safety and, above all, traffic, socio-economic profitability and the financial profitability of projects financed by public funds and, since 1991, by public-private partnerships contracts are respected. An assessment of the risks that have been treated or that have not been treated by these new practices is also carried out. Finally, this part analyses whether new risks are revealing themselves.

##### 4.1 Assessment of forecasts concerning traffic, travel time, safety, cost, profitability of completed projects provided for in the 1991 master plans

The analysis method is based on a comparison between forecasts linked to these objectives that are in the final draft design file and their results several years after having been commissioned. The a posteriori evaluations (called the LOTI assessments) carried out in France by the client for each infrastructure provide access to the data. The evaluation criteria are: traffic, travel time, safety, cost, socio-economic profitability for the community and for the client-operator. There are other criteria in these assessments that are not included here as they do not concern the planning objectives as directly. Twelve infrastructures have been analysed (four HSL and eight motorways) among those commissioned since the beginning of the 1990s and covered by the 1991 master plans [12, 13].

A synthesis of the comparison between the forecasts and the achieved results reveals the following results (see Table 5). The infrastructures have been financed by public funds or by the concession. Datas are not available for HSL which are financed by partnership contracts.

**Table 5** Synthesis of the comparison between forecasts (final draft design files) and the results attained by the constructed infrastructures (traffic, travel time, safety, cost and profitability)

	Traffic	Travel time	Safety	Cost	Socio(economic) profitability	Financial profitability
Lower than forecasts	<b>8 projects</b>	<b>7 projects</b>	5 projects		<b>9 projects</b>	<b>7 projects</b>
In compliance with forecasts		3 projects	2 projects		1 project	
Greater than forecasts	4 projects		1 project	<b>8 projects</b> (Additional cost of between 7 and 22%) <b>3 projects</b> (including additional cost of between 1 and 4.5%)	1 project	3 projects But moderate rate of return

Source: LOTI assessments. Motorways (A 51, A 57, A 20, A 54, A 66, A 83, A 14, A 75, LGV Méditerranée, LGV Rhône Alpes, LGV Atlantique, LGV Est)

Note: data is not available for all criteria. This occasionally brings the total number of infrastructures down to below 12

The figures in bold indicate that the criteria do not comply with forecasts.

The analysis shows that traffic levels on eight motorways and HSL are lower than forecasts. Traffic forecasts are optimistic either because the traffic model variables are not accurately evaluated or because the project needs to be legitimised by a high level of traffic.

The cost is greater than the forecasts for all infrastructures. The overcost is between 7 and 22% for eight infrastructures and 1 and 4,5% for three infrastructures. Public owners can consider that an overcost of 5 to 7% is acceptable.

The socio-economic profitability for the community and the financial profitability for the client operator are also lower than forecasts for approximately two-thirds of the projects. The context of financing a proportion of the motorways taken into consideration also explains this result. Four motorways profited from the equalisation system defined above, which implies that they are not profitable.

## 4.2 Assessment of risks handled or not handled by existing planning practices

### 4.2.1 Risks and uncertainties linked to the construction of projects are generally controlled. The risk of additional costs is less covered

The social, political, institutional and environmental risks are generally controlled by the client, no matter whether public or private. In France, for instance, there are increasing links between public and private practices in the management of projects and risks [14]. The anticipation of these risks, as described in part 1, means that they can be limited and projects handed over on time or within an acceptable delay.

Table 6 compares the additional costs and delays for three HSL projects according to their type of financing and whether or not they have used risk management and ongoing consultation methods. Recent projects benefiting from the risk analysis method and continuous consultation were handed over without delays (Perpignan Figueras HSL, conceded project) or with a moderate delay (HSL Est, project having a public client) when compared with the HSL Méditerranée (3 years delay). It can be noted that there is an additional cost for projects financed using public funds (between +8.3 and +14%), but not in the case of a project financed by a concession. This level of additional cost is considered as standard for projects of this size (or metro lines).

For these three project examples, the risks seem generally well identified and treated to ensure that the project is handed over within the deadline or with an acceptable delay. The risk of additional cost is less well covered. The Perpignan-Figueras conceded project, being the only project without any additional costs, is currently subject to discussions between the private partner and the two licensor countries, being France and Spain ().

### 4.2.2 A highly present traffic risk

The traffic risk remains a topical issue for several reasons.

The decision to carry out certain projects using public-private partnerships was taken when traffic forecasts were modest and did not call for rapid implementation. The joint report issued in 2003 [15] by the Inspection Générale des Finances (general inspectorate of finance) and the Conseil Général des Ponts et Chaussées (civil engineering general council) led to the recently completed A 65 Langon – Pau motorway, the Bretagne Pays de Loire high speed railway line

**Table 6** Comparison between three HSL projects (anticipated and real commissioning dates, anticipated and real costs)

	HSL Méditerranée	HSL Est (Paris- Strasbourg) phase 1 (Paris-Baudrecourt)	HSL Perpignan Figueras (France- Spain)
Commissioning date	2001	2007	2009
Whether or not risk management and continuous consultation methods were used	Beginning of consultations, no formalised risk management	Yes	Yes
Type of financing	Public funds	Public funds	Concession
Client	Public	Public	Public then private
Difference between the anticipated and real commissioning date	3 years	12 months	On time
Duration of the works	5 years (1996–2001)	4 years (2003–2007)	5 years (2004–2009)
Difference between forecast costs and real costs	+8.3%	+14%	No additional costs for the works.
Length	250 km	300 km	44 km
Number of tunnels, bridges and viaducts		14 viaducts, 70 bridges	1 tunnel (Col du Perthus): 8.2 km

Sources: RFF, SNCF, Bilan LOTI de la LGV Méditerranée, report, June 2007, 117 p. RFF, Bilan LOTI de la LGV Est européenne, report, May 2013, 104 p. Discussions with the Eiffage concession-holder for the Perpignan Figueras HSL

and the Sud Europe Atlantique high speed railway line project to be classed as being non-priority projects. These projects have been subject to strong political support, a mobilisation of public financing and recourse to private financing.

Within a context of moderate traffic growth, there can be competition between infrastructures that make it impossible to attain the expected traffic and profitability levels. For example, questions are currently being asked as to whether there is sufficient traffic to make the Sud Europe Atlantique high speed railway line now under construction profitable due to its competition with a standard performance railway line (220 km/h as opposed to 300 km/h for the high speed railway line) and much less expensive for operators. This line will cost them €11/train.km as opposed to €18/train.km for the high speed railway line. This line will also be in competition with the Paris Bordeaux, Toulouse and Biarritz airline routes whose prices are competitive with those of high speed railway lines for passengers. The issue of the number of trains on the high speed railway lines has been the subject of debate as the high cost of tolls paid to concession-holders is susceptible to reducing road traffic. In addition, the high cost of the toll rate could disturb the concession's balance between insufficient toll revenues and high investment and operating charges.

Traffic forecasts can also be confronted by a changing context.

The operation of the 44 km long Perpignan - Figueras high speed railway line between France and Spain, encountered various problems which meant that it could not attain the forecast traffic levels and commercial performance objectives. The high speed railway line between Figueras and Barcelona was completed with a 3 years

delay on the Spanish side when compared with the French side. Consequently, the concession-holder was only able to collect toll revenues once the line on the Spanish side had opened after a 3 years delay. There are only five return trips per day between Perpignan and Figueras instead of the nine that had been anticipated in the traffic studies. Consequently, the concession-holder could not receive the forecast toll revenues for the rental of train paths to operators. As a result, it could not cover the debt burden and operating costs. It went bankrupt in July 2015 while awaiting a legal settlement of its financial situation.

The concession-holders of these two high speed railway lines prepared their own traffic forecasts in answer to a very long term (up to 50 years) call for bids. However, the concession-holder does not necessarily know all the commercial policy parameters of railway operators (impact of toll levels on the choice of routes, marketing strategy, competition). Railway operators can vary their commercial policy over time in a manner that cannot be anticipated.

#### 4.2.3 Anticipating risks is liable to produce other risks

The consultation procedures and environmental regulations have increased the safety of decision-making and planning processes for projects. However, they can also be the source of other risks.

- Is the application of the environmental regulations too demanding?

The second part of this article showed that the application of the environmental regulations is now stricter. This can lead



to an increase in the number of environmental evaluations. For example, the A65 Langon-Pau motorway concession-holder had to redo its surface compensations file three times before obtaining a favourable assessment from the environmental authority. This body multiplied the land surfaces intended to compensate the impact of the motorway on the natural environment by 21. It was a measure that generated a 6 months delay in the commissioning, an additional cost and a delay in the receipt of tolls for the concession-holder. This was considered as a major risk with regards the terms of the concession contract. The State assumed this risk and had to pay €90 millions of compensation to the concession-holder and increase the concession period by 5 years to cover the additional cost. The difficulty of a strict application of the environmental regulations is now under discussion in France.

- The continuous participation of the public in the studies and an integrated consultation procedure does not prevent subsequent controversies.

In general, major controversies cannot be resolved by the classic consultation procedure. They can result in legal recourse, a fresh evaluation of the project or a halt in the decision-making process that can last several years. The example of the Sud Europe Atlantique HSL reveals that the State called on three different experts to evaluate the compensation to settle the appeals made by the Poitou-Charentes Nature association against the project. In certain cases, specific demands for the adaptation of a project made by elected representatives, neighbours and nature protection associations within the framework of the consultation or agreed to by the client to resolve conflicts can result in increased costs.

## 5 Conclusion

This article has shown that the use of competitive procedures in railway transport, the privatisation of semi-public motorway companies and the use of public-private partnerships have led to changes in socio-economic and financial evaluation practices, and reinforced the use of risk management and continuous consultation in the planning of transport projects. These practices seek to anticipate uncertainties and risks of all types, to identify them and introduce measures able to limit or avoid them. It can also be noted that the increasing importance of environmental concerns has also reinforced the incorporation of risks in the impact assessment.

Overall, this article has shown that public consultation, risk management, environmental assessment, socio-economical assessment allow to limit the risks linked to the project (social, political, institutional, environmental, etc. risks). However, the risk of additional costs is less easily covered. This can be explained by the modifications made to the project due to

geological, technical and safety constraints or resulting from demands made by local elected representatives, associations or neighbours. The latter case is fairly frequent during consultations.

In parallel with the risk of additional cost, it can be noted that the socio-economic profitability forecasts for the operator and the community are often overestimated when compared with the profitability measured following commissioning. This can, in particular, be explained by the “optimism” of forecasts on the one hand and the possible increase in construction costs and the difficulty of making reliable traffic forecasts over the medium and long term on the other hand.

Traffic studies can be used both to assess the profitability of the project and to integrate sustainable mobility objectives. How limiting traffic overestimation to reduce traffic risk and business risk and how integrating sustainable mobility objectives?

First, low, medium and high assumptions are made in France. They are based on data about evolution of population, employment, residential mobility, etc. Then, traffic forecast scenarios are set up. This can be a solution to limit the overestimation of the demand if the knowledge of the variables taken into account to establish the hypotheses is correct. A better understanding of demand in two domains can be useful: (i) missing data for trends, for example the growth of weekend, night or seasonal trips and (ii) the analysis of external variables of the project (the impact of digital mobility for example).

Secondly, clear objectives for sustainable mobility can be established. The Paris Agreement of 2015 sets a greenhouse gas emission target of zero from 2050 onwards. Planning documents can set out a doctrine (objectives for limiting pollutant emissions, objectives of modal shift for public transport, etc.) and can influence behaviours with different means (limitation of the use of private cars by parking tariffs, urban tolls, etc., and incentives for modal shift with a better public transport offer). These objectives can be integrated into the assumptions made in the traffic forecast studies (objectives of private car use, modal shift targets, objectives of public transport offer). These choices can reduce the environmental risk associated with the use of polluting modes. Although the trend of the « predict and provide » is now criticized, traffic studies remain useful in assessing the profitability of a project within the framework of public funding and of a PPP contract. But they need to incorporate sustainability objectives.

Taking risk into account in planning raises the question of transparency of data and information on risk. A first question concerns a fair distribution of benefits and costs to the project partners. CBA analyzes costs and benefits to society (project cost, health benefits/costs, environmental costs/benefits, time savings, etc.). The CBA gives a single ratio that does not take into account the distribution of these costs and benefits to the different partners and groups involved in the project. The



circular dated 9 December 2008 issued by the Ministry of Ecology recommended a comparison between the risks and the social impacts, environmental impacts, and economic impacts of each variant of the project and for each actor concerned (households, companies, vulnerable groups, etc) through a multi-criteria analysis (see. Section 3–4 for details).

It seems necessary to develop the multi criteria analysis method that can take account of the different points of view from the public consultation. A further research can concern the improvement of the identification and evaluation of social, economic and environmental impacts of the projects and the risks and opportunities associated with each impact. For example, the impacts of a project on employment (number of direct and indirect jobs created) remain difficult to assess. For the moment, risks and opportunities associated with each impact, each variant and each actor are not well known. The method for identifying them finely, and taking them into account in the decision making process needs to be deepened.

A second issue relating to transparency may be the access of the public to the documents resulting from the studies. The public has access in France to syntheses of studies. These synthesis can be simpler than in-depth studies. These include traffic forecasts, socio-economic assessment, environmental assessment, preliminary design studies, detailed pre-project studies, the result of consultation (public debate, public inquiry, etc.), funding protocols, etc.

In-depth studies can generally be consulted by associations on request. Owners can work with environmental protection associations to carry out impact studies in order to obtain administrative authorizations and to avoid a risk of opposition to the project by these associations. These two issues can cause delays of several months and significant additional costs for certain projects.

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