



WHITE PAPER

Maintaining and preserving transport infrastructure assets: a requirement for France

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Foreword

In our collective subconscious, road infrastructures evoke an image of sturdiness and durability conferred by the materials they are made of, in most cases stones cement or bitumen. In fact, the very idea of "rolling" on the surface layers and the gliding movement this suggests conceals a much less idyllic truth: our roads and streets are getting old.

And even if many of them, some dating back to historical times, seem to have been there since times immemorial, their presence at the heart of our lands and cities is not eternal. By using them on a daily basis and constantly wearing shoes and tyres on their surfacings, as their users, we almost take them for granted and no longer view them as the public asset that they are.

In this respect, the magnificent Pont du Gard aqueduct, time and again admired for its technical and architectural feats, built over 2,000 years ago and still standing fast, masks a painful reality. This work of art would not enchant 1.4 million visitors each year, if several major investments had not been made in the course of its exceptional longevity.

Getting back to the ageing issue, the mechanism is as simple as it is insidious. Infrastructures are objects with a long technical lifespan (several decades). In fact, their wear, mainly related to heavy-weight vehicle traffic and the impact of water on the structure, particularly the frost-defrost process, is relatively slow. Without any visible signs for many years, deterioration remains confined; then, after a certain threshold is reached, it continues at the rate of an exponential curve.

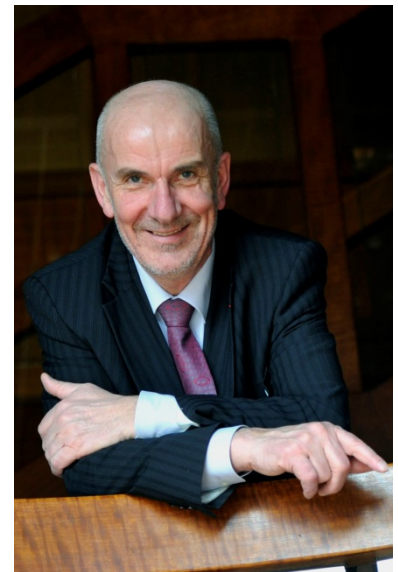
Thus, our infrastructures and the services they provide are not eternal and, to ensure their quality and performance over time, they require regular maintenance budgets and investments during their lifespan and must be reconstructed at the end of the cycle.

If, however, for any reason whatsoever, we should underinvest, their usage value would plummet. This would create the risk of increasing routine maintenance expenses, by now just a stopgap measure, just to "maintain" the level of service. This increasing expenditure is nothing more than "an interest charge" on this new type of debt, sometimes called a "grey debt", since it is invisible.

Why are transport infrastructures such fertile ground for "grey" or "invisible debts"?

On the one hand, because they are highly complex technical objects, and understanding their operational or wear state and assessing their "normal" maintenance costs appear too abstract for the public decision-makers in charge of determining the final budgetary trade-off decisions.

On the other hand, because the effects of the "grey debt" on the level of service are by definition invisible, since they are not immediately felt. Thus, they are noted only much later, which does not motivate decision-makers to address them as a priority.



In such a situation, two scenarios are possible:

Either funds are raised to pay off the debt by making the long-deferred or ignored investments. In this case, we can "recapture" the intrinsic value of the object and guarantee the provided level of service over the expected life span.

However, if the delay is too long, the total "recapturing" costs will prove much higher than the total sum of interest charges and accumulated debt. In some cases, this may even reach a threshold that imposes restrictions in the use of the infrastructure (for example, by prohibiting the traffic of vehicles above a certain weight on a bridge), thereby generating huge indirect costs to users. Moreover, in most cases, significant investment delays will simply shorten its lifespan.

The virtual interest rates discussed above are not dependent on any "rating agency". They are however directly related to the management of infrastructure ageing and obsolescence, which is a highly specialised and sensitive area of expertise. It is only the interest of decision-makers in this phenomenon that can reduce this "interest rate" and enable controlling it. Ignoring it carries enormous risks.

All proportions maintained, our road infrastructures, streets and urban spaces need the same attention and the same investments as the Pont du Gard aqueduct (in fact, how would you even get there without a well-maintained and safe infrastructure to access the site?). This is also true of infrastructures' usability, which will decline more or less rapidly at the whim of weather's and traffic's impacts, but still following a virtually pre-programmed course.

Still, the time scale of the infrastructure, which is much longer than the time scale of political and economic areas, does not always allow elected representatives, decision-makers in general, and entrepreneurs to comprehend this state of things.

The study "Management and Maintenance of the Urban and Road Assets: Methods, Tools and Techniques (GEPUR), was launched in 2012 in response to this urgent need, and this White Paper is largely based on the results of this study.

Here is therefore the goal of this White Paper: it is IDRRIM's stated intent to raise the awareness of decision-makers (government or local elected officials) of the need to maintain and preserve this public asset, by bringing to their knowledge all the economic and technical issues that underpin policy and budgetary trade-off decisions.

Yves Krattinger

President of the General Council of Haute-Saône

Chairman of the Institute for Roads, Streets and Mobility Infrastructures (IDRRIM)



1 | Transport infrastructures, the genuine drivers of economic growth

Ensuring a high-quality, high-performance transport system over time is a key issue for a country and its economy.

In fact, we should recall that it is the quality of the French transport infrastructure (road, rail, port and airport facilities) that enabled the country to rank second in Europe and third worldwide in terms of attractiveness for foreign companies wishing to establish themselves outside their home country.

1.1 | A public asset leading to growth and investment attractiveness

The attractiveness of France for foreign direct investment is particularly strong. With \$57 billion in direct investment (out of \$526 billion towards developed countries), France ranks third in the world after the U.S. and China (Hong Kong included). This accounts for 21% of foreign investment projects in Europe, placing France second after the UK, which draws more than one quarter¹.

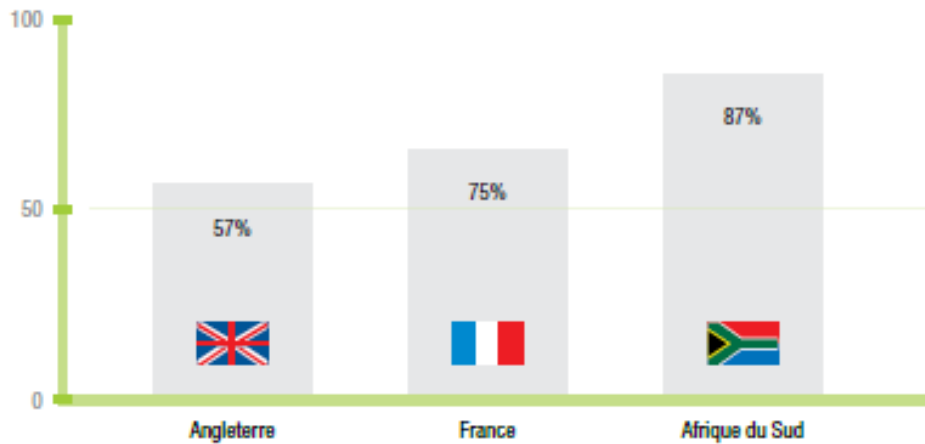
As confirmed by the AmCham-Bain Barometer² study, the factors of investment attractiveness include the quality of infrastructures, the level of Internet penetration and the skill level of the workforce, which were the main incentives cited by U.S. investors based in France.



¹ Centre for Strategic Analysis (Commission for Strategy and Prospective Planning), France Attractiveness Scoreboard Worldwide, 2011.

² "The Morale of U.S. Investors in France", 15 October 2013.

*Valeur réelle amortie des infrastructures de transport en % du PIB
(source McKinsey Global Institute)*



Gerhard Meinen, Piet Verbiest and Peter-Paul de Wolf of the Department of National Accounts, Statistics Netherlands were the first to propose a method whereby infrastructures are linked to the GDP³. This allowed the McKinsey Global Institute to compare the estimated value (amortised real value) of infrastructure stocks (national roads and highways, ports, airports, railways, power, water and telecommunications) to the GDP of each of the twelve studied countries⁴.

France, where this value is 75% of GDP, scored around the average of these countries, with values ranging from 57% for the UK to 87% for South Africa. The economist's conclusion was to establish a direct link between the GDP growth rate needed to support the economy and the equivalent growth of the value of infrastructure stocks, to ensure that the ratio of infrastructure stock to GDP does not become eroded.

A country's public infrastructure asset has an extremely significant and often misunderstood value. However, its link to the country's GDP is essential, given its value added to a given area in terms of its attractiveness⁵.

Thus, similarly to real estate assets, we should take into consideration their cost and their amortisation based on their operating lifespan the maintenance costs required for preserving both their asset value and their ability to provide the expected service.

In such a case, underinvestment or lack of maintenance can lead to their depreciation, or worse, to their progressive unsuitability for the services for which they were designed, causing disruptions of the local or national economy and hazards to users.

³ "Perpetual Inventory Method, Service Lives, Discard Patterns, and Depreciation Methods", 1998.

⁴ MGI "Infrastructure productivity, how to save \$1 trillion a year" 2013.

⁵ "Infrastructure and Economic Importance of Transportation System"* Urs Weber, General Secretariat of the Federal Department of the Environment, Transport, Energy and Communications DETEC SG, Bern - Review of Economic Policy - Economic Life (Switzerland).

1.2| Maintenance, an investment for the future

Unlike public infrastructures of national or regional concern, which are assured of attention (highways, ports, airports, high-speed rail lines, large electrical infrastructures, etc.), this is less the case of local-interest infrastructures, such as local roads or train lines, even if they also have major significance for the economy of local communities.

If we examine the national road and highway network operating under concession, the estimated value of this asset of approximately 20,000 km is 250 billion euros (value of rebuilding anew). If we add to this the departmental and local roads, the commonly accepted value is 2,000 billion euros for the entire system, which is nearly the equivalent of the country's annual gross domestic product. We should recall, however, that no accurate studies have been conducted on this matter, especially in terms of calculation method.



From a legal standpoint, it should be recalled at this point that local administrators of this asset are only the custodians of national public property pertaining to the general public, of great practical value for the life and development of the local communities and vital for the communities themselves, which also promote the country's attractiveness to its neighbours and the prosperity they could bring. In this respect, administrators' responsibility exceeds by far the scope of local concerns, as the consequences of decisions can impact not only local economic life, but also entire aspects at regional or even national development level.

The financial stakes related to the maintenance of these assets can therefore be summarised as follows: it is necessary to establish a budgetary framework for the periodic maintenance enabling economic life to be conducted normally without obstructions caused by denying or limiting the use of one or more network links which would cause financial impacts significantly greater than the approved budgetary framework.

Thus, this proposal takes a comparative perspective and looks at the investment allocation needed to maintain the asset in good condition (directly relating it to the asset's value) in relation to the investment required for:

- > Restoring the damaged asset to operational condition,
- > Offsetting the financial and economic impacts caused by limitations of use.

To conclude these economic considerations, we should recall that letting a core functionality feature of an asset deteriorate is tantamount to letting slowly depreciate its asset value, as it will no longer be suited to provide the expected services, while also running the risk of being unable to restore it to operational condition when it has become unusable.

Let us recall that the asset value of the infrastructures, as the investment made to build them, amounts to approximately 2,000 billion euro. Failing to continue investing suitably in maintenance and upgrading implies that this asset could soon be jeopardised, with serious consequences not only in terms of road safety, but also causing significant economic, social and societal impacts. Rebuilding this network later would be extremely costly.

The country thus faces a crucial challenge, since the major part of the real economy may falter without viable transport infrastructures, thereby endangering GDP.



2 | Four imperatives at the basis of policy decision-making

- 1) Acquiring knowledge of one's infrastructure assets*
- 2) Determining the value of the infrastructure assets*
- 3) Prioritising service levels and optimising maintenance techniques*
- 4) Selecting the best contractual relationship during the works phase*

Awareness of the importance of infrastructures for the country's economic life is a requirement, but it is not sufficient. Indeed, it is only by means of a policy decision that a strategy of maintenance and preservation of the infrastructure asset can be implemented in concrete terms.

The decision-maker's trade-off in the face of restrictions on other budgets must rely on arguments that are simple, understandable and easily explained to the taxpayers.

Consequently, he or she must take into account all the parameters, and whenever necessary, take a long-term view, particularly for built infrastructures having a lifespan exceeding thirty to forty years.

If this medium- and long-term vision has become fairly ingrained in the minds of decision-makers when relating to buildings, stadiums or architectural projects, it still remains rather less widespread when it comes to roads, railways or waterways, with the exception of bridges, viaducts and tunnels, where the analogy with buildings and civil engineering is instinctive and immediate.



Being responsible for the management and maintenance of the assets, the project owner has every interest to seek the best solution for both safeguarding them and optimising public expenditure, while providing the target service of the infrastructure (accessibility, smooth traffic flow, safety).

To fully understand this equation, the project owner needs concrete elements:

- > The quantitative and qualitative status report of its asset
- > The asset value
- > The management and maintenance costs as overall figures: workforce, own equipment and outsourced work, as relevant.
- > Determining the network priority areas in order to define the target service levels and quantify objectives.



2.1 | Knowing one's infrastructure assets

The precise knowledge of one's infrastructure assets starts right with their design through the documents required of the engineering firms that performed the work. In fact, irrespective of scale, the construction of structures always relies on plans prepared at various stages. Such plans are used for their precise and accurate completion in accordance with industry practice and standards, in order to meet the contractual requirements they will be subjected to.

Since some elements may have changed during the work phase, the building contractors should be required to submit the "as-built" plans after completion, namely the plans of the actually constructed structures, including the calculation and design sheets that were used to compile the project. These are the basic documents for acquiring knowledge of the asset. They allow tracking the evolution of the infrastructure over time and provide the tools to understand the observed phenomena, thereby ensuring their repair and enabling optimal maintenance.

2.1.1 Diagnosing the network condition

During the structure's service life, its condition must be regularly assessed to:

- > Have a picture of the structure at a given moment.
- > Prepare the necessary maintenance programmes to preserve the structure's core functionality (see the Foreword).

Of course, neither are all structures nor networks intended for the same purpose, nor are they subject to the same service level requirements. These criteria will determine the frequency of the routine diagnostic assessments and their contents in terms of technical procedures.

For pavements, this includes the structural bearing capacity, the surface waterproofing, skid resistance, wearing course quality (levelling, stripping of materials, etc.) and the quality of auxiliary equipments. For engineering structures, this will also include the structural bearing capacity, the sealing of pavement joints, if any, the condition of the water drainage devices and the quality of the safety equipment.

Having these data is an absolute necessity in order to be able to justify a budget trade-off decision.



2.1.2 Identifying the main causes of infrastructure ageing and measuring their impact on maintenance costs

The two main sources of disturbance discussed herein primarily concern road infrastructures. Nevertheless, there are many similarities between road and railway structures, with obvious differences in the "rolling" and "signalling" areas.

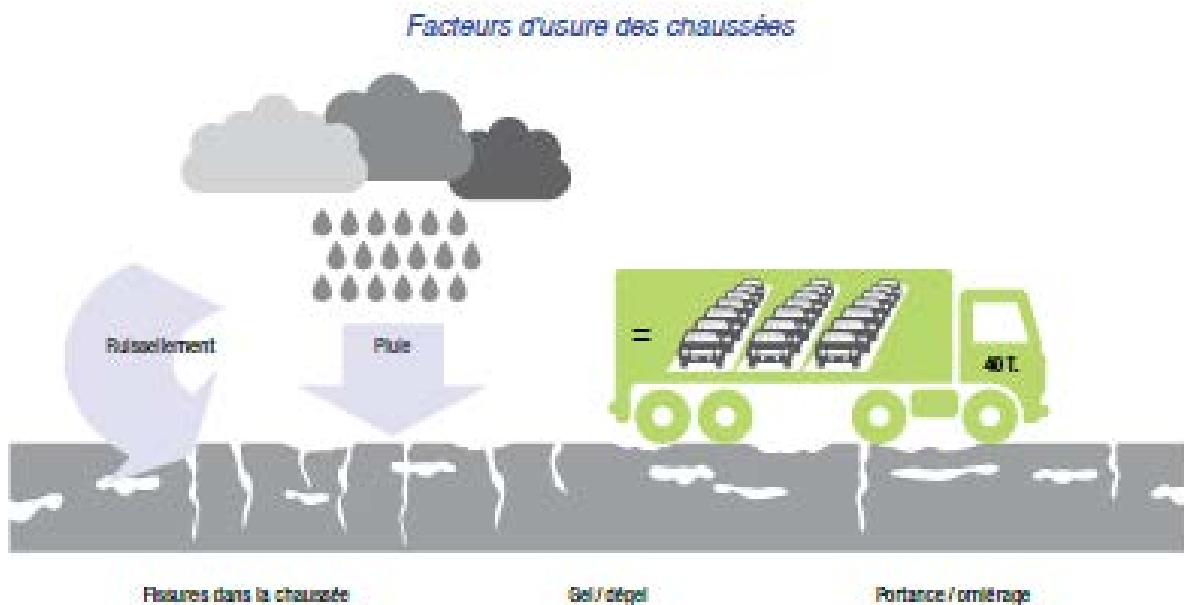
a) The primary cause of ageing is water in all its forms (frost, defrost)

By penetrating through the various pavement layers (three on average) water causes either a destructuring of materials (by making them pass from a dry and resistant state to a wet and less resistant state) or by exercising its direct destructive effect through the swelling of freezing water (if the freezing depth reaches the concerned area, followed by defrost and so on).

This water may originate on the surface, highlighting the vital importance of wearing course waterproofing, which can be ensured by applying inexpensive techniques. However, water can also penetrate through the sides, if the platform's sewage system, i.e., the drainage, is inadequate, which highlights the importance of dredging the side ditches.

b) The second cause of ageing is the supported load, which basically means heavy vehicle traffic.

For the pavement, the aggressiveness of one 40-tonne truck is equivalent to that of several thousand light vehicles. Consequently, the structures' thickness design is based on the heavy vehicle traffic only. Therefore, this type of traffic must be very well known both for the initial design and for subsequent checks to make sure that it does not exceed the values taken into account at the design stage.



2.2| Determining the value of the infrastructure assets

The financial appraisal of infrastructure assets is a key issue. In fact, the entire discourse on the need to maintain these assets makes sense only if such maintenance is cheaper than rebuilding from scratch. The recent proliferation of disposable products to the detriment of sustainable development is another good illustration of this issue.

For infrastructures, the maintenance cost is, quite obviously, significantly lower than the cost of construction. However, as stated earlier, there is no standard method for assessing the value of a road or railway section.

There are several coexisting approaches:

- > The cost of replacement as new, used by the Government
- > The method prescribed by the public sector accounting system, used by local authorities, which takes into account partial elements, without amortisation
- > Other proposed methods (see Section 1.1) that place the GDP in parallel with the stock value of infrastructures.



Yet, it is essential to know the real value of an asset, for example, the value of a 4,000 km road asset to a “department”, before attempting to draw a correlation between its maintenance investment and its intrinsic value. The sums at stake are significant: the GEPUR study will propose an evaluation model.

2.3| Prioritising levels of service and optimising maintenance techniques

A good management policy must be based on optimising the actions performed on the asset. Infrastructures must thus be prioritised according to their functions (access routes to economic centres, main thoroughfares, tourism, high traffic roads, etc.) and to their economic impacts, whether positive when used, or negative when closed, for any reason whatsoever.

Levels of service must then be assigned for each category.

What naturally follows is the possibility to adapt routine maintenance activities to each category, thereby optimising them to closely match the needs, while achieving great flexibility in managing the budget resources, which can be allocated to items of greatest economic impact first. Two guides proposing various solutions and targeting city and departmental authorities will be published within the GEPUR study.



Once prioritizing has been completed, the techniques can be adapted according to needs. Several databases and reference systems have been made available, some of them by IDRRIM, to determine the most appropriate technique to optimally meet specific needs according to the diagnostic analysis and to the project owner's policy, as relevant (type of materials, resource and energy savings, innovative processes, etc.).



At this stage in the standard life of the structure, it is important to take into consideration the overall issues related to the infrastructure to ensure optimised maintenance management over its entire lifetime, rather than at individual life stages.

There are countless examples of programmes that proved to be very costly in the long run due to a recurrent need for maintenance, despite a completely different short-term impression given by the relatively low immediate cost.

We must learn to seek the optimum approach by trying to take into account, for obvious reasons, both the immediate costs and the provided service without however neglecting or compromising the long-term economic model. In tender procedures, given their thorough knowledge of the lifespan of materials and methods, bidding companies could be asked to meet this type of challenge, for example by leaving open the option to submit alternative proposals, the compliance of which would be monitored over time.

2.4| Selecting the best contractual relationship during the works phase

Based on these network knowledge elements, which are required for decision-making and in order to optimise public expenditure, the project owner can choose among several options, each necessarily involving advantages and disadvantages:

- 1) Preparing, based on appropriate studies, a defined and quantified statement of the planned works according to an approved programme based on a multi-year plan (current system).
- 2) Offering a form of performance-based, medium-range contract (e.g., for 5 to 10 years) covering an entire road asset or part thereof, based on a defined cost target:
 - > Lower than the total amount of the 5 to 10 year period, with a guaranteed quality of service, or
 - > Equivalent either to a defined level of service, or including additional services.
- 3) Offering a "turnkey" contract according to the "Design Build Operate Maintain" model, within a project owner-contractor consortium (not including financing) and retaining the project ownership.
- 4) Delegating the operational project management, such as in the case of public sector-private sector partnerships.





Provided that the decision-making elements discussed above are available (asset's quantitative and qualitative assessment, management and maintenance costs, and network prioritisation), the project owner may use any of these five options, which are not mutually-exclusive.

Let us illustrate this point by suggesting a few assessment criteria:

> In the case of a degraded system section that belongs to the structural network, option 3) could be very attractive, as it will serve as incentive, selection criterion, remuneration element for the selected consortium (engineering firm-contractors) based on performance and innovation.

> In the case of a less degraded network, option 2), which also seeks high-performance, may be better adapted to the need to optimise expenditure in a framework of works activities that need less innovation.

> Finally, if the owner wishes to retain full control of operations on a portion of the network, then option 1), which does not preclude any clearly-delimited variations, could also be a good solution.

The comprehensive approach to the task of managing and maintaining infrastructure assets has nowadays become truly necessary for project owners. A mix of the methods proposed here is not only possible, but undeniably represents a source of progress towards innovative contracting solutions conducive to potential savings for the project owner.

In this respect, performance of diagnostic analyses, prioritization, defining levels of service, scheduling and performance of optimised works over the entire lifespan of the infrastructure will enable policy decision-makers, administrators, citizens, taxpayers and users to reap the benefits of this pragmatic and responsible process.



3 | A major policy issue

Returning to policy decision-making, it should be clearly understood how important these infrastructures are for residents, for whom they are their highways, their streets or their public square. In fact, according to recent opinion polls, transportation ranks third among the concerns of French people, after security and housing quality⁶.

People's ability to travel in conditions of comfort, flowing traffic and safety, whether when driving their own vehicle, in buses, motor coaches or trains, which they have today and wish to continue to have tomorrow, is in fact an essential need.

For the policy-maker, this represents a genuine political challenge and an urgent requirement involving the executive official's ability to address the concerns of the population and guarantee the basic right of all citizens to move freely, including in the most remote and sparsely-populated areas⁷.

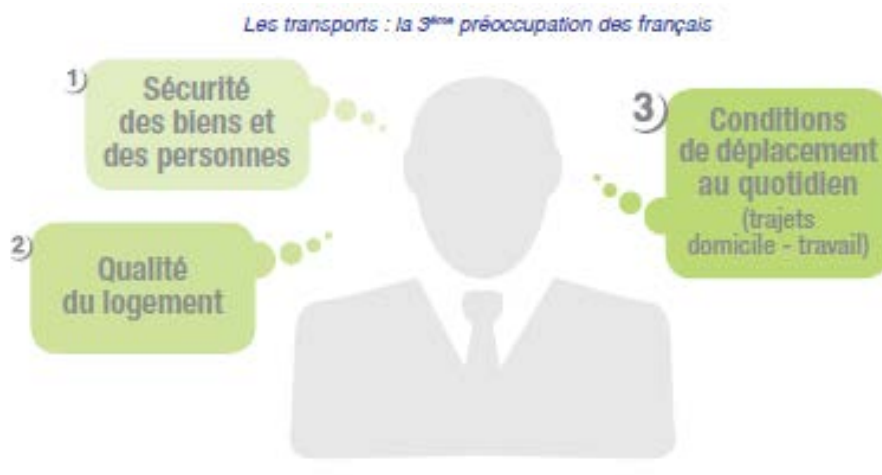
It is unfortunate however that, all too often, the only time political leaders pay any attention to transport infrastructures is in connection with accident reports or weather-related news. Moreover, the time scale of the infrastructure, which is much longer than the time scale of political and economic issues, does not always allow decision-makers to understand the life cycle and decline of the infrastructure over the medium and long term.

Still, isn't the official opening of a newly upgraded twenty-kilometer stretch of road or its maintenance as important as a day-care centre or a school?

In addition, statements stressing the concern for the country's assets by limiting the emissions of greenhouse gases or preserving natural resources through recycling are certainly political actions of equal importance to commissioning a bypass road or outfitting an intersection.

Elected officials should view this as a means to prove that yesterday's investment has become the asset's added-value which today's and future generations will inherit. In this way, public money has not been spent in vain; it has been invested.

This need for political action also compels decision-makers to face their responsibility in ensuring that all residents enjoy their right of free movement by preserving infrastructure-related services, and primarily the ability to travel, whether for leisure, daily activities or business purposes.



⁶ Ipsos survey for VINCI Autoroutes Foundation "The new functions of the road", December 2013.

⁷ Universal Declaration of Human Rights, Article 13.



4 | Four key messages that public decision-makers should keep in mind

1) Transport infrastructures are a public asset

2) Transport infrastructures support economic growth

3) Preserving an asset worth over 2,000 billion euros

4) Maintaining the infrastructures is an "investment" in the future

- ***Transport infrastructures are a public asset***

Vital to the life and development of local communities, the public infrastructure asset is the basis for all forms of mobility. Its maintenance, smooth flow and safety are the best guarantees of the basic right of all citizens to move freely, including in the most remote and sparsely-populated areas.

Accordingly, the responsibility of decision-makers and administrators exceeds by far the local, regional or even national scope; it calls for political action to ensure that all residents enjoy their right of free movement by preserving infrastructure-related services, and primarily the ability to travel.

- ***Transport infrastructures support economic growth***

A country's public infrastructure asset has an extremely significant and often underestimated financial value. However, its link to the country's GDP is essential, given its added value to a given area in terms of attractiveness⁵.

The quality of the transport infrastructures (road, rail, port and airport facilities) has enabled France to rank among the most attractive countries among foreign companies wishing to become established outside their home country. Ensuring a quality high-performance transport system is a key issue for a country, since without viable transport infrastructures, a major part of the real economy may falter and endanger the GDP.

- ***Preserving an asset worth over 2,000 billion euros***

The value of approximately 20,000 km of national road and highways under concessions is estimated at 250 billion euros (value of rebuilding anew). If we add to this the departmental and rural roads (1 million kilometers), the value of this asset in relation to the investment made to build it has been estimated to a total of 2000 billion euros, a figure that is comparable to the country's GDP.

Failing to invest continuously in suitable means for its maintenance and upgrade, this asset could rapidly lose a part of its value, and therefore of its usefulness.

- ***Maintaining the infrastructures is an "investment" in the future***

If we don't want to let the asset value and usage value of infrastructure networks slowly depreciate and run the risk of making their refurbishing impossible once they have become unusable, then the maintenance of existing networks should be considered an investment for the future on the same level as new infrastructures: because they promote interchanges and the free movement of goods and people.

The players

The Institute for Roads, Streets and Mobility Infrastructure, IDRRIM

IDRRIM rallies all the public and private bodies operating in the mobility and urban spaces infrastructures sector. Created in 2010 at the initiative of the Ministry of Ecology, Energy, Sustainable Development and Territorial Development, the Assembly of the Departments of France and the national private-sector engineering and public works federations, the Institute proposes a framework for reflection and action resulting in a jointly-produced and shared repository of common data.

Serving as a meeting and exchange forum, its purpose is to provide consistent responses to technical and strategic issues and promote the development of infrastructure assets and public spaces toward sustainable design and management and increasing optimisation of their use. IDRRIM also strives to promote and expand the reputation of French technical expertise in Europe and abroad.

Bringing together 50 members representing the public and private sectors (government agencies, local authorities, public and private engineering firms, partnership-based associations, training and research organizations) and more than 40 local authorities, individual companies and engineers, the Institute rallies all the public and private players of the transport infrastructure sector.

50 representative bodies and more than 40 individual members: Communities, contractors, engineering firms and engineers.

GEPUR (Management and Maintenance of Urban and Road Assets)

In recent years, roads have been exposed to consistently higher climatic stresses (scorching summers and harsh winters) which, combined with occasionally significant heavy vehicle traffic, cause a weakening of structures.

The gradual decrease of available funds reduces the frequency of maintenance servicing and consequently makes them increasingly susceptible to damage. It is therefore crucial for project owners and their administrators to use suitable management and methodology tools to optimise the maintenance policies of their infrastructure assets if they want to maintain a satisfactory level of service.

This realisation spurred the launch of the GEPUR study by IDRRIM, USIRF⁸ and CoTITA Est⁹ who entrusted it to representatives of various departmental and urban infrastructure network administrators and to Cerema¹⁰. Its objective is to establish an inventory of their practices, assess the condition of their networks, and define a consensus-based approach for developing a management and maintenance methodology adapted to their needs.

⁸ Union of French Road Industry Associations

⁹ Technical Interdepartmental Conferences on Transportation and Planning

¹⁰ The Centre for Expertise and Engineering on Risks, Urban and Country Planning, Environment and Mobility.



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