Ex-post evaluation of major projects supported by the European Regional Development Fund (ERDF) and Cohesion Fund between 2000 and 2013

First Tramway Line of Le Havre Agglomeration

France

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Contact: Jan Marek Ziółkowski

E-mail: REGIO-B2-HEAD-OF-UNIT@ec.europa.eu

European Commission
B-1049 Brussels

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The consortium selected comprises CSIL – Centre for Industrial Studies (lead partner, Italy), Ramboll Management Consulting A/S (Denmark), Significance BV (The Netherlands), TPLAN Consulting (Italy).

The Core Team comprises:

- Scientific Director: Massimo Florio (CSIL and University of Milan);
- Project Manager: Silvia Vignetti (CSIL);
- Scientific Committee: Ginés de Rus, John Nellthorp, Emile Quinet;
- Task managers: Silvia Vignetti (CSIL), Gerard de Yong (Significance), Roberto Zani (Tplan), Emanuela Sirtori (CSIL), Xavier Le Den (Ramboll), Julie Pellegrin (CSIL);
- Thematic Experts: Gianni Carbonaro (CSIL), Enrico Bernardis (Tplan), Mario Genco (CSIL), Eric Kroes (Significance), Kim Ruijs (Significance), Barry Zondag (Significance).

A network of National Correspondents provides the geographical coverage for the field analysis.

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Cover picture source: Own picture

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LIST OF ABBREVIATIONS

ANRU	Agence nationale pour la Rénovation Urbaine
AURH	Agence d'Urbanisme de la Région du Havre et de l'Estuaire de la Seine
AFITF	Agence de Financement des Infrastructures de Transport de France
CBA	Cost-benefit analysis
CF	Cohesion Fund
CODAH	Communauté d'Agglomération du Havre
DG REGIO	Directorate-General for Regional and Urban Policy
DUP	Déclaration d'Utilité Publique
EC	European Commission
ERDF	European Regional Development Fund
ESIF	European Structural and Investment Funds
EU	European Union
EUR	Euro
ICT	Information and communication technologies
INSEE	Institut national de la statistique et des études économiques
ISPA	Instrument for structural policy for pre-accession
MCA	Multicriteria Analysis
NUTS2	Nomenclature of Territorial Units for Statistics
PDU	Plan de Déplacements Urbains
SCOT	Schéma de Cohérence Territoriale
TEN-T	Trans-European transport networks
ToRs	Terms of References
UNESCO	United Nations Educational, Scientific and Cultural Organization

EXECUTIVE SUMMARY

This study relates to the construction of a new tramway line in Le Havre, in the Normandy region in France, a major infrastructure investment co-financed by the EU over the programming period 2007-2013. More specifically, this is an ex-post evaluation assessing the long-term effects produced by the project and disentangling the mechanisms and determinant factors that have contributed to producing these effects. The analysis draws from an ex-post Cost-Benefit Analysis (CBA)[1] and from an extensive set of qualitative evidence, both secondary (technical reports, official reports, press articles, books and research papers) and primary (interviews with key stakeholders and experts have been carried out in the period from August 2017 to January 2018[2]).

OVERALL APPROACH AND METHODOLOGY

The overall approach and methodology followed in the evaluation study is briefly recalled hereafter and more extensively in Annex I.

The Conceptual Framework delivered in the First Intermediate Report has been developed to answer the evaluation questions included in the ToR, and further specified and organised in accordance with the study team's understanding. In particular, there are three relevant dimensions of the analysis:

- **The 'WHAT'**: this relates to the typologies of long-term contributions that can be observed. The Team classified all the possible effects generated by transport projects (including road, rail, and urban transport projects) under the four following categories: 'Economic growth', 'Quality of life and well-being', i.e. factors that affect the social development, the level of social satisfaction, the perceptions of users and the whole population, 'effects related to environmental sustainability' and 'distributional impacts'.
- **The 'WHEN'**: this dimension relates to the point in the project's lifetime at which the effects materialise for the first time (short-term dimension) and stabilise (long-term dimension). The proper timing of an evaluation and the role it can have in relation to the project's implementation is also discussed here.
- **The 'HOW'**: this dimension entails reasoning on the elements, both external and internal to the project, which have determined the observed causal chain of effects to take place and influenced the observed project performance. To do this the Team identified six stylised determinants of projects' outcomes (relation with the context; selection process; project design; forecasting capacity; project governance; managerial capacity). The interplay of such determinants and their influence on the project's effects is crucial to understand the project's final performance.

The methodology developed to answer the evaluation questions consists of ex-post Cost Benefit Analysis complemented by qualitative techniques (interviews, surveys, searches of government and newspaper archives, etc.), combined in such a way as to produce a project history. CBA is an appropriate analytical approach for the ex-post evaluation because it can provide quantification and monetisation of some of the long-term effects produced by the project (at least those also considered in the ex-ante

[1] Data, hypotheses and results are discussed in Annex II.

[2] See Annex III for a detailed list of interviewees.

CBA). However, the most important contribution of the CBA exercise is to provide a framework of analysis to identify the most crucial aspects of the projects' ex-post performance and final outcome. It also worth noting that the purpose of this evaluation is not to compare ex-ante and ex post CBAs and that the results of these assessments are not easily comparable, because even if they rely on the same principles and draw from the established CBA methodology, there are often important differences between how the ex-ante and ex-post assessments were scoped and what data were taken into account. Qualitative analysis on the other hand is more focussed on understanding the determinants and causal chains of the delivery process as well as to assess effects that may be difficult to translate in monetary terms.

MAIN PROJECT FEATURES

The new tramway line is located in Le Havre, in the Normandy region in France, a city best known for its important port and UNESCO World Heritage architecture. Urban mobility in Le Havre and its broader agglomeration is managed by the Communauté d'Agglomération du Havre (CODAH). **The First Tramway Line of Le Havre Agglomeration concerns the construction of a new tramway line 13 kilometres long and composed of 23 stations and 22 rolling stocks, as well as a 575 metres long tunnel, a tramway and bus depot, park-and-ride facilities, bicycle lanes, overall street renovations from 'façade-to-façade'[3], and new trees.** The tramway line has a distinct y-shape, composed of a common section which then splits into the 'A' and 'B' lines. **Preparation and ex-ante studies began in 2004, while the construction of the functional tramway line began in March 2010** and ended two years and eight months later, in December 2012.[4] The line entered into service on 12 December 2012.**The project's total cost amounted to EUR 420.1 million in nominal value.** To finance this cost, EUR 87 million originated from various financers, including the EU. The rest of the costs was financed via a loan from the EIB of about EUR 100 million, and CODAH via its own resources and the 'versement transport'[5]. In June 2010, the Normandy managing authority approved an ERDF subsidy of an amount of EUR 10 million.**The project was inscribed in a political desire from its mayor at the time to transform the image of the city as modern and attractive** following the declining socio-economic trends of the 1980's, but also to align with current practice in urban transport in France towards the implementation of tramway systems as a modern and sustainable transport mode.[6] The project's key objectives also were to improve transport quality with modern equipment, to foster sustainable urban mobility and social cohesion with low-income populations of the North and Eastern parts of the city, and to improve environmental performance of the public transport system. The city already benefited from a bus system including two lines of articulated buses on main transport arteries of the city (on the current tramway's path), which interviewees and ex-ante studies noted were overcrowded.

Project performance

Based on the different findings produced by the project analysis, the final assessment of the project performance is presented hereafter, along a set of evaluation criteria.

[3] Pavements, cycling paths, roads, and trees were renovated or created as part of the project, and the city invested in building renovations particularly in the city centre as a separate financial and urbanistic effort.

[4] Finalisation of the works extended into 2014, however the system could operate as planned in December 2012.

[5] The versement transport is a contribution by private or public employers in the form of a hypotheticated tax on the total gross salaries of all employees. The product of the versement transport is dedicated to financing public transport, both investment costs and operational costs.

[6] http://transporturbain.canalblog.com/pages/le-tramway-a-t-il-une-couleur-politique--/35712998.html

Project relevance and coherence

Le Havre's first tramway line was appropriately designed vis-à-vis urban renewal objectives of the city by refurbishing streets all along the tramway line and providing a modern and sustainable mode of public transport, contributing to the city's attractiveness in a period of socio-economic decline. The project also contributed to improving means of transport to low income populations, providing access to the city centre, various services and recreational facilities (including Le Havre's beach). **The tramway has proved to be a more attractive transport option than buses for previous bus users and persons with reduced mobility**, facilitating travel thanks to new and improved infrastructure adapted for disabled and elderly people. The project also was also attractive in policy-makers' view due to the urban renewal opportunities it offered. The tramway was constructed according to original planning, connecting low income neighborhoods and other residential areas to the city centre and the beach. The tramway also replaced overcrowded bus lines with a system offering higher capacity. The increasing number of public transport users is a clear sign that the project is becoming more relevant over the years. **However, the lack of an ex-ante in-depth assessment of the potential performance of alternative options** (bus rapid transit) **has not allowed to prove that the tramway project was most appropriate and least costly to achieve transport objectives**.

On the negative side, the aim to encourage a modal shift from private cars to public transport was not taking sufficient account that the city in fact still encouraged car travel due to low congestion and availability of free or cheap parking (in areas where a fee does apply). This context was expected to change as a result of the tramway yet also affected its performance. In this sense, the city and CODAH may have chosen to implement the tramway system together with stronger actions to incentivise the modal shift.

The project quickly became a leading project in Le Havre's broader urban renewal and transport policy. The tramway project was from its inception, and continues to be, a centerpiece of Le Havre's urban development policy. However, the tramway line still struggle to compete with the preferred use of private vehicles due to strong car culture in Le Havre, low congestion and high parking availability. Today the city and CODAH are still planning multiple projects in coherence with the transport service offered by the tramway. These projects include new housing, leisure and recreational facilities, and redevelopment of public space and of other areas to attract investments, visitors and inhabitants.[7]

Tramway systems were a trending mode of transport in French cities, supported by the State for their environmental performance and appeal to sustainable urban ways of life. As such, the project was also in coherence with national practices and policy objectives.

Project effectiveness

The results of the CBA, as included in the Annex II to this report, indicate that the project's measurable benefits fall short of the costs from a socio-economic point of view. The CBA resulted in a benefit to cost ratio of 0.18 which suggests that the social costs of the project are higher than the quantifiable socio-economic benefits. This is in contrast to the ex-ante evaluation which forecasted a positive result. A number of factors led to this effect, including higher investment

[7] Le Havre City Hall. (2018). *Les Grands Projets.* Retrieved from: https://www.lehavre.fr/ma-ville/les-grands-projets

costs of the project, lower passenger numbers than predicted and a less pronounced modal shift from private cars to the tram than expected. Also, methodological differences played an almost equally important role in the different results. For example, the most important socio-economic benefit generated by the project is time savings. The monetary unit used in the ex-ante CBA followed French CBA guidelines and is considerably higher than the unit costs recommended for this study (see the First Intermediate Report). However, applying the same values as in the ex-ante CBA would not turn the overall result of the economic analysis positive;) the same applies to social accident costs. Finally, the ex-ante CBA took a number of effects into account (following French guidelines), which are not considered in the ex-post CBA due to the uncertainties attached to them and lack of evidence. These effects include reduced erosion of paving and improved availability of parking spaces (the latter effect was included in the ex-ante CBA though there was no major shortage of parking space at that time), both due to former car users switching to the tram.

With 38,461 passengers per day projected in 2017, **the tramway has struggled to reach transport objectives of 56,000 passengers per day, likely due to optimism bias with regard to its ability to stimulate a modal shift in Le Havre**. However, it is experiencing rising passenger traffic growth by an average of 3% per year and has successfully increased passenger traffic on the entire public transit system. Interview respondents noted that a main source of transport traffic was likely to be induced mobility. A modal shift seems to have occurred to a lower extent than expected, but possibly contributes to traffic gains. In absence of further studies on passengers' travel habits (planned for 2018), these observations cannot be corroborated with a high level of certainty.

The project has had immediate effects related to quality of life, with 'façade-to-façade' renovations bringing aesthetic value to the city and facilitating travel. Aesthetic improvements could not be captured in the CBA, yet were valued unanimously by stakeholders interviewed. However, the socio-economic context of Le Havre, characterised by declining population trends and relatively high unemployment, still affects its socio-economic development. The introduction of the tramway system alone is unlikely to change this dynamic on its own but should be seen in the context of a broader development policy.

It is also important to note that the indicators used in the CBA only partly reflect the socio-economic effects of the project while qualitative assessments are used to include additional aspects such as aesthetic improvements, reduction of crowding, and synergies with recent urban developments. This mix is particularly appropriate, because it allows adopting a wide perspective in assessing long-term effects, while sticking to a prudent approach based on robust facts.

The tramway system was constructed in perfect alignment with intended structural features, and opened within schedule on 12 December, 2012. Strong political will, good managerial capacity of CODAH, adequate involvement of experts and of the public ensured that the ambitious construction schedule was met despite the high financial investment costs. As a matter of fact, the project was completed in time (under three years'), as described further in section 5.3 below on Project efficiency.

Technical difficulties with electronic ticketing in the first year prevented monitoring of punctuality and passenger traffic, and in the year it became functional the data shows that a larger share of the tramways were not circulating on time. The transport operator has however managed to improve performance within two and a half years of service, meaning that the service became reliable as of mid-2015.

Broader and longer-term socio-economic impacts of the project are yet to be measured in upcoming studies from Le Havre's local urbanism agency, although findings of the present study from field visit and interviews show that the tramway is unlikely to have significantly affected the fabric of the city, such as in terms of local economic activity. Overall, the city is seeing a stabilisation of its socio-economic indicators in recent years (unemployment, population), which may be due to quality of life improvements, to which the tramway has certainly contributed.

As the city pursues its urban renewal policy with several major projects in development around the tramway line[8], Le Havre is expected to experience an improvement in economic activity and overall attractiveness. These long-term effects are not directly imputable to the tramway, however they are expected to stimulate the demand of public transport. As such they are reflected in the CBA by the increasing number of passengers in the future.

Project efficiency

The project has not performed well financially due to much higher investment costs than forecasted. As further explained in section 2.2, these higher costs are likely to have originated over the entire construction phase due to an accumulation of unexpected costs, and in relation to contractors' billing claims, still subject to litigation procedures. These claims are expected to lead to an increase of EUR 10 to 30 million in the coming years, depending on court decisions. The cost of the system thus bears heavily on CODAH's overall budget. In total, the investment costs amount to almost EUR 540 million (in 2017 present value) instead of the EUR 333 million (in 2009 present value) originally foreseen in the ex-ante studies. The EUR 540 million also include a total of EUR 20 million (nominal) which have not yet been paid to contractors. This amount is currently debated in court with contractors demanding EUR 30 million and the operator willing to pay only EUR 10 million[9].

Construction of the tramway line began in March 2010 and ended two years and eight months later, in December 2012, when the line entered into service and as originally planned.

Following French law, the financial sustainability of the project is ensured by transfer payments from the region.

From a financial point of view, the choice of a tramway rather than bus rapid transit (as considered among alternative options) was too expensive however the project's objective to renew the city's urban environment and reduce local atmospheric pollution would have been unlikely to materialise to a same extent under the alternative option of setting up a service of conventionally (diesel-) fuelled buses in a bus rapid transit system. Unfortunately, the ex ante studies did not compare the benefits of alternative options to provide more conclusions on the issue.

EU added value

The application process and the high level of the requirements for accessing ERDF funding were described by the project manager at the time of planning and construction as having contributed to an important amount of resources invested in its preparation, contributing to good technical design. The total cost of the project was

[8] These projects include new housing, leisure and recreational facilities, and redevelopment of public space and of other areas to attract investments, visitors and inhabitants. See Le Havre City Hall. (2018). *Les Grands Projets.* Retrieved from: https://www.lehavre.fr/ma-ville/les-grands-projets

[9] Due to the unknown outcome of this procedure the EUR 20 million have been included as mean value in the calculations.

however not well anticipated in the ex-ante studies and led to an underestimated project cost being presented in the proposal.

The EU contribution to the project goes beyond the provision of funding and also includes providing the strategic framework for implementation of transport projects provided by the ERDF, setting out clear urban development and environmental sustainability objectives. The objectives of the project were indeed in line with EU sustainability and transport objectives. The EU contribution was also described as a leverage for additional funding. At the same time, optimism bias might have played a role in the ERDF application process by presenting an overly positive list of impacts and a high level of ambition, with quantified objectives which proved difficult to attain.

As reported by interviewed stakeholders, even without **EU funding the project would have likely still been implemented** due to the high political interest from local actors. The financing decision from Regional Managing Authorities drastically reduced the amount of the EU subsidy from the maximum of about EUR 54 million to a sum of EUR 10 million.[10] This amount is therefore unlikely to have significantly affected the financial sustainability of the project. A higher subsidy may have positively contributed to the financial sustainability of the project, however it would not have been unlikely to contribute to avoiding the issues which the project faced during implementation and which led to costs overshoot.

MECHANISMS AND DETERMINANTS

In terms of mechanisms and determinants explaining the project performance, a number of findings can be drawn from the project assessment.

- The process for **project selection** was driven by strong political will which steered it towards the most expensive but also most prestigious option of a tramway in the city's centre, integrating social cohesion objectives. The comparative assessment of alternative options (bus rapid transit) was not considered in depth, when such option may have fulfilled transport objectives at a lower cost, but with lower effects in terms of environmental sustainability. Implication of the local population and local experts was very important in this process. Good relations with DG REGIO and Regional Managing Authorities in the *ex-ante* phase contributed positively to its selection for ERDF funding.
- The project was planned with weak **forecasting capacity** with regards to passenger demand and project costs assessed *ex-ante*, due for the first part to an overestimation of the potential for modal shift and to underestimated and unexpected costs. The projected cost of the project in the *ex-ante* studies was much lower than the actual cost. Also, the forecasted demand did not meet the expectations
- The project's **relation with its context** was relatively negative considering Le Havre's lack of traffic congestion and good parking availability. On the other hand, the tramway line was an integral part of broader urban renewal and social cohesion efforts and continues to contribute to it. On its own, the tramway project is unlikely to have significant effects on the city's economic fabric. This is due Le Havre's social and economic conditions which the tramway alone could not change. The **project's design** was excellent, with no aspect of the infrastructure or of the tramway route which could be criticised or

[10] Discussions with the project manager (CODAH), the Regional Managing Authority and DG REGIO could not clarify the reason for this final decision, however it is likely that this decision was taken in order to allow funding for other eligible projects.

led to important issues. Also, the project contributed to various aspects of the service including punctuality, travel comfort, passenger capacity, reduction of crowding, and aesthetic quality.

- **Managerial capacity** of actors involved has proven to be rather positive: CODAH and the transport operator have been responsive to unexpected issues and led to project to completion in time and according to plans. The project was however not monitored appropriately as per the *ex-ante* schedule and national CBA guidelines.
- **Project governance** was noted as quite positive by most stakeholders, with a compact and dynamic team set up for managing the project and good interactions with all other actors (contractors, local urbanism agency, Regional Managing Authorities, and DG REGIO).

CONCLUSIONS

In conclusion, Le Havre's first tramway line is an example of a project with important ambitions in terms of urban renewal, attractiveness and social cohesion. The case study does not provide evidence that the project has had important urban renewal impacts. For instance, the price of real estate was not affected by the project. The project had very high investment costs which tipped the balance of benefits in favour of the costs in the CBA, however the above unquantified benefits should neither be overlooked nor underestimated in their contribution to making Le Havre progressively more sustainable and an attractive place to live. The project had a broad range of objectives, some of which were ambitious and difficult to achieve, and others could not be achieved by the project on its own and would require more time and concerted action to materialise, such as the shift from private vehicles to tramway in a context of a non-congested city. The project's good insertion within an urban renewal policy is likely to reap new benefits as other projects are developed, creating synergies to realise overarching social cohesion, environmental sustainability and economic objectives. Despite technical difficulties setting up a reliable service, the project's governance has provided adequate incentives to improve the service over time and within a few years of service. Follow-up assessments should be conducted to conclude on the longer-term effects of the tramway line's implementation

1. PROJECT DESCRIPTION

This study relates to the construction of a new tramway line in Le Havre, in the Normandy region in France (see Figure 1 below), a city best known for its important port and UNESCO World Heritage architecture. The project originated from elected officials further developed by local experts in the context of a broader urban renewal policy originating in the mid-1990's. Together with setting up the new transport system, the project was the occasion for the city to change physically with renovated streets and intermodal infrastructure.

Figure 1. Map of France and surroundings, showing the location of Le Havre.

Source: Authors, based on Google Maps (2017).

The construction of the functional tramway line began in March 2010 and ended two years and eight months later, in December 2012.[11] The line entered into service on 12 December 2012. **Overall, the line is 13 kilometres long and composed of 23 stations and 22 rolling stocks.** It has a distinct y-shape, composed of a common section which then splits into the 'A' and 'B' lines. The route and stations of the line can be seen in the figure below.

[11] Finalisation of the works extended into 2014, however the system could operate as planned in December 2012.

Figure 2. Le Havre tramway route.

Source: Mission Tramway. (2009). GRAND PROJET - DEMANDE DE CONFIRMATION DE FINANCEMENT EN VERTU DES ARTICLES 39 À 41 DU RÈGLEMENT (CE) N° 1083/2006 FONDS EUROPÉEN DE DÉVELOPPEMENT RÉGIONAL/ FONDS DE COHÉSION - INVESTISSEMENT DANS DES INFRASTRUCTURES.

The creation of the tramway line has allowed to replace existing bus routes and connect with other transport infrastructure (roads and railroad). The project total cost amounted to EUR 420.1 million in nominal value.

This section contains a brief description of Le Havre's first tramway line. The socio-economic context, the target population and key structural features of the infrastructure and service delivered are outlined in order to give a general description of the project context and objectives.

1.1 PROJECT CONTEXT

Le Havre has faced significant socio-economic and population decline since the 1980s. It suffers from the perception of being a city in decline with high unemployment, bleak industrial and urban landscape, and economic disparities. This unattractive image contrasts with urban development efforts engaged by the municipality in the past couple of decades to provide the city with a more modern and attractive identity anchored in its architecture, high education facilities and recreational opportunities. **In the past decade or so, these efforts seem to have stabilised the performance of the city on population and unemployment indicators.**

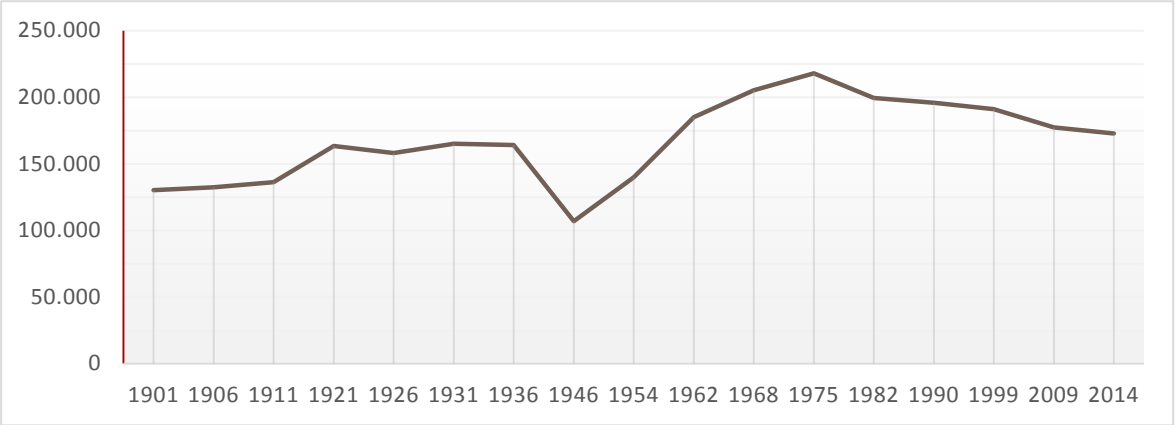
As of 2014, the population of Le Havre reached 172,805 inhabitants, a 2.5% decrease compared to 177,258 in 2009 (see figure below).[12] The decline in Le Havre's population can be traced back to the 1970-80s[13] and related to migration from the city to its outskirts, but also due to low attractiveness to youth and their migration to other French cities.[14] Prior to this decline, the city was experiencing rapid growth which followed World War II , when the city was destroyed and subsequently rebuilt.

[12] AURH (2017) based on INSEE.

[13] http://cassini.ehess.fr/cassini/fr/html/fiche.php?select_resultat=16833.

[14] Delamare J., Follin J., Cousin M-H. (2014). Perspectives démographiques de l'agglomération havraise à l'horizon 2030. *INSEE and AURH.* Retrieved from : https://www.insee.fr/fr/statistiques/1560126

Figure 3. Evolution of the population of the city of Le Havre between 1901 and 2014.



Note: The chronology is established based on data for available years. For that reason, the plotted line can appear somewhat distorted as the interval between each point is not regular.
Source: Authors, based on Ldh/EHESS/Cassini, INSEE and AURH (2017).*
**Retrieved from: http://cassini.ehess.fr/cassini/fr/html/fiche.php?select_resultat=16833*

Le Havre is part of a larger urban agglomeration of 17 municipalities of which it is the largest, named 'communauté d'agglomération du Havre' and abbreviated CODAH to designate either the institution or the municipal agglomeration (see box below). It reached 240,201 inhabitants in 2016.[15]

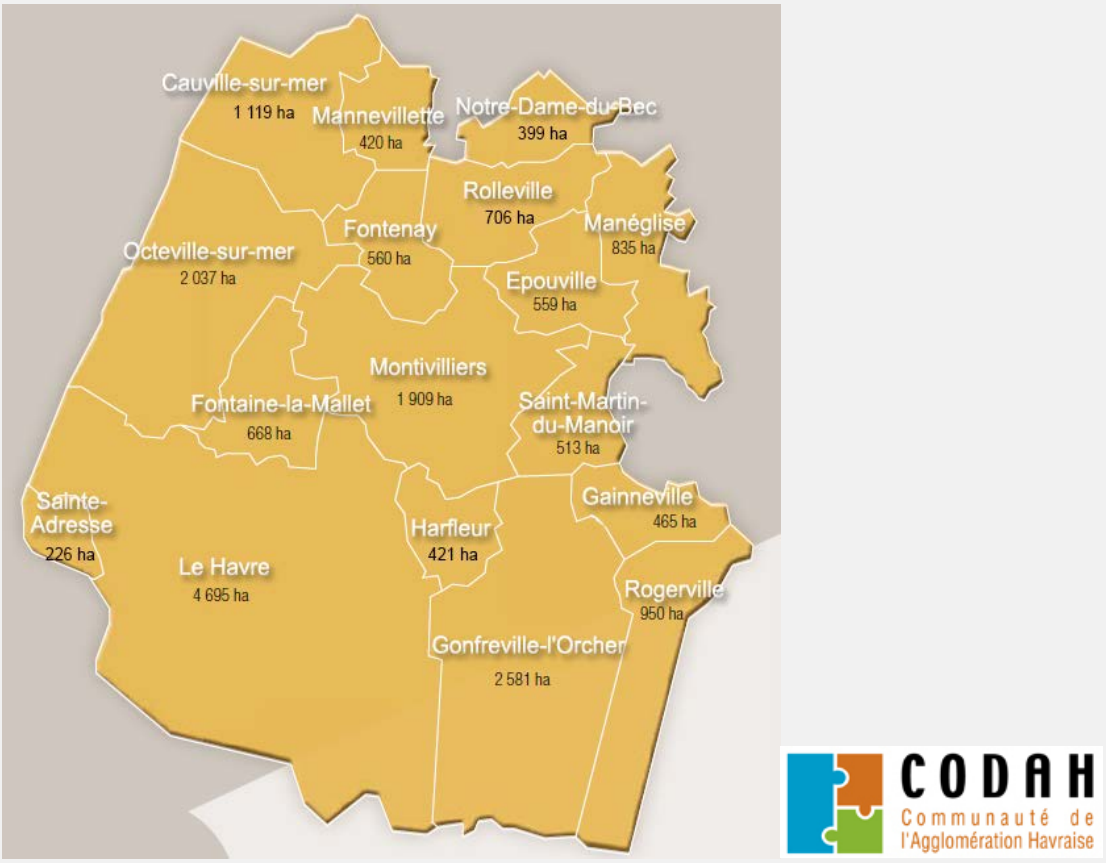
While Le Havre's population is declining, the population of the broader peri-urban and rural region has presented an upward trend signalling movement of the city's population to its outskirts. This trend has slowed down since 2010.[16]

[15] INSEE.

[16] Chambre Régionale des Comptes Basse-Normandie et Haute-Normandie. (2014). Rapport d'observations définitives de la chambre régionale des comptes de Basse-Normandie, Haute-Normandie sur la gestion de la communauté d'agglomération du Havre (CODAH) – Politique des transports urbains. Retrieved from : https://www.ccomptes.fr/sites/default/files/EzPublish/JF00145094_JF_INTERNET1.pdf

Box 1. Presentation of CODAH.

CODAH is the abbreviation for Communauté d'Agglomération du Havre. This abbreviation corresponds to both the urban agglomeration of 17 municipalities, and the institution which represents them. The following map shows the urban agglomeration.



Source: CODAH. Retrieved from: http://www.codah.fr/sites/default/files/Territoire-17-communes_codah.jpg

The institution of the same name (see logo) was created in January 2001 and takes charge of a wide range of competences, including urban transport planning. CODAH is administered by a community council composed of elected officials representing the different municipalities, the president of which is also the mayor of Le Havre.

Following World War II, the reconstruction of Le Havre took place between 1945-1964. The work was consigned to the firm of architect August Perret.[17] The style of Perret's firm largely influenced the notoriety of Le Havre's city centre with its characteristically sober concrete architecture. Architectural landmarks in the vicinity of the tramway include Le Havre's City Hall and the Saint-Joseph Church, the Porte Océane (see picture below), as well as several apartment blocks in the city centre. Since 2005, Le Havre's rebuilt city entered the UNESCO list of World Heritage Sites.

[17] UNESCO. 2005. *Le Havre, the City Rebuilt by Auguste Perret*. Retrieved from: http://whc.unesco.org/en/list/1181

Figure 4. Photograph of the Porte Océane, designed by August Perret, traversed by the tramway and leading to Le Havre's beach.

Source: Authors.

In the 1960-70s, Le Havre expanded with new neighborhoods North of the city centre being absorbed into its boundaries. These include the areas of Mont-Gaillard and Caucriauville, the end points of the tramway line. **These neighborhoods are composed of large housing developments** originally aimed to host blue collar workers of Le Havre's port and industries. **They remain low income areas with low education level, making them 'Sensitive urban zones' prioritised for urban development policies**.[18] In the mid-2000's, the French National Agency for Urban Renovation (ANRU) co-financed together with the city the rehabilitation of these neighborhoods, rebuilding a large number of housing and creating new public spaces.[19]

[18] http://www.caucriauville.fr/

[19] Simon, P. (2010). Le bilan de l'ancien maire. *Le Point.* Retrieved from : http://www.lepoint.fr/villes/le-bilan-de-l-ancien-maire-16-12-2010-1278875_27.php

Figure 5. Map of Le Havre, showing the tramway line and selected neighbourhoods.

Note: The blue dotted line identifies the cliff separating the Upper City from the Lower City.
Source: Authors, based on Google Maps (2017).

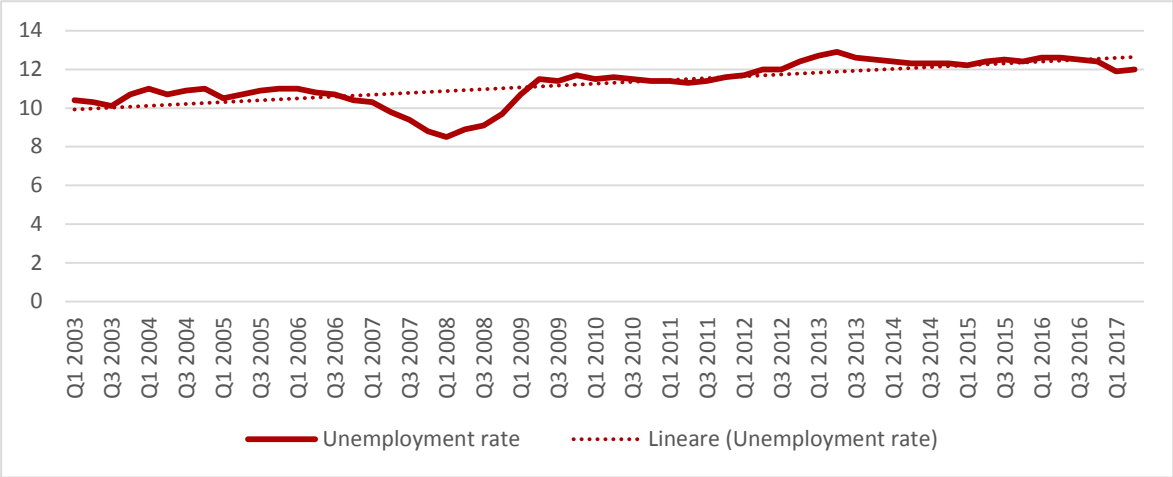
Despite high economic activity in the periods before and after World War II, Le Havre has experienced relatively high and increasing unemployment compared to the rest of France (11.9% of the active population in 2017, compared to 9.8% nationally).[20] The city centre also presents many closed shops. This situation is well known in the city and region and has been the target of ongoing development objectives.

Employment in industry, factories and the port has diminished with closures and offshoring. In recent years, old industrial quarters South of the city reconverted into shopping, restauration and housing areas.[21] Le Havre has faced difficulties reconverting a large secondary sector workforce to tertiary sector activities. The local economy attracts few white-collar jobs despite the presence of several higher education institutions.

[20] https://www.seine-estuaire.cci.fr/sites/seine-estuaire.cci.fr/files/2017_09_chiffres_cles_sie.pdf

[21] Simon, P. (2010). *Le bilan de l'ancien maire.* Le Point. Retrieved from : http://www.lepoint.fr/villes/le-bilan-de-l-ancien-maire-16-12-2010-1278875_27.php

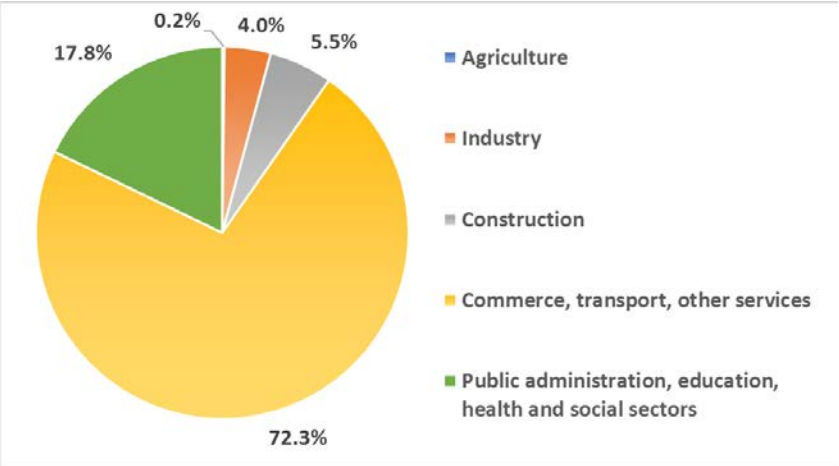
Figure 6. Unemployment rate in Le Havre, per quarter since 2003 until Q1 2017.



Source: Authors, based on Chambre de Commerce et d'Industrie Seine Estuaire (2017).

A majority (72.3%) of the city's establishments are in the services and commercial sector (trade, retail, transport services, other services), followed by public administration, education, health and social sectors (17.8%). Less than 10% of establishments in the Le Havre are from the sectors of construction, industry and agriculture.

Figure 7. Share of establishments by type of economic activity.



Source: Authors, based on Chambre de Commerce et d'Industrie Seine Estuaire (2017).

Historically key to its economic development, Le Havre hosts the second largest port of France in terms of maritime traffic after Marseille, making it one of France's gateway to global maritime trade. The city is located on the Atlantic TEN-T Core Network Corridor and it has core network maritime and inland ports, as well as rail/road terminal (RRT). In 2016, the port hosted a total freight traffic of 66 million tonnes. This maritime traffic connects with road and rail transport with 64 million tonnes transiting through the port. Still in 2016, the port provided 31,000 direct and indirect jobs.[22] The tramway line is unlikely to have affected this activity due to its local scope, therefore its effects are not further discussed within this context.

Le Havre is also characterised in its topography, as the city is separated in two by a cliff (see Figure 5 above). This cliff separates the 'Ville Basse' (Lower City), located at sea level, from the 'Ville Haute' (Upper City), elevated at 90 and up to 115

[22] HAROPA – Port du Havre. Activities report 2016.

metres high. The Lower City has direct access to the sea and therefore to the beach and the city's port.

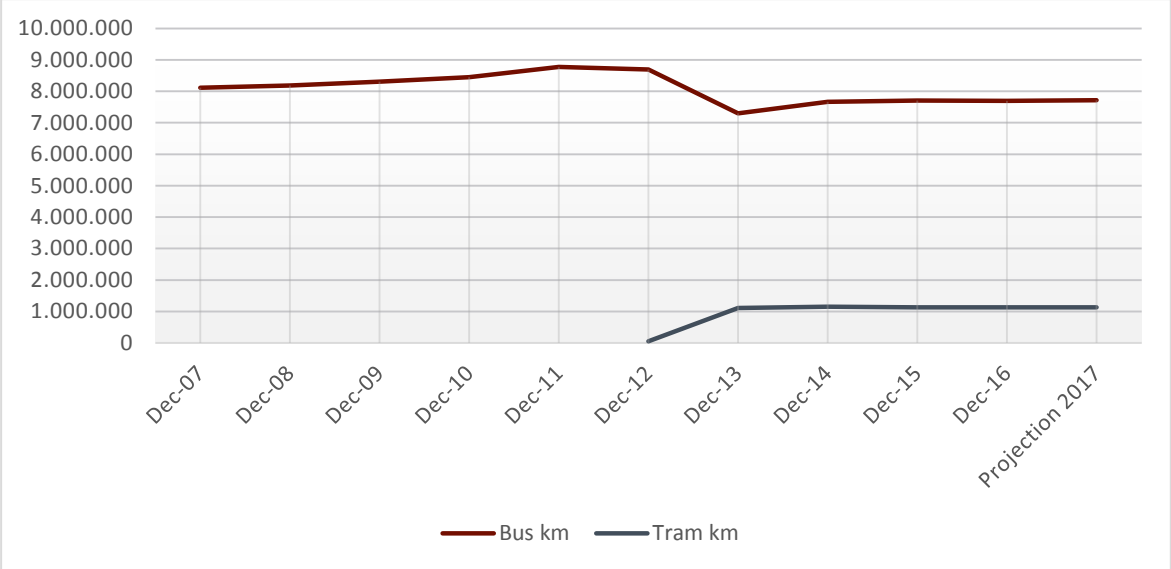
Public transport is managed by CODAH, which is responsible for organising mobility in Le Havre's urban agglomeration. CODAH thus procures and owns all transport equipment (vehicles and infrastructure). Also relevant to mention, CODAH manages roads and parking, as well as cycling and pedestrian infrastructures.

Transport services are contracted to a private sector operator selected via a public tendering procedure. Since the 1980s, this contractor has been the Compagnie des Transports de la Porte Océane (CTPO), whose name changed to LiA for 'lignes de l'agglomération' (the agglomeration's transport lines) in July 2012.[23] The contract was most recently renewed in 2012 and until 2017, when it was renewed again for five years.[24] The company is a subsidiary of Transdev, an important French multinational public transport operator present across France and on six continents.[25] LiA provides transport services to the entire agglomeration of Le Havre, including the city itself and its 17 municipalities.

Until 2010, before the construction of the tramway line, LiA operated a system of regular bus lines in densely populated areas and on-demand bus transport in least dense areas. A map of the system in 2007 is presented in Appendix.

The entry into service of the tramway has enabled CODAH and LiA to overall restructure and improve the quality of public transport services and urban mobility in Le Havre. Despite a notable reduction in bus-kilometres travelled, bus services replaced by the tramway were in part redirected outwards and toward the Le Havre's periphery.

Figure 8. Vehicle kilometres per year since 2007 for tramways and buses (as of December of each year).



Source: LiA (2017). Note that only projected data are available for 2017.

[23] For the purpose of this study, we only refer to the company as LiA.

[24] The terms of the contract and particularly incentives for improvement of the services are explored in more detail in section 4.5.

[25] LiA, 2016. Rapport d'activité. Retrieved from : http://www.transports-lia.fr/ftp/FR_document/LIA_rapport-activite_2016.pdf

The tramway has been conceived as the city's new "backbone": a structuring element of its transport network and for urban renewal. The tramway connects with 11 of the 15 LiA urban bus lines and several regional, national and international bus and train lines operated by other companies and accessible from the train and bus stations (adjacently located). The tramway line also connects 9 bicycle parkings and 2 park-and-rides.

1.2 PROJECT OBJECTIVES

The project was inscribed in a political desire from its mayor at the time to **transform the image of the city as modern and attractive**, but also to align with current practice in urban transport in France towards the implementation of tramway systems as a modern and sustainable transport mode.[26] In an article, Rubén *et al.* (2013) suggest that, between 1990 and 2010, the tramway became a "tool for urban requalification and a marketing instrument" for local elected officials due to modern aesthetic of the new generation of vehicles and the opportunity they offer for urban renewal.[27] Many tramway systems were indeed built in medium or large French cities, particularly since the early 2000s (16 new systems from 2000 and until 2012, excluding Le Havre's).[28]

The new tramway was expected to provide coherence to Le Havre's urban transport infrastructure network, in order to **foster urban density** by increasing population in Le Havre rather than its outskirts, and foster **sustainable urban development**. Taken in the context of the overall transport and urban policy of the CODAH, the project was hoped to contribute to making Le Havre's agglomeration a more economically, culturally and socially attractive place, and to increase its urban population which had been in decline (see section 1.1 above).

It aimed to **foster sustainable urban mobility** behaviour in Le Havre by offering low-carbon solution and an alternative to the private car in the city centre, a difficult objective in view of the important use of the car within the city and with its outskirts, facilitated by low congestion and good parking space availability. The tramway line would however have improved the offer for multimodal travel by linking with other public transport modes such as buses and inter-regional trains, as well as active travel including cycling and walking.

A key **social objective** was **improving territorial and social cohesion** in Le Havre by providing a better link between the Upper and Lower parts of the city. The project aimed to contribute to increasing access and mobility of populations in low income suburban neighbourhoods of Mont-Gaillard, Mare Rouge, Bois de Bléville and Caucriauville (see Figure 5 above). As part of the project, street works involved 'façade-to-façade' renovations along most of the tramway line, including renovation or creation of pavements, cycling paths, roads, and trees not only in the city centre but in all areas of the city crossed by the tramway, including its poorer neighbourhoods. Urban renewal thus provided low-income areas with more attractive urban spaces, such as green or open space. The project was inscribed in a broader social cohesion and urban renewal policy (see section 1.1 above). However, it must be noted that not

[26] http://transporturbain.canalblog.com/pages/le-tramway-a-t-il-une-couleur-politique--/35712998.html

[27] Quote translated from the original language (French). Source: Rubén, C. *et al.* (2013). Le tramway entre politique de transport et outil de réhabilitation urbanistique dans quelques pays européens : Allemagne, Espagne, France et Suisse. Annales de géographie, 2013/6, no 694, pp619-643. Retrieved from : https://www.cairn.info/revue-annales-de-geographie-2013-6-p-619.htm

[28] Wikipedia. (2017). Liste des tramways de France. Retrieved from: https://fr.wikipedia.org/wiki/Liste_des_tramways_de_France

all the street renovations are financially attributed to the project, as some occurred in the 1990s before tramway works.

The project set a number of **transport objectives** based on the situation at the time of the ex-ante studies. In 2009, the public transport network included 15 urban bus lines and connection to intercity and regional train lines. The tramway would replace two articulated bus lines covering almost the same route, and which had become overcrowded (according to interview respondents and as reported in the *ex-ante* opportunity study).

Since its inception, the project aimed to **increase the modal share of public transport (bus and tramway) compared to the private car**. In 2005, the overall public transport network accommodated 86,300 daily trips. The objective was to reach 124,000 daily trips in 2013 of which 56,000 daily trips on the tramway line. Since the 1990s, the public transport offer had not increased relative to the car despite an absolute growth in public transport use. Consequently, the Urban Mobility Plan set an objective of a 2% yearly growth on all public transport travel. Among new expected public transport users, 70% were expected to originate from a modal shift from the private car, and 30% from new induced mobility. The introduction of the tramway line would also allow to modify eight bus lines, causing a net yearly reduction in bus-kilometres (bus-km) of 750 000 bus-km, and redistributing part of the bus network out towards peripheral neighbourhoods and municipalities.

The modal shift was expected to occur by **improving the attractiveness of the public transport offer** on the one hand, and **incentivising reduced private car use** on the other. This included improving the commercial speed of urban transport services, as well as providing better regularity, frequency, and comfort that a tramway service can offer. Modern tools were introduced such as electronic ticketing and real-time information, which would improve travel information and facilitate transport while allowing better monitoring of the system's performance. Furthermore, the new tramway line and reorganised bus network was expected to reduce offloading (connections).

The tramway's circulation on dedicated space was expected to reduce road space and thus provide a disincentive to car use. It would also increase traffic safety thanks to fewer traffic in the area and improved pedestrian and cycling infrastructure, and by separating public transport (tramway) traffic from the rest. The works would also include reducing on-street parking along the tramway line, create park-and-ride stations, and introduce attractive pricing policies for car and bicycle users parking their vehicle or bike and using public transport.

The project also contained a number of **environmental objectives**. The first of these was that, by using electricity as main energy source, the tramway line would **emit less greenhouse gasses and air pollutants than private cars and diesel buses** thus contributing to reducing adverse health effects from atmospheric pollution and global warming. Secondly, **noise pollution was expected to decrease** due to fewer vehicles including cars and buses. Finally, **energy consumption was expected to diminish by 2.5%** upon opening of the line due to the switch from diesel buses to electric tramway.

Compared to existing buses, new tramway can offer **easier access to persons with reduced mobility** including the elderly, handicapped people and blind people. This objective was integral to the tramway system's design with low-floor rolling stock, adapted ticket vending machines, adapted street crossings and pavement, voice and braille signalling.

The project's construction work in particular also placed emphasis on **gender equality** and the role of women. Important positions and jobs were granted to women in the construction and the operation and maintenance of the tramway line.

Due to the early (since 2002) and strong political will for the tramway system to be implemented, broader local policy documents such as the Urban Mobility Plan (PDU) of 2003, the Local Urban Plan (PLU) of 2007, and the Territorial Coherence Scheme (SCOT) of 2008 were all adopted in coherence with the creation of a tramway line linking the Upper and Lower parts of the city.[29]

The overall public transport services may have been affected by other projects which were expected to alter the city's traffic patterns. These are summarised in the box below.

Box 2. List of connected projects[30]

- Requalification of Road (RD) 6015 through Gainneville and Gonfreville L'Orcher (construction 2011-2012): creation of a roundabout, reduction of the width of the carriageway, pavements expansion, creation of bus stops.[31]
- Requalification of the road entrance to Le Havre (RD 6015).[32]
- Creation of Le Havre's new Northern bypass (construction 2007-2011).[33]

In 2011, the environmental evaluation[34] of the Urban Mobility Plan (PDU) assessed that projects presented in Box 2 would reduce vehicle traffic during peak hours on the tramway line and on roads in the city centre, while increasing transit on the (new) Northern bypass. The total reduction was estimated at by 2,500 vehicles per hour at the scale of CODAH.

1.3 STRUCTURAL FEATURES

The tramway line was designed so as to serve three areas of Le Havre: the rebuilt neighbourhoods of the city centre in the South, and the middle- and low-income residential neighborhoods in the city's North and East. These three directions gave the line's distinct y shape (see Figure 2 and Figure 5). The common section of the line, located in the city centre, departs from the beach (see photo below).

[29] In some documents, the project is simply referred to as public transport on dedicated lane which can therefore also indicate the possibility of bus rapid transit and trolleybuses. However interviews clearly indicate that a tramway was the preferred option from the project's inception.

[30] They were not co-financed by EU funds.

[31] Ville de Gonfreville l'Orcher, 2011. La requalification de la RD 6015. Retrieved from : http://www.gonfreville-l-orcher.fr/spip.php?article154

[32] Agence L'Anton & Associés, paysagistes-urbanistes (mandataire) / Infraservice, BET infrastructure CDVia, BET déplacements / Ingedia, BET génie civil / M. Kagan, architecte consultant / F. Franjou, Eclairagiste, 2011. CONCOURS NATIONAL DES ENTRÉES DE VILLE DOSSIER POUR LA REQUALIFICATION DES BOULEVARDS W. CHURCHILL ET DE LENINGRAD - RD6015- ENTRÉE DE VILLE DU HAVRE. Retrieved from : http://patrimoine-environnement.fr/wp-content/uploads/2010/01/Le-Havre-2011.pdf

[33] Actu.fr, 2012. La rocade nord du Havre ouvrira ce lundi. Retrieved from: https://actu.fr/societe/la-rocade-nord-du-havre-ouvrira-ce-lundi_267757.html

[34] At the horizon 2022.

Figure 9. Photograph of the first tramway station (on the right), located by the beach (on the left).

Source: Authors.

The common section (lines A and B, in the Lower City) is composed of 8 stations: La Plage (the beach), St-Roch, Hôtel de Ville (City Hall), Palais de Justice (Justice Palace), Gares (train and bus station), Université (University), Rond-Point (roundabout), Place Jenner.

Two lines depart from the beach: the A and B lines. At the beach stop, tramways alternate between the two destinations, meaning that every other passing tramway is an A line preceded/followed by a B line.

- **The A line goes northwards** and is composed of 8 stations in the Upper City: Place Jenner, Mare au Clerc, Sacré-Coeur, Mare Rouge, Mont Gaillard, Queneau, Bigne à Fosse, and Grand Hameau.
- **The B line goes eastwards** is also composed of 8 stations in the Upper City: Place Jenner, Frileuse, Curie, Verlaine, Schuman, Atrium, Saint Pierre, Pré Fleuri.

The structural features of the tramway system include:

- A 575 metres long tunnel (Jenner Tunnel; see Figure 11 below).
- 7 to 8 metres large tramway platforms, partly grassed, and holding 3,299 eight-metre rail sections. The lawns do not require artificial watering.
- Tram stations, including furniture, shelters, lighting, information panels, ticket machines.
- 22 'Citadis' low-floor rolling stocks (see photo below), each 32.6 metres long and 2.4 metres high, with a capacity for 250 people including 54 seated. The Citadis was designed and built by Alstom Transport.
- Tramway equipment: high voltage equipment, including the overhead cabling, traction equipment, rectification substations; low voltage equipment, including traffic lighting, operating systems, user information systems, communication systems.
- Street planning and works, including pedestrian and cycling infrastructure, and car parking. Plants, including 500 new trees were also planted.
- Depot and maintenance centre comprising vehicle storage facilities (capacity for 22 tramways and 60 buses), workshops, maintenance equipment, cleaning equipment, offices, fuelling station, parking spaces.

- Two park-and-ride facilities at the Grand Hameau terminus in Mont-Gaillard and Schuman station for 350 and 70 vehicles; ten bike-and-ride facilities. All parking is free to LiA travellers.

The investment cost of the project is depicted in the table below: **the most relevant share of the budget is allocated to construction** (EUR 291.3 million out of approx. 420.1 million, corresponding to 69% of the total project cost) and supply of rolling stock which amounts to EUR 57.2 million or 14% of the overall investment budget.

Table 1. Share of investment categories

TYPE	AMOUNT (EUR)
Preparatory phase (studies, design, documentation)	39,188,429
Land acquisition and legal settlements	10,033,920
Construction works	291,315,814
Supply of rolling stock and other equipment	57,174,800
Supervision, project management, information and other costs	22,412,373

Source : Authors

The tramway runs on electricity, provided in France mainly by nuclear power. Additionally, a small share of the tramway's energy is provided by converting kinetic energy from braking (about 10%), thanks to technology integrated in the rectification substations (converting alternating current into direct current or traction current, necessary to move the rolling stock).

Figure 10. Photograph of the tramway.

Note: In homage to Auguste Perret's architectural style, the tramway is decorated with the typical motifs found in the architect's ornaments.
Source: Authors.

The city centre is located in the low-elevation part of the city, also known as the 'Ville basse' (Lower City). The tramway offers the possibility to link this Lower City with the Upper City via the Jenner Tunnel. The tunnel is 575 metres long and was built specifically for the tramway. The tunnel follows a slope of about 4% inclination. It was added to two other tunnels which serve motor traffic going both directions, including

buses. The new Jenner Tunnel was built to allow separating tramway and motor traffic, thus avoiding congestion. The photo below shows the three tunnels as well as part of the cliff, separating the Lower and Upper city.

Figure 11. Lower City entrance of the Tunnel Jenner.

Note : on the left handside are the two original entrances for motor traffic, the third entrance on the right is the tramway-dedicated tunnel.
Source: Google Maps, 2017.

The construction of the tramway line was a chance for the City of Le Havre to regenerate public space along the line "from façade to façade". As part of the project investment cost, most street elements were refurbished (see example figure below), thus increasing the quantity and quality of pedestrian infrastructure (pavement, crossings, safety railing, traffic lighting, low-mobility infrastructure) and cycling infrastructure (bicycle paths, secured bicycle parking) while reducing on-street parking. The works also embellished public space with plants, including grass between tramway tracks and a net increase in the number of trees with about 500 new individuals (1,500 trees uprooted for 2,000 trees planted).

Cycling paths were built along most of the tramway line where the infrastructure was limited (asphalt road painting) or non-existent (no cycling indication or path).

Figure 12. Photographs of a redesigned boulevard (Boulevard de Strasbourg) in 2008 and 2017.

On the left (2008): pre-tramway planning with one 4-lane carriageway, on-street parking, pavements, single two-way cycling path and additional carriageway and on-street parking separated by a line of trees. On the right (2017): two single lane carriageways separated by two tramway lanes, on-street parking, and cycling paths and pavements on the sides.
Source: Google Maps (2017).

2 ORIGIN AND HISTORY

2.1 BACKGROUND

The city of Le Havre has a long history with tramway systems, in line with the developing trend for this transport mode in France in the late 19th century. Le Havre thus opened its first line in 1874 in the midst of a period of economic expansion. After a break in its usage during the First World War, the rise of the private automobile caused the tramway to lose popularity. Le Havre's tramway was closed after the Second World War in 1951, to be replaced by a system of buses and trolleybuses.[35]

In 2003, Le Havre city hall's elected officials took the political decision to build the new tramway system to renew the city's image in line with current trends in France, to improve transport quality with modern equipment, to foster social cohesion with low-income populations, and to improve environmental performance of the public transport system. The project was placed under the responsibility of CODAH, who created a team tasked with managing the project under the name 'Mission Tramway'. The idea was further integrated in the Plan de Déplacements Urbains (PDU) published that year. The city already benefited from a bus system including two lines of articulated buses on main transport arteries of the city (on the current tramway's path), which interviewees and ex-ante studies noted were overcrowded.

Although the construction of a tramway system often represents a costly investment, according to interviews at the time of the creation of CODAH in 2001 it appeared that available budget made the project financially feasible. In 2003, Le Havre was one of the several other French mid-sized cities to consider this type of infrastructure. Bordeaux is another example of such cities, starting the operation of its tramway system in 2003. Interview respondents noted that the proximity and acquaintance between Le Havre and Bordeaux city officials had helped promote the idea of a tramway for Le Havre.

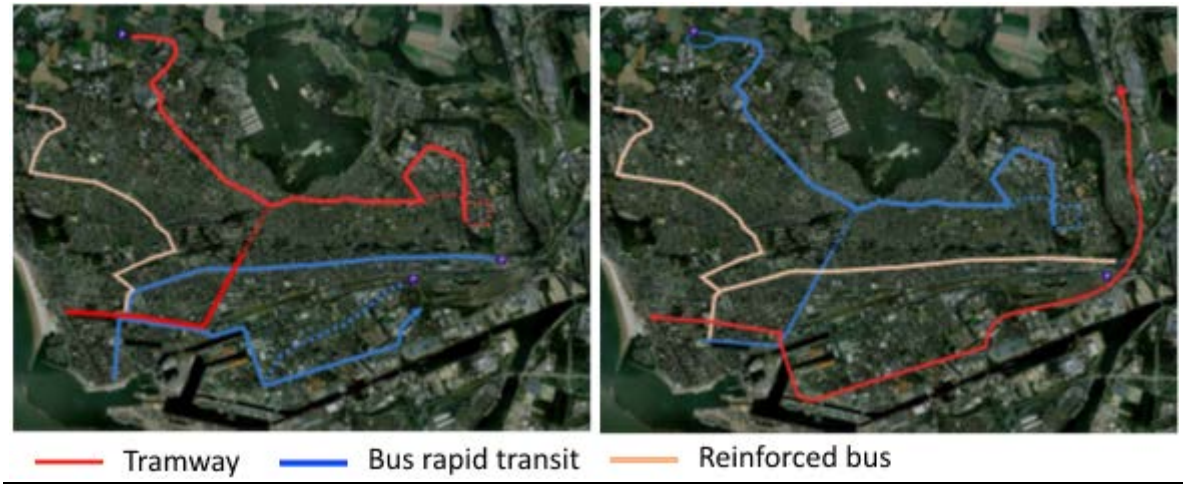
In 2005 and 2006, *ex-ante* studies assessed the feasibility and impacts of alternative two main options (options A and E; see maps below). **The option of a trolleybus was also discussed among elected officials but not preferred due to the political preference for a tramway**, and therefore excluded from the studies. The two options are described below but not in great detail, as the various sub-options were not in the end comprised in the *ex-ante* CBA nor the actual project (bus rapid transit and reinforced bus services), which only included the tramway line:[36]

- Option A: (1) a tramway using a route similar to finally chosen; (2) BRT services along the cliff and to the East of the city centre, in a redeveloping area of the old industrial quarters and (3) reinforced bus services to the North of Le Havre.
- Option E: (1) a BRT using a similar route as for option A, but taking a different route in its southernmost part; (2) a tramway line starting from the city centre and moving South and East through a redeveloping area of the old industrial quarters, then North to connect with a regional train line; (3) reinforced bus services along the cliff and to the North of Le Havre.

[35] Source: http://transporturbain.canalblog.com/pages/les-tramways-du-havre/28999261.html

[36] The BRT and reinforced bus services were created in 2018 following close to the same routes. Source: CODAH.

Figure 13. Maps of alternative options A and E.



Source: Foglia, L., Olivier, Y., Laurent, S., Attica. (2006). TCSP DE L'AGGLOMERATION HAVRAISE RAPPORT DE PHASE 2 : ETUDE DE FAISABILITE. Systra, Attica.

As the two options above show, the new transport services would either prioritise mobility in and between the city centre and low-income neighbourhoods (social and territorial cohesion), or support redevelopment of the South-Eastern areas of the city where new economic activities and housing were expected to develop.

Three transport mode options were considered together in 2005: tramway, bus rapid transit, and reinforced bus services. In the end, a tramway line opened in 2012, and in 2018 new bus rapid transit and reinforced bus services were implemented to further improve the service with available budgetary resources. The choice for a tramway to be developed first had been made long ago in favour of a tramway due to the better service and aesthetic it would provide. During interviews, different respondents indeed stated that "the client knew what they wanted". Studies weighed in favour of the tramway for the transport capacity it offered, the efficiency of the system, and its reduced environmental impacts.

One of the main technical issues to solve was the travel from Lower to Upper City characterised by higher elevation, and which had to be operated via a tunnel. The city first considered integrating the tramway to the existing tunnels hosting motorised and pedestrian traffic. In the end, however, the choice was made to build a new tunnel reserved for the tramway. This choice would avoid increasing congestion by mixing traffic, and risk causing further disruptions to transport flows during the construction phase.

In 2007, the option of a tramway over other technical options was voted unanimously by the City Council following *ex-ante* study findings and the original proposal. The studies supported the design of the system, however their influence on the decision to opt for a tramway appear rather limited.

The intention originating from the political class to build a tramway system was further supported in 2006 and 2007 with a **public concertation phase and communication campaigns**, informing the public and inviting citizens to engage and discuss around the project. Communication campaigns reached most media (informational videos, public film projections, leaflets, posters, newspaper articles, televised news segments), and also took form of local exhibitions in city halls and public buildings, and interactive public meetings. Furthermore, eight 'ambassadeurs tramway' (tramway ambassadors) were posted at the construction site and intervening in events during the works to inform citizens and answer their questions.

In 2007, the project incited interest from the population who were generally in favour. Some concerns were raised however regarding the cost of the investment, the impact on the city's architectural heritage, the price of tickets, and the impact on real estate prices. These were answered during open public meetings or via communication material.

In 2009, a year before the start of the works, the Préfecture (French State represented in the region) initiated a six-week Enquête d'Utilité Publique (Public Utility Inquiry) to gather opinions from Le Havre citizens. The inquiry ended in 2010 with the publication of the Déclaration d'Utilité Publique (Public Utility Declaration, DUP), concluding favourably on the project as proposed.[37]

The project went forward with construction in 2010. Disapproval from local citizens rose again during the works in 2011 and appeared in local media,[38] notably from the 'Association des riverains du tramway' (an association of local citizens) who demanded cancellation of the DUP.[39] Their concerns related to the aesthetic of the overhead cabling to be installed among the Auguste Perret buildings in the historical quarters of the city centre and on the beachside. Other local citizens further promoted the idea of grounded electrical power to minimise visual pollution; however as reported by CODAH and local experts during interviews, this option was judged too expensive and less flexible, and was known to have been technically challenging in other French cities.

Inhabitants of the city centre also raised concerns over possible increase in small crime (including degradation of the vehicles) due to the access to the system from lower income populations from the North and Eastern neighbourhoods of the city. As reported during interviews and in the media, this has to a large extent not been a significant issue and crime has seen a steep decreasing trend in the last ten years in Le Havre (for instance, local policy recorded 20 broken windows in public transport vehicles in 2016, compared to 400 in 2012).[40]

On 12 December 2012 at 12:12 P.M., the tramway line began operating fully in accordance with the project planning. The works were finalised in certain zones in the months which followed, and costs of the project rose steeply in order to meet the planning.

The tramway has now been operating for five years and has not received significant changes to its structure or functioning, nor are there plans to do so in the near future. However, according to CODAH, in 2018 and 2019 CODAH and LiA plan to introduce new bus lines with a high level of service or BRT.[41] These bus lines named "Chrono" improve existing lines by replacing their service with higher frequency, larger (articulated) buses with priority at stop lights. These improved services correspond to plans presented in *ex-ante* studies to the project discussed above in this section. According to a CODAH respondent, expansion of the tramway service to replace BRT is

[37] The Public Utility Declaration is a procedure established in France mandatory to all important infrastructure projects. The procedure aims to involve citizens in deciding whether the project should be implemented.

[38] Paris-Normandie, Le tramway du Havre fait un arrêt au tribunal. 14/01/2011 http://www.paris-normandie.fr/hemerotheque/le-tramway-du-havre-fait-un-arret-au-tribunal-421182-KYPN421182

[39] The association is no longer active and its members could not be contacted for this study.

[40] http://www.paris-normandie.fr/le-havre/au-havre-la-delinquance-enregistre-une-hausse-de-3-87-MN8294358

[41] CODAH. (2017). Du nouveau sur le réseau LiA en 2018. Retrieved from: http://www.codah.fr/actualite/des-nouveaut-s-sur-le-r-seau-lia-en-2018

not out of question. This remained highly hypothetical and would only occur provided financing and political backing become available.

2.2 FINANCING DECISION AND PROJECT IMPLEMENTATION

The project application for ERDF funding was prepared by Mission Tramway. Mission Tramway coordinated studies and presented the project to the Managing Authority, who gave approval and submitted the request for ERDF funding in October 2009. At the time, feasibility studies and cost-benefit analysis had been completed and the total investment cost of the project was expected to be EUR 332.99 million. The project owner however recalled that a revised budget of EUR 395 million was established afterwards in 2010 to include potential overshoots. Due to this budget not being confirmed in any document provided to the study authors, the original figure of EUR 333 million was kept.

The financing decision from the European Commission approving ERDF funding was signed in June 2010 for a maximum amount of EUR 52 million, representing 21% of the total eligible amount of the 2009 request, or EUR 249,450,000 calculated ex-ante. The final amount for the ERDF subsidy was finally set at EUR 10 million by the managing authority. Discussions with the project manager (CODAH), the managing authority and DG REGIO could not clarify the reason for this final decision, however it is likely that this decision was taken in order to allow funding for other eligible projects.

The total project cost calculated *ex-post* is of EUR 540 million (in 2017 present value) instead of the EUR 333 million (in 2009 present value) originally foreseen in the ex-ante studies, thus there is a considerable overshoot from the 2009 budget. As explained above, this overshoot can be explained due to having been made on incorrect assumptions in the ex-ante studies and additional costs occurring during project implementation and described below. On top of this cost, EUR 10 to 30 million are expected to come additionally depending on the outcome of litigation procedures with contractors in relation to payments for provision of services and goods.

To finance this cost, EUR 87 million originated from various financers, including the EU. This is presented below.

Table 2. External sources of funding for the project.

SOURCE OF THE FUNDING	AMOUNT (EUR)
ERDF	10 million
French State	48.1 million
Agence de Financement des Infrastructures de Transport de France (AFITF)	0.75 million
Normandy Region	10 million
Département Seine-Maritime	14 million

Source : Authors

The rest of the costs was financed via a loan from the EIB of about EUR 100 million, and the “versement transport” collected by CODAH (see box 3).

Construction met some unexpected issues. One construction worker died during the digging of the tunnel. A fire destroyed an important facility hosting IT systems which belonged to the construction contractor. Despite the inconvenience, work stations could be relocated with the help of CODAH and the fire did not lead to the loss of important files. Finally, a part of the construction site required additional investment

to stabilise platform foundations in at least two streets of Le Havre: one where an old main sewer was located (on the Boulevard de Strasbourg) and another (Avenue du Bois au Coq). **These issues and a number of other smaller unexpected issues altogether incurred additional costs to meet the project's schedule.** The amount of these costs could not be found or estimated by respondents.

From the financial stand point, the ex-post profitability of the project is negative. The Financial Net Present Value (NPV) on investment is EUR -581 million (at a discount rate of 4%, real), with an internal rate of return of -8.57%. Also, the Financial Net Present Value on capital is negative with the level of EUR -451 million and with the internal rate of return for capital of -12.12%. These negative values confirm that the project was in need of EU funding since no private investor would have been motivated to implement it without an appropriate financial incentive.

Box 3. Description of the versement transport.

The versement transport is a contribution by private or public employers in the form of a hypotheticated tax on the total gross salaries of all employees. Until 31st December 2015, the tax applied to organisations employing at least nine persons in the zone where this tax is located, and was raised to companies with eleven employees in 2016. The product of the versement transport is dedicated to financing public transport, both investment costs and operational costs.

Source: République Française. (n.d.). Versement transport. Retrieved from : https://www.service-public.fr/professionnels-entreprises/vosdroits/F31031

During the 30 months construction period (between March 2010 and December 2012, as stated above), the works caused disturbance to traffic in the city, impeded access to local shops, disfigured the streets and caused a peak in particulate pollution.[42] To compensate for these costs, the CODAH provided free bike rental to inhabitants and compensated some shops for income losses. Compensations to shopkeepers reached EUR 0.98 million for 171 requests made from over 80 different shops.

Digging the Jenner Tunnel represented an important share of the cost of the project with EUR 26 million invested to build the tunnel.

2.3 CURRENT PERFORMANCE AND OTHER INVESTMENT NEEDS

Since entry into service of the tramway line, **Le Havre public transport users have expressed their perceived improvement in the service in yearly user satisfaction surveys (available since 2013), and appreciate better the tramway system than the alternative bus system.** Data and results from user satisfaction surveys are presented in several figures in section 3.

The number of trips is presented in detail in the figure below aggregated per year, also compared with bus trips.[43] Since 2009 (before the tramway and disruption from construction) and until 2017, **overall public transport services have experienced an increase in traffic of 20%.** This increase is largely attributed to the tramway service, which captured the larger share of traffic (according to respondents), but also in part to the redistribution of the bus services.

As reported during interviews, the first tramway line of Le Havre very quickly attracted a new customer base using the new transportation system. Persons with reduced

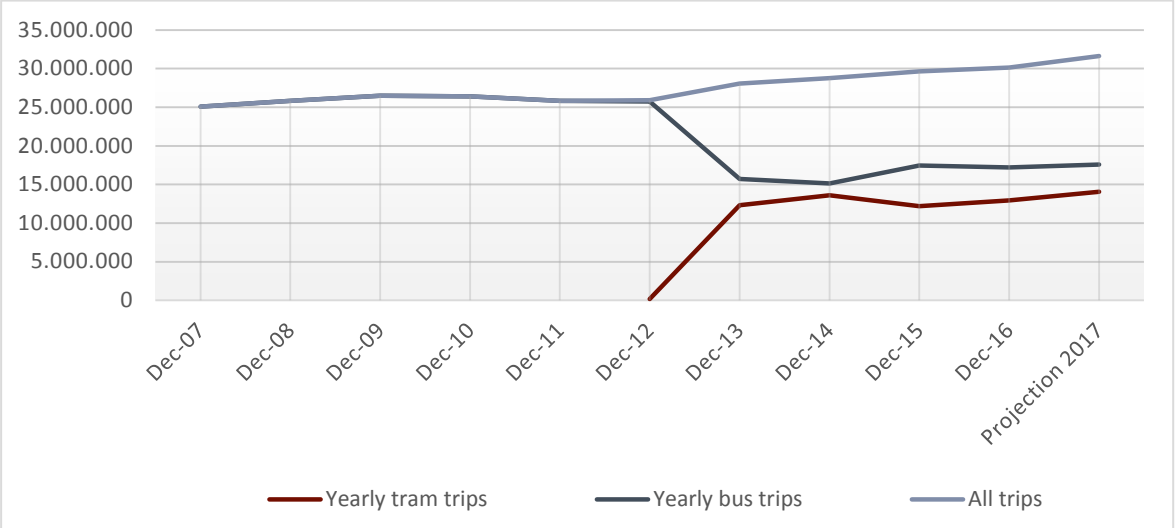
[42] AtmoNormandie (2012), Bilan 2011.

[43] Note that, due to the combined ticketing system allowing for intermodal travel and connections between bus and tram, it is difficult to precisely attribute the shares of trips between the tramway and the bus. Consequently, the transport operator assumed a split based on the share of ticket validations on board tramways.

mobility, including the elderly and persons with handicaps significantly gained from the new tramway system due to its improved access infrastructure (low-floor wagons, access ramps at tramway stops, ticket machines at low height).

Since 2013 (first full year of service), **the number of tramway trips has been increasing at an annual average rate of about 3%.** The average number of daily trips has progressed from 33,764 in 2013 to 38,461 projected in 2017.[44] **Despite the clear increase, this remains below the ex-ante expectation** of 56,000 daily trips.

Figure 14. Yearly tramway and bus trips between December 2007 and until December 2016, with projections for 2017.

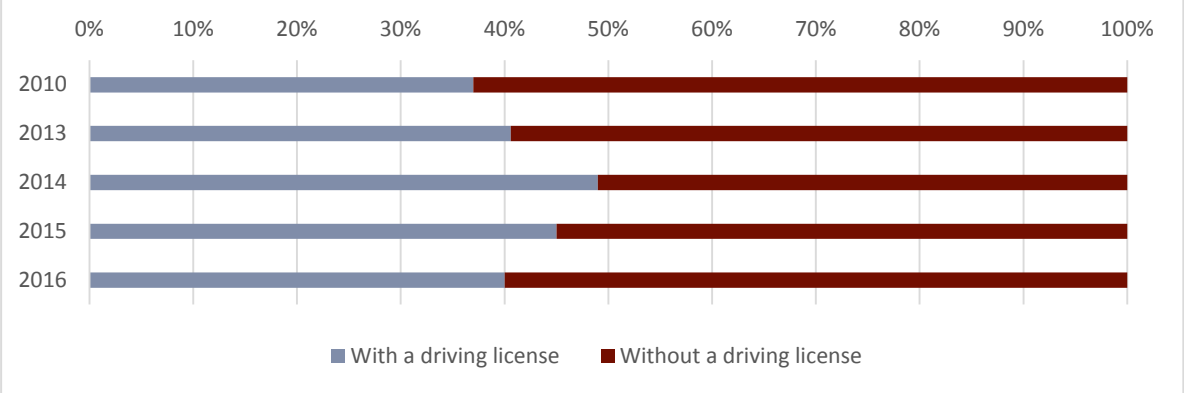


Source: LiA (2017).

Assessing the modal shift from the new tramway is difficult in absence of a specific study on travel habits. As respondents suggested, **the difficulty for the tramway to create a modal shift from the private car to the tramway is likely to be the reason behind underperformance**, together with overestimation of the system's potential. Indeed, user satisfaction surveys point towards the fact that only a small share of tramway users has access to another means of transportation: between 2007 and 2016, the share of public transport users who had a driving license oscillated between 37% and 50% (see figure below). Furthermore, LiA user satisfaction surveys show that in 2015 and 2016, 70-75% of respondents did not have an individual alternative (motorised) mode of transport. These results however do not clearly indicate a change in the types of public transport users and whether the share of car drivers has increased.

[44] Computed based on yearly trips (total number of trips divided by 365). Email exchanges with the transport operator however indicate that on a Winter day outside of week-ends and holidays in 2017, passenger traffic can reach 45,000 travellers.

Figure 15. Shares of public transport users (bus and tramway) with and without a driving license across 5 different years, based on representative samples of about 800 users.



Source: LiA user satisfaction surveys.

The tramway has allowed a complete redesign of streets on its route, improving the aesthetic of the city and quality of life of citizens. These were perceived by most respondents as an improvement: pavements were rebuilt, cyclists benefit from more and better infrastructure, streets appear more open. Overall, travel by public transport in Le Havre has become easier and more pleasant thanks to the new type of vehicle (tramway). Some respondents also thought the streets felt safer from traffic accidents, thanks to clearer signalisation. This is however not concludingly corroborated in the accident data analysed in section 3.

It is worth mentioning that in 2018, Le Havre's local urban planning agency AURH is scheduling to conduct a study observing the effects of the tramway. This study was planned for 2017 but delayed. In addition, a survey on household trips is also planned in 2018, which will shed light on the motives for mobility of CODAH citizens. In the future, these studies will further inform the analysis of the impacts and success of the project.

In 2018 and 2019, bus rapid transit and improved bus services will be introduced (as mentioned at the end of section 2.1) and are expected to continue structuring and improving public transport offer. These developments may provide further incentive to use the services and reduce private car usage, thus improving the tramway's performance.

3 DESCRIPTION OF LONG-TERM EFFECTS

3.1 KEY FINDINGS

The long-term contribution of this project is considered under the following four main categories: economic development, quality of life and well-being, environmental sustainability and distributional effects.

The **economic growth** aspect includes the quantifiable benefits derived from faster means of transport within Le Havre, increasing the accessibility of the districts which were originally connected by bus and road transport only. These effects are incorporated in the CBA in the form of travel time savings as well as vehicle operating costs savings.

Under the heading of **social well-being and quality of life** safety is considered together with effects related to the noise level.

Among the **environmental sustainability effects**, reduction of air pollution and greenhouse gas emissions are considered in the CBA.

As for the **distributional effects**, a positive effect on territorial cohesion is visible with the network extension and associated development of adjacent districts. Also, the project facilitated the accessibility of elderly and disable people to public transport services.

The results of the Cost-Benefit Analysis, as included in the Annex II to this report indicate that the **project's measurable benefits** fall short of the costs from a socio-economic point of view.

In the analysis, the Socio-Economic Net Present Value (ENPV) equals EUR -498 million, whereas the Economic Internal Rate of Return is at the level of -6.29% with the applied discount rates of 2.55% backwards and 3.30% forwards, referring to the time of completion of the project.

The risk assessment shows that the expected value of the ENPV is equal to EUR -462.2 million, and that the expected value of the ERR is -5.4% as in the reference case. The probability that the ENPV will become positive and that the ERR will be higher that the SDR adopted in the analysis is almost nil. However, there is nearly 45% and 40% probability that respectively the ENPV and the ERR assume a higher value than in the reference case. However, overall these results show that the project yields negative socio-economic net benefits.

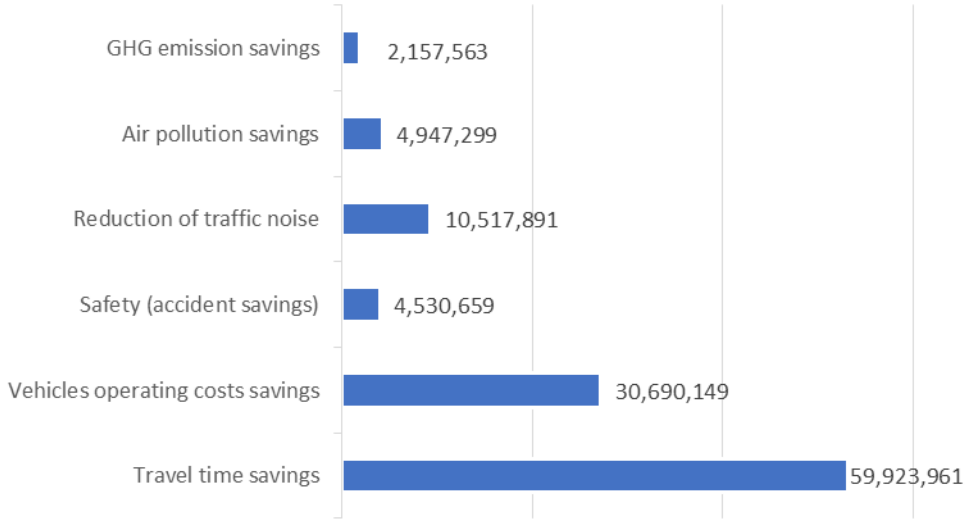
At the time of this study, the project has been in place for five years and most positive effects already materialised and can be observed while others continue to unfold. The tramway has had immediate effects related to quality of life, with 'façade-to-façade' renovations bringing aesthetic value to the city and facilitating travel. However, the socio-economic context of Le Havre, characterised by declining population trends and relatively high and rising unemployment, affects the overall positive performance of the project. The introduction of the tramway system alone is unlikely to change this dynamic on its own. Societal change and reversal of these trends may only occur after several more years development of the city, to which the tramway certainly already contributes but is difficult to measure. The tramway should be seen in the context of a broader development policy, as CODAH and Le Havre municipality are organising new projects around the tramway line. These projects include new housing, leisure and

recreational facilities, and redevelopment of public space and of other areas to attract investments, visitors and inhabitants.[45]

It is also important to note that **the quantitative indicators used in the CBA only partly reflect the socio-economic effects of the project**. There are intangible long-term contributions that, although observable in an ex-post perspective, may be **difficult to translate in monetary terms**, such as aesthetic improvements, reduction of crowding, and synergies with recent urban developments. Although they are expected to be ancillary to effects accounted for in the CBA, they may be relevant particularly with respect to a comprehensive understanding of the mechanisms of change. For this reason, together with the CBA providing the main measure of the projects' long-term effects, **qualitative assessment is used to include also such additional aspects**. This mix is particularly appropriate, because it allows adopting a wide perspective in assessing long-term effects, while sticking to a prudent approach based on hard facts.

The distribution of measurable benefits in the CBA is presented in the figure below.

Figure 16. Main socioeconomic benefits (% on the total benefits)



Source :Authors

In addition to these measurable impacts, as mentioned, there are also other effects difficult to be captured in monetary terms, but relevant for the comprehensive assessment of the project, which are discussed in the following sub-chapters.

The table below summarises the nature and strength of the project's effects classified under the above referred four categories (economic growth, quality of life and well-being, environmental sustainability and distributional issues), as well as the territorial levels where these are visible, and the time-horizon of their materialisation.

Table 3. Evaluation scores on project's non-monetary effects (the effects highlighted in green are those included in the ex-post CBA)

CATEGORY	EFFECT	STRENGTH*	LEVEL
Economic growth	Travel time	+4	Local – regional
	Vehicle operating costs	+4	Local – regional

[45] Le Havre City Hall. (2018). *Les Grands Projets.* Retrieved from: https://www.lehavre.fr/ma-ville/les-grands-projets

CATEGORY	EFFECT	STRENGTH*	LEVEL
	Reliability	+3	Local – regional
	Income for the service provider	0	Local – regional
	Wider economic impacts	0	Local – regional
	Institutional learning	+4	Local – regional
Quality of life and well-being	Safety	+3	Local – regional
	Crowding	+3	Local – regional
	Service quality	+5	Local – regional
	Security	0	Local – regional
	Noise	+3	Local
	Aesthetic value	+3	Local
	Urban renewal	+3	Local
Environmental sustainability	Local air pollution	+3	Local
	Greenhouse gases (climate change)	+2	Global
	Biodiversity	N.R.	Local – regional
	Water pollution	N.R.	Local – regional
Distributional issues	Social cohesion	+4	Local – regional
	Territorial cohesion	0	Local – regional

*Note: * the strength score reflects the weight that each effect has with respect to the final judgment of the project. In particular:*
-5 = the effect is responsible of the negative performance of the project;
-4 = the effect has provided a negative contribution to the overall performance of the project;
-3 = the effect has contributed in a negative way to the performance but it was outweighed by other positive effects;
-2 = the effect has a slightly negative contribution to the project performance;
-1 = the effect is negative but almost negligible within the overall project performance;
0 = the effect has no impact on the project performance;
+1= the effect is positive but almost negligible within the overall project performance;
+2 = the effect has a slightly positive contribution to the project performance;
+3 = the effect has contributed in a positive way to the performance but it was outweighed by other positive effects;
+4 = the effect has provided a positive contribution to the overall performance of the project;
+5 = the effect is responsible of the positive performance of the project;
N.R. = The effect is not relevant for the specific project;
No data = The effect is potentially relevant, but no evidence on impacts is available. This shall be used only for relatively low significant effects whose inclusion would in no case dramatically affect the overall assessment.

3.2 EFFECTS RELATED TO ECONOMIC GROWTH

Measurable effects

Economic effects for users of public transport services can be evaluated in terms of **travel time savings** for users that either formerly used slower means of transportation or did not have access to means of transportation. This is usually one of the most important benefits accruing thanks to the construction of new, or improvement of, existing transport infrastructures. The quantification of this benefit relies on observed time reductions and predicted time reductions and by multiplying an appropriate unitary value of time with those time savings.

The commercial speed of the tramway was 18.64 km/h in 2016, compared to 17.76 km/h for standard urban buses. Based on a study from the ERRAC and UITP from 2009, this is in line with average commercial speeds for tramways in France (18 km/h) but below EU-15 average of 22.76 km/h. On average, travel time savings resulting from the project are 2.1 minutes for former bus users. Former car users gained 1.05

minutes in travel time, as did new users attracted by the project.[46] This effect amounts to EUR 60 million in monetised benefits, which represents 53.1% of total benefits.

Vehicle operating costs are defined as the costs borne by the owners of road vehicles to operate them[47] and depend on the type of vehicle, travel speed and characteristics of roads such as design standards and surface conditions. These costs are calculated for urban public transport projects, such as tramway systems, as these investments can divert passengers from road who will benefit from not operating their vehicles any longer. For Le Havre's tramway line, vehicle operating costs amount to EUR 30.7 million, and thus represent 27.2% of the project's benefits.

Non-measurable effects

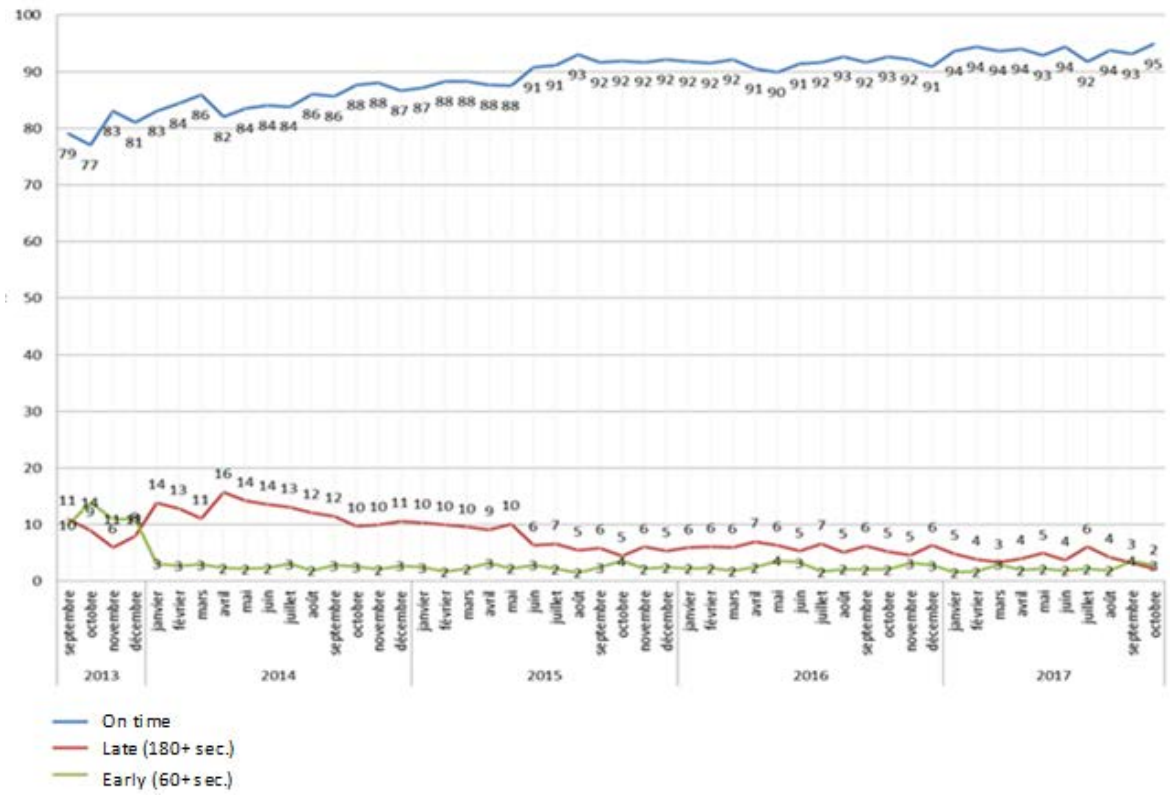
The tramway also offers frequent and **reliable service**. Tramways run every 4 or 8 minutes, depending on the period of day. In 2016, users rated its reliability 8.3 / 10 and its punctuality 8.5 /10 compared to 7.5 / 10 and 6.9 / 10 for buses. However, interviews with respondents note the relative ease for vehicles to circulate in Le Havre both before the project and after. Respondents reported that congestion was relatively rare and does not tend to influence reliability of road traffic (including buses) and travel time.

The graph below shows how the tramway's punctuality has consistently improved after a period of relatively high share of delayed service between September 2013 and June 2015.

[46] Figures come from the ex-ante (2006) feasibility using traffic modelling at the time. This is further explained in Annex II. No traffic model could be used to test these assumptions ex-post, however interviews with local experts indicate that the tramway is performing as expected.

[47] VOCs include, among others, wages of drivers, fuel consumption, lubricants consumption, tires deterioration, repair and maintenance costs, insurance, overheads, and so on. See European Commission's Guide to Cost-Benefit Analysis of Investment Projects (2014; p. 94) for details.

Figure 17. Evolution of the tramway service's punctuality between September 2013 until October 2017 in percentages.



Source: LiA (2017).

As mentioned earlier the tramway increased the number of trips in the public transport system. This effect leads to incremental **income for the service provider**. As is normal for public transport providers, the ticket revenues only cover a small share of the actual costs of the system. Le Havre tramway is thus also subsidized from CODAH in order to balance the budget. In addition, as is common in France, the system is also financed by the 'versement transport' (see Box 3 above). To avoid double counting with possible other already considered economic benefits (such as VoC or VoT) that may be reflected in the income value the income has not been considered in the economic analysis as suggested in the First Interim Report.

With regard to **wider economic impacts** two different effects can be observed. Firstly, the project had effects on employment to a limited extent. Documentation on the project suggests that the construction of the tramway systems has allowed to employ 900 to 1,800 people, relative to the period of the works.[48] Also, as a result of the project, the transport operator has durably increased the number of employees by 40 new persons, from 565 in 2011 to 605 in 2013 (according to LiA respondent). In addition, the project has allowed 32 contracts of professional insertion (diploma and job) to materialise from the construction works, following a trial period. These contracts were brokered by CODAH and with the construction contractors directly, facilitating the entrance into various professions of young graduates or unemployed persons. In line with the First Interim Report, however, those effects represent a cost in the economic analysis (i.e. it reflects the 'use' of a resource). Employment effects are captured by a CBA through the use of shadow wages. The shadow wages still represent a cost, but as long as it is lower than the market wage, it implicitly includes an employment benefit in the form of a social cost lower than financial cost.

[48] CODAH, 2012. Le tramway de l'agglomeration havraise. Rivages Communication.

Secondly, the tramway has improved accessibility within the city of Le Havre for a number of locations of economic activity. This includes a hospital, shops and restaurants, and places for leisure (swimming pools, sports centres, etc.). This effect could not be measured, and no studies have been conducted to further investigate this effect. Discussions with stakeholders have supported the conclusion that the tramway has so far not materialised into economic gains for the city in terms of employment or local revenues. Anecdotal examples from stakeholder interviews indicate that some shops have lost significant clientele after the start of the tramway service while others gained or did not experience significant change (despite being geographically proximate). Correlation between the setting up of the tramway and changes to economic activity was made by respondents but could not be corroborated with further data.

The reduction in number of on-street parking space has raised some disapproval among the population still using their car to travel in Le Havre. This issue may affect shops in certain areas of the city centre both for potential customers and for delivery of goods.

Institutional learning was noted by several respondents from CODAH, Le Havre City Hall, and the transport operator as having been a particularly important benefit of the project. The City of Le Havre and CODAH's services, in particular, were able to gain experience and professionalise their practices in terms of managing public concertation and consultation processes, organising land acquisitions, digitalising information systems, conducting tendering procedures, and streamlining decision-making processes. Furthermore, the tramway project improved CODAH's ability to design and implement urban mobility and development policies towards a better inclusion of persons with handicaps and reduced mobility, and of 'soft' mobility modes.

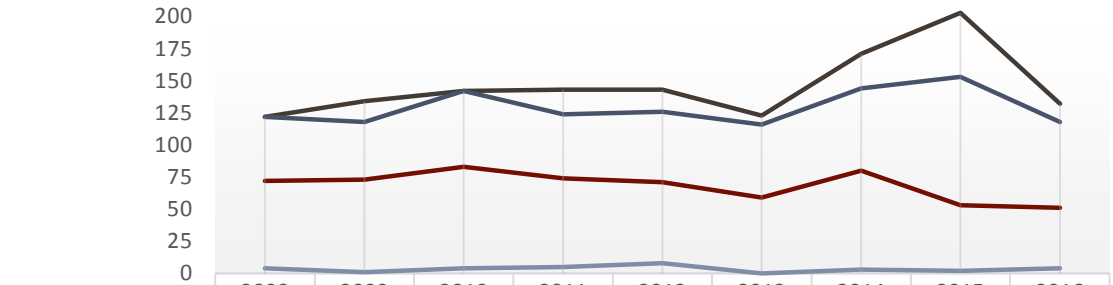
For the transport operator, the implementation of the new form of service has also led to professionalisation of transport services. Employees were trained to new sets of skills, and overall the modernity of the tramway service helped drive upwards the quality of the service with regards to information to passengers, driving behaviour, and ticket controls. The project was indeed followed by digitization of services, driver training and spill-over effects on bus driving, and less sanctionary approaches to ticket control (more 'commercial', as stated by a LiA respondent).

3.3 EFFECTS ON QUALITY OF LIFE AND WELL-BEING

Measurable effects

All transport activities, by their nature, imply a risk for users of suffering an accident. New infrastructures, or their improvements, are expected to reduce accident rates. As shown in the figure below, **traffic safety** in Le Havre does not appear to have improved or might have worsened.

Figure 18. Statistics on outcomes of accidents between 2008[49] and 2016, in terms of number of killed, hospitalised, lightly injured, and unharmed victims.



	2008	2009	2010	2011	2012	2013	2014	2015	2016
Killed	4	1	4	5	8	0	3	2	4
Hospitalised	72	73	83	74	71	59	80	53	51
Lightly injured	122	134	142	143	143	123	171	203	132
Unharmed	122	118	142	124	126	116	144	153	118

Note: 'Hospitalised' means that the victim stayed in hospital for over 24 hours, 'Lightly injured' means no hospital stay or under 24 hours. Source: Authors, based on Transport Safety Service of the Département Seine-Maritime (2017), using local police data.

However, when looking at averages Table 4 indicates a higher average number of persons killed and hospitalised, and slightly more accidents in the period prior to the tramway and comprising construction (2008-2012) than in the period of operation (2013-2016). Consequently, it is possible to say that traffic safety in Le Havre has slightly improved in the period when the tramway was in operation.

Table 4. Statistics on outcomes of accidents and total number of accidents, clustered between two periods before and after the entry into service of the tramway.

AVERAGE DURING PERIOD	KILLED	HOSPITALISED	LIGHTLY INJURED	UNHARMED	TOTAL NUMBER OF ACCIDENTS
2008-2012 (5 years)	4.4	74.6	136.8	126.4	178.2
2013-2016 (4 years)	2.25	60.75	157.25	132.75	173.5

Note: 'Hospitalised' means that the victim stayed in hospital for over 24 hours, 'Lightly injured' means no hospital stay or under 24 hours. Source: Authors, based on Transport Safety Service of the Département Source : Seine-Maritime (2017), using local police data.

As the data is aggregated for the city as a whole, it is difficult to attribute any effects directly to the tramway. However, in line with the First Interim Report, the safety effect has been calculated based on the number of reduced kilometres from tramway users that have been using private cars or buses before. This effect accounts for EUR 4.5 million in total and thus represents 4% of the total socio-economic benefits.

Another effect included in the ex-post CBA is the reduction of **noise**, which amounts to EUR 10.5 million and thus 9.3% of the total economic benefits. Based on field visit and interviews, the noise of tramways can be said to be relatively low. Some disturbance was however noted on one segment of the line where the tramway passes

[49] Although our period of analysis is 2009 to 2017, here we present 2008 data because it allows to observe accident trends over a longer period.

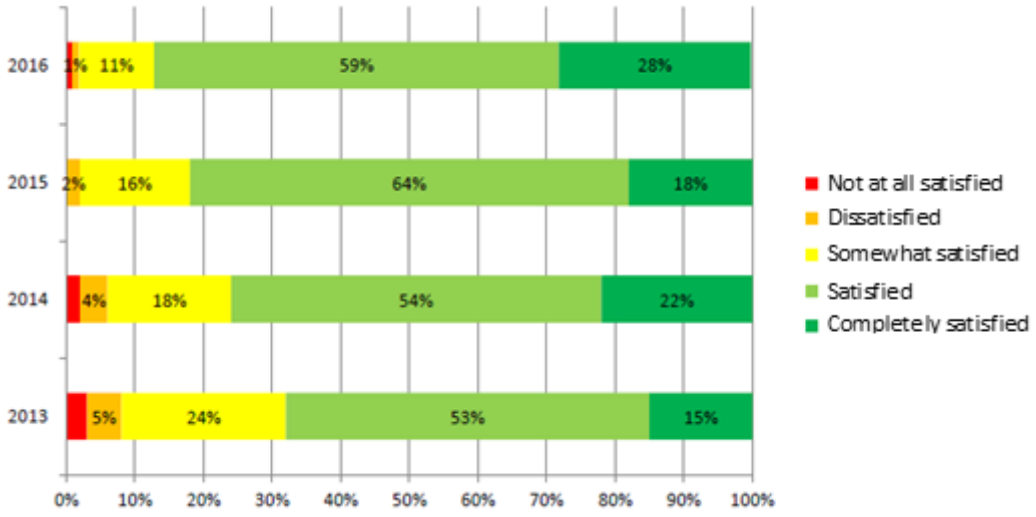
through the Boulevard de Strasbourg, where noise and vibration are more prominent and cause some concern for local residents. Other noise produced by the tramway (e.g. breaking, turning) is limited thanks to regular oiling of the tracks and driver training, teaching drivers about what speed to approach turns in order to avoid noise from wheels grinding along the tracks. The noise of the tramway's bell remains a necessary disturbance for traffic safety, nevertheless some inhabitants have voiced complaints about it.

Non-measurable effects

A reduction of **crowding** in public transport is mainly relevant for projects that provide significant additional capacity in public transport. Although this could not be measured quantitatively in case of Le Havre tramway, the respondents commented during interviews that articulated buses operating along the current tramway route were overcrowded.[50] The tramway was suggested to have eased crowding thanks to the higher capacity of the vehicles and the higher frequency of the service.

The overall **service quality** refers mainly to the availability of specific service features increasing the journey comfort, e.g. smoother movement of the vehicles, more comfortable seats. The overall **quality improvement of the transport services** is reflected in user satisfaction surveys, which clearly show an upward trend over time in the shares of 'satisfied' to 'completely satisfied' users, compared to the 'somewhat' to 'not at all'. Unfortunately, data does not exist prior to the tramway's installation, therefore the data only speaks for improvement over the period after the tramway came into service.

Figure 19. Transport users' (bus and tramway) overall satisfaction with transport services each year between 2013-2016.

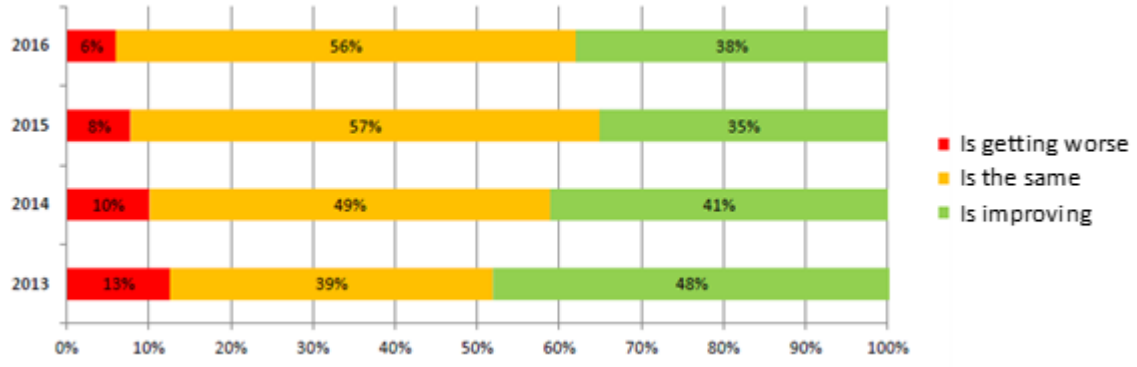


Source: LiA user satisfaction survey report 2016.

The figure below also shows users' perceived improvement of the quality of service since 2013, showing that a large part of users saw an improvement in the quality of service after the entry into service of the tramway line.

[50] This is also corroborated in *ex-ante* studies.

Figure 20. Transport users' (bus and tramway) perception of the improvement of the quality of service each year between 2013-2016.



Source: LiA user satisfaction survey report 2016.

More specifically, service quality is shown to have improved with regard to multiple aspects of the services. A first point is the **comfort of travel** offered by tramway trips: the tramway tends to be a more comfortable vehicle as stated by users in 2016 who rated the tramway 8.2 / 10 in terms of comfort and 8.2 / 10 in terms of driving comfort, compared to 7.7 / 10 and 7.0 / 10 respectively for buses. The tramway indeed circulates on its own lane, reducing the number of stops due to other traffic, and making transport smoother. The vehicles are also more stable than buses for standing passengers (less movement and smoother braking), and more seats are available per vehicle allowing more people to sit. Based on field experience, it can be confirmed that the vehicles offer comfortable seating.

The introduction of the tramway also gave the opportunity to the transport operator to overhaul and modernise electronic systems and passenger information services. In 2012 LiA introduced **electronic ticketing** and later on, internet purchase. On the side of users, these improvements increased ease of travel by facilitating ticket purchase. For LiA, this also enabled better tracking of passenger data and collect figures on number of trips. These new systems however met some technical issues at their implementation, and only became functional in 2013.

Information to passengers substantially improved also with the availability of real-time information about the network, accessible at stops and via a smartphone application. Via the application, users can consult itineraries, deviated bus traffic, fares, locate shops and activities within 500 metres from a station, etc.

Regarding **security** of travellers no changes have been carried by the project.

Aesthetic value has improved significantly in Le Havre thanks to façade-to-façade restauration of the streets, planting of new trees, modern traffic infrastructure, and a tramway designed to integrate into Le Havre's UNESCO World Heritage Perret architecture. One downside of the project has been, for some citizens, the visual aspect of overhead cabling. This concern was only expressed *ex-ante* and was not met again in reviewing recent press or during interviews for this study. Overall, the project has overall provided improved aesthetic value to the city.

Urban renewal refers to the spill over effects of urban transport projects on residents (not necessarily users of the project) due to an improved local context. **Real estate price** can typically indicate an improvement in local context. Data for Le Havre is presented in Table 5 below.

Table 5. Total yearly average price of houses and average yearly sales price per square metre of apartments in Le Havre per year between 2009-2016.

	2009	2010	2011	2012	2013	2014	2015	2016
	Houses in neighbourhoods with tram stop							
Average sales price	170,863	192,501	176,943	173,855	167,995	161,208	165,577	165,057
Difference from previous		11.2%	-8.8%	-1.8%	-3.5%	-4.2%	2.6%	-0.3%
Cumulative difference		11.2%	2.4%	0.7%	-2.8%	-7.0%	-4.4%	-4.7%
	Houses in neighbourhoods without tram stop							
Average sales price	165,148	177,500	171,656	174,185	178,781	151,684	160,971	166,876
Difference from previous		7.0%	-3.4%	1.5%	2.6%	-17.9%	5.8%	3.5%
Cumulative difference		7.0%	3.6%	5.0%	7.6%	-10.3%	-4.5%	-1.0%
	Apartments in neighbourhoods with tram stop							
Average sales price per m^2	1,739	1,890	2,057	1,966	1,922	1,795	1,622	1,636
Difference from previous		8.0%	8.1%	-4.6%	-2.3%	-7.1%	-10.7%	0.9%
Cumulative difference		8.0%	16.1%	11.5%	9.2%	2.1%	-8.6%	-7.7%
	Apartments in neighbourhoods without tram stop							
Average sales price	1,468	1,600	1,752	1,750	1,418	1,496	1,342	1,341
Difference from previous		8.3%	8.7%	-0.1%	-23.5%	5.3%	-11.5%	0.0%
Cumulative difference		8.3%	16.9%	16.8%	-6.6%	-1.4%	-12.9%	-12.9%

Source: Authors, based on AURH (2017).

The table does not allow to identify a clear trend. Interview with a real estate agent did not confirm that the tramway had impacted the price of real estate in Le Havre. Instead, the numbers more likely reflect general trends of the French housing market and socio-economic context in Le Havre. The issue of noise and vibrations on the Boulevard de Strasbourg was however noted as an issue making housing sales slower and more difficult on that part of the tramway line.

3.4 EFFECTS ON THE ENVIRONMENTAL SUSTAINABILITY

Measurable effects

Effects from the project on **local air pollution** and **GHG emissions** have been assessed on the basis of its contribution to the reduction of road traffic. These effects are incorporated in the CBA and constitute, respectively, 4.4% and 1.9% (EUR 4.9 million and EUR 2.2 million each) of total socio-economic benefits.

It is certain that the tramway has reduced atmospheric pollutants on the tramway line, where large (articulated) buses used to transit. A key temporary impact is however noted in the regional air quality agency AtmoNormandie's (previously Air Normand) 2011 report, where a spike in particulate matters and nitrogen dioxide was

recorded at some stations near the construction works for the tramway. That year, particulate emissions exceeded European guidelines.[51]

The tramway is operated with electricity coming from the general grid in France while buses run on diesel. France is one of the leading IEA countries when it comes to a low-carbon energy mix[52]. Only 47% of energy came from fossil fuels in 2015, thanks to the large share of nuclear energy, which made up 46% in the energy mix and 78% of electricity generation, the highest share worldwide. Additionally, a small share of the tramway's energy is provided by converting kinetic energy from braking (about 10%), thanks to technology integrated in the rectification substations (converting alternating current into direct current or traction current, necessary to move the rolling stock).

Non-measurable effects

The project has no direct effects on **biodiversity** and water **pollution**.

3.5 EFFECTS RELATED TO DISTRIBUTIONAL ISSUES

These effects encompass the allocation project's impacts over different groups of the population (social cohesion) and between the local area of the project and its periphery (territorial cohesion).

From a **social cohesion** perspective, the tramway project has provided a new and modern means of public transport to a large part of its population: over 50% of Le Havre's population lives within 500 metres from a tramway stop.[53]

Le Havre's low-income populations located close to the far North and East stations of the tramway line are key beneficiaries of the project. Interview respondents commented several times on the easier access to the beach offered to "kids who had never been to the beach" by the direct tramway line, despite living less than ten kilometres away.

There is currently no quantitative data about the socio-economic background of the tramway users. However, field visit has allowed the national expert to observe the very important diversity of passengers: men and women, including mothers with strollers, elderly people, persons in a wheelchair, school children. From these basic observations it also seemed that passengers represented the diversity of ethnic backgrounds found in Le Havre. This has been reported by respondents as an overall success of the project. The concrete effects of improved access and mobility are not sufficiently known to draw conclusions.

Territorial cohesion seems to have somewhat improved as a result of the tramway project. As reported by respondents and in user satisfaction surveys, LiA transport services are used at more than 70-80% by inhabitants of Le Havre rather than other CODAH municipalities or other areas. User satisfaction surveys for 2014-2016 show that the share of users from Le Havre seems to have increased from 70% to over 80% since 2014. This finding may be attributed to the methods or sample of respondents, comprised of over 800 people surveyed in person on board buses and tramways and by phone.

Discussions with a few respondents who did not live in Le Havre have highlighted that the tramway mostly did not change their travel habits. Interviewed inhabitants used to

[51] Air Normand, 2012. Bilan 2011.

[52] https://www.iea.org/publications/freepublications/publication/Energy_Policies_of_IEA_Countries_France_2016_Review.pdf

[53] Calculated by the authors, based on geolocated data from AURH.

travelling outwards for commuting also preferred using the car. Overall, car travel still dominates their travel habits due to being faster and more convenient for longer trips between the city and its surrounding municipalities.

3.6 TIME-SCALE AND NATURE OF THE EFFECTS

The tramway system started operating in December 2012, therefore the discussed observed effects materialised in the short-run. With reference to the spatial scale of the effects all of them are of local nature. The effects on economic growth are positive in relation to transport effects and institutional learning. With the implementation of new projects in Le Havre, the city may be seeing a positive contribution of the tramway to employment trends and other economic indicators in the future. Quality of life and well-being benefits have already materialised with more comfortable and modern public transport services, and more pleasant urban environment. Furthermore, the environmental sustainability effect resulting from GHG emission reduction and reduced local air pollution contributes in a positive way to the global effect.

Table 6. Temporal dynamics of the effects

CATEGORY	SHORT RUN (1-5 YEARS)	LONG RUN (6-10 YEARS)	FUTURE YEARS	COMMENT
Economic growth	**+/-**	**+**	**++**	**Some time savings, improved vehicle operating costs, improved reliability; positive experience for organisations involved in terms of governance and learning**
Quality of life and well-being	++	++	++	High satisfaction from tramway users related to service quality and comfort of travel; improved aesthetic value of the city thanks to urban renewal, but mixed results on real estate price indicators.
Environmental sustainability	+	+	+	Positive reduction of local air pollution and GHG emissions in spite of works-related emissions during construction; no impact on biodiversity or water pollution.
Distributional issues	++	++	++	Improved accessibility to modern public transport to low-income neighbourhoods; but no change to car drivers and people living outside of Le Havre.

Note: + = slight positive, ++ = positive, +++ = strongly positive, +/- = mixed effect.

4 MECHANISMS AND DETERMINANTS OF THE OBSERVED PERFORMANCE

In this section the key mechanisms and determinants of the long-term effects discussed in the previous chapter are illustrated and discussed along the different phases of the project cycle. Finally, the importance of each determinant for the project's final performance and the interplay between them and the observed outcomes is discussed.

Table 7. Determinants of project outcomes

DETERMINANT	STRENGTH*
Relation with the context	-1
Selection process	-2
Project design	+5
Forecasting capacity	-3
Project governance	+4
Managerial capacity	+3

*Note: * the strength score reflects the weight of the role that each determinant played with respect to the final judgment of the project. In particular:*
-5 = the determinant is responsible of the negative performance of the project;
-4 = the determinant provides a negative contribution to the overall performance of the project;
-3 = the determinant contributes in a moderate negative way to the overall performance of the project;
-2 = the determinant has a slightly negative contribution to the project performance;
-1 = the determinant plays a negative but almost negligible role to explain the overall project performance;
0 = the determinant does not play a role on the project performance;
+1= the determinant plays a positive but almost negligible role to explain the overall project performance;
+2 = the determinant has a slightly positive contribution to the project performance;
+3 = the determinant contributes in a moderate positive way to the performance;
+4 = the determinant provides a positive contribution to the overall performance of the project;
+5 = the determinant is responsible of the positive performance of the project.

4.1 RELATION WITH THE CONTEXT

The tramway project came at a period at which the city had had a negative image due to its decline in the 1970-80's. Since then, a policy (which is still ongoing) to make citizens 'fiers d'être Havrais' (proud to be from Le Havre) has led to efforts to renovate the city. **The tramway line thus aimed to contribute to urban renewal in Le Havre** and to the city's broader objectives of social cohesion, mobility and environmental performance.

Urban renewal is still ongoing with a number of projects in planning which integrate or develop around the new tramway line. These projects include new housing, leisure and recreational facilities, and redevelopment of public space and of other areas to attract investments, visitors and inhabitants.[54] In this sense, the tramway has truly become a structuring element of the city's urban development policy, as it was aimed to be.

This urban renewal policy was broadly welcome by local populations, and the tramway also benefited from mostly encouraging feedback from the population who agreed on the positive impact it would have, and indeed has today in terms of improved city aesthetics and mobility.

[54] Le Havre City Hall. (2018). *Les Grands Projets.* Retrieved from: https://www.lehavre.fr/ma-ville/les-grands-projets

Box 4. Le Havre's 500 years festivities.

Photograph of "500 years" banner on Le Havre's City Hall.

In the Summer of 2017, Le Havre celebrated its 500 years of existence with a events which attracted over 2 million visitors, of which about 25% had never been to Le Havre (double from 2016). Of these 500,000 visitors, a survey showed that 93% wished to return.[55] The success of this event has led commentators to note the city's ability to invest strategically in becoming a more attractive and dynamic over the past few years.[56]

Photo source: Authors

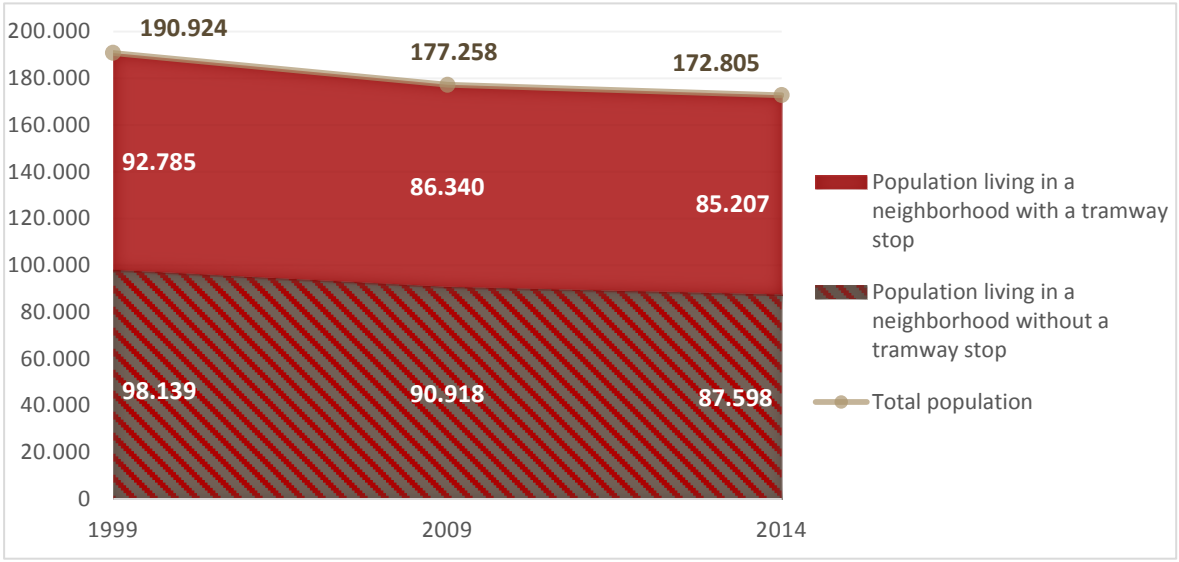
The underperformance of tramway demand has been most strongly attributed to longer-term trends which the tramway could not be expected to solve on its own, and an optimism bias towards viewing the tramway project as expected to be more attractive and competitive compared to the private car, despite trends facilitating preference for private mobility (lack of congestion, population movement to the city's outskirts). Of these trends, the most important one mentioned by respondents is the prevailing car culture in Le Havre, incentivised by low congestion and availability of free or cheap parking (where a fee does apply). Despite some efforts based on soft policies to change habits, such as encouraging company mobility plans favouring public transport, these efforts were potentially insufficient to significantly change car usage. In parallel to policies encouraging a modal shift towards public transit, the city has also been improving road infrastructure, which may have had the opposite effect. CODAH respondents suggested that, over time, the city's policy towards increasing paid parking could alter the situation in favour of the tramway. This policy has been progressively put in place over the past few years.

Another long-term trend has been the declining population in the city, which has potentially negatively affected the number of users of the tramway services. One objective of the project was to contribute to urban density by increasing Le Havre's population, however this did not materialise substantially as shown in the figure below.

[55] Procos. (2018). Palmarès Procos 2018 des centres-villes commerçants les plus dynamiques. Retrieved from: http://www.procos.org/images/procos/presse/2018/procos_palmares-2018.pdf

[56] Maligorne, C. (2018). Non, tous les centres des villes moyennes ne sont pas moribonds ! Le Figaro. Retrieved from: http://www.lefigaro.fr/conjoncture/2018/02/03/20002-20180203ARTFIG00024-non-tous-les-centres-des-villes-moyennes-ne-sont-pas-moribonds.php

Figure 21. Evolution of the population of Le Havre in 1999, 2009 and 2014, showing the evolution in neighborhoods with and without a tram stop when the tramway opened in 2012.



Note: The tramway system opened in 2012. Source: Authors, based on AURH and INSEE (2017).

Although it could not be quantified, the tramway has been reported as an effective tool to replace overcrowded bus services along its route. In this sense, the project was in good alignment with the context of urban services and traffic to provide more comfort to passengers.

To conclude, the tramway project was set up and became part of a broader transition period in Le Havre, where urban renewal policy and more targeted policy towards reducing private car usage were being implemented. In this sense, the tramway was met with slight underperformance due to the context being unfavourable at implementation (in 2012).

From a forward-looking perspective, the tramway project can be seen has having a positive relation with its context in the sense that will be relevant to the city's sustainable urban development policy and projects as these projects unfold. Ongoing or future improvements to the city's public transport system (including BRT and improved bus lines) mentioned in section 2.1 are expected to continue to facilitate travel and contribute to lower car usage in the future by extended the areas of the city where public transport becomes a rapid form of transport, providing faster access to residential areas, to places of economic activities, and to nearby municipalities.

4.2 SELECTION PROCESS

The selection of a tramway as the new transport infrastructure was essentially a political decision driven by elected officials from CODAH and the municipality to contribute to urban renewal, improve social cohesion as well as embellish the city with a modern and prestigious transport system. In this sense, studies were not expected to affect the project significantly aside from more technical details, and the ex-ante comparison of alternative options was not carried out in sufficient depth to conclude on the necessity of a tramway or a bus rapid transit system. The higher expected cost of the project (compared to other options which involved expectedly less infrastructure-related investments) was not seen as a block to the decision, although as this case study shows, the cost proved to be higher than expected. Citizens were extensively consulted, and advice from local experts and from contractors truly shaped the project and contributed to reinforcing this decision.

As described previously in section 2.1, CODAH put in place an **open and participatory concertation process** three years before the construction of the tramway line, to ensure that citizen's voices were heard and taken into consideration. This procedure went according to French legislation, which prescribes that any major project should be subject to a Déclaration d'Utilité Publique[57], but went also beyond with extensive communication and consultation activities as described in the respective section.

Interviews with local urbanism agency and CODAH during field visits have shown that technical aspects of the project were designed or at least considered in order to respond to citizens' concerns. Most notably, these concerns included the expected noise from the tramway and visual pollution from overhead cabling. These concerns led CODAH and local experts designing the project to consider alternative options. The issue of noise could be addressed with technical solutions, however the option of 'hiding' electrical equipment underground was not retained due to its cost. During the national expert's visit, interviews with local citizens have not raised further issue with these concerns and in fact citizens continue to praise the project.

The ERDF application process was cited by one respondent previously in charge of the project as having created positive incentive to improve the design and structure of the project, mobilising resources to build a strong case. The selection of the project for ERDF funding was also seen as an important support to the project's viability and to attract investors.

The European Commission desk officer in charge of the project and interacting with CODAH at the time reported that the project had appeared potentially successful at the time. Close communication and good interactions in the preparation of the *ex-ante* studies was reported as having contributed to good relations and trust from the European Commission.

In conclusion, on the one hand observations from respondents regarding the project selection process reflect a positive experience on the effects of the project, driven by strong political will, participatory public concertation activities, extensive communication from CODAH, city officials, as well as experts working on the project. Reflexions by local stakeholders on the project's performance remained optimistic during interviews, and prompted assertions that the project was viewed as the best option on the table. On the other hand, the cost of the tramway does not always appear to be taken into account in positive assessments as it is still expected to rise and burden the municipal budget. **Political drive may have steered towards over-incentivising the most costly option over others solution** such as bus rapid transit and reinforced bus services potentially providing a similar service level.

4.3 PROJECT DESIGN

The project was designed by urbanists and transport experts from the city's local agency, CODAH and contractors. **The project was well designed and implemented** according to plans to connect the Upper and Lower parts of the city. Some minimal technical disturbances and unexpected issues were met which are discussed in this section.

The target populations for the tramway line included a number of prioritised residents, including low-income residents. For these residents, the tramway route (leading into the Northern and Eastern neighbourhoods of Le Havre, see Figure 5) ensured proper

[57] See footnote **Errore. Il segnalibro non è definito.** for a definition of the term.

access to improved service from the existing (pre-2012) bus lines. Persons with reduced mobility or with disabilities also gained better access to public transport services thanks to adapted pavement and signalisation, low-floor rolling stock and more accessible travel information and ticket machines.

A key structural feature is the passage between the Upper and the Lower city via the Jenner Tunnel. Time proved that the design and construction of this new tunnel (rather than having tramways sharing the same tunnel as other vehicles) was the best solution as it avoided potential traffic congestion. It had also not been anticipated that the city would need to upgrade the existing road tunnel to national fire standards, and therefore close it for almost a year as of January 2018.[58] For that reason, it now appeared a good choice to build a new tunnel.

The creation of park-and-rides also would support a modal shift, however as noted above this shift is unlikely to have occurred to a significant extent due to the city's car culture. From field observations and interviews with the local urbanism agency and transport operator, these park-and-rides are used, however no data could be provided to quantitatively assess their usage.

The project also contributed to redesigning Le Havre's streets. One of the objectives for doing this was providing safer pedestrian and cycling infrastructure. Even though not clearly reflected in accident data due to the limited statistical baseline in smaller agglomerations, tramlines are generally considered to increase safety in a given traffic network. A second objective was to improve the city's aesthetics. On that aspect, interviewed respondents tend to be unanimously positive.

Overall, **very few alterations were made to the original project design**. Respondents from CODAH, the local urbanism agency, contractors, and local citizens generally agreed that from a technical perspective, the project continues to be a success. Structural features described in section 1.3 were appropriate with regard to the projects' objectives. Any underperformance of the project from a transport demand perspective is likely not due to design and implementation, but to the other determinants.

4.4 FORECASTING CAPACITY

***Ex-ante* studies had predicted higher passenger traffic than actually observed**. Demand predictions were therefore probably too optimistic with regard to the context of the project. Multiple reasons were provided by the respondents. A first reason is the prediction of rising car usage which could be absorbed instead by the tramway service, however the ease to drive a car in Le Havre and its inhabitants preference for this mode of transport have likely reduced the actual share of passengers originating from a modal shift. Secondly, passenger traffic predictions may have been based on trends observed in other more populated French cities.

The investment cost of the project was also underestimated. While the *ex-ante* studies predicted a cost of EUR 332.99 million, this budget was surpassed significantly. As explained in section 2.2, this overspend is due to the fact that ex-ante studies had been built on wrong assumptions regarding the final cost. A number of unexpected issues during the construction of the line also created additional costs. A main issue pertains to the need for additional works on the Boulevard de Strasbourg and Avenue du Bois au Coq, where survey had not allowed to identify infrastructure

[58] Morvan, A. (2017). Au Havre, le tunnel Jenner fermé à la circulation durant un an : tout ce qu'il faut savoir. *Actu*. Retrieved from: https://actu.fr/normandie/havre_76351/carte-travaux-tunnel-jenner-havre-circulation-interdite-pendant-an-2018-deviations-tarif-special-tram_14387259.html

which required strengthening before tramway platforms could be installed. In addition, a fire caused damage to the building contractor's facilities and had to be compensated, and number of smaller issues also added to the cost. In addition, respondents mentioned additional costs to ensure that the project would be completed in time. These unexpected costs could not be estimated accurately. Furthermore, additional billing was presented to CODAH during and after construction by the contractors. These additional payment requests are still at the time of writing this report subject of litigation procedures and may increase the total cost of the project by EUR 10 to 30 million, according to CODAH's financial services. As CODAH noted, the total cost of the project continues to bear heavily on its total budget.

Actual operational costs for the tramway and bus lines also present some discrepancies with *ex-ante* estimates. Concerning the tramway, operating costs was expected to reach EUR 7 per kilometre when in fact it hovered at EUR 5. Bus operating costs presented a different pattern where they tended to increase prior to the implementation of the tramway, then decreased afterwards. This was also noted by the Chambre Régionale des Comptes[59] as an issue which could not be explained.

Overall, forecasting capacity for the project proved rather low at the time of the ex-ante studies**, which impacted the project negatively.**

4.5 PROJECT GOVERNANCE

The size and importance of the tramway line meant that many stakeholders were mobilised in its preparation and proper implementation, but also that CODAH (as project manager) had to increase its capacity.[60] When it comes to design and management of the project, only a few persons and organisations held steering roles. This governance structure ensured clarity of leadership and division of responsibilities.

The project was initiated by Le Havre's government officials and CODAH, which took main design decisions and delegated the technical design work to AURH and to contractors. CODAH's Mission Tramway team took lead on the management of the project, from steering the *ex-ante* studies to following construction works, and managing stakeholder relations. The team was composed of only a few people working full time on the project.

CODAH and the transport operator LiA entered into contract in 2012 and for the period 2012-2017 to define the shared responsibility for the organisation and management of the transport services. The contract is designed to ensure that operation and maintenance of the services is maintained at a high level of quality, thanks to a system of financial reward or penalties of EUR +180,000 or EUR -210,000 to the operator based on three criteria: punctuality of services, cleanliness of vehicles, quality of travel information, accessibility to persons with low mobility, sustainability, fraud prevention, and certification. Monitoring is based on indicator information and visits from CODAH.

[59] Chambre Régionale des Comptes Basse-Normandie et Haute-Normandie. (2014). Rapport d'observations définitives de la chambre régionale des comptes de Basse-Normandie, Haute-Normandie sur la gestion de la communauté d'agglomération du Havre (CODAH) – Politique des transports urbains. Retrieved from : https://www.ccomptes.fr/sites/default/files/EzPublish/JF00145094_JF_INTERNET1.pdf

[60] Chambre Régionale des Comptes Basse-Normandie et Haute-Normandie. (2014). Rapport d'observations définitives de la chambre régionale des comptes de Basse-Normandie, Haute-Normandie sur la gestion de la communauté d'agglomération du Havre (CODAH) – Politique des transports urbains. Retrieved from: https://www.ccomptes.fr/sites/default/files/EzPublish/JF00145094_JF_INTERNET1.pdf

This incentive system is common in France and since the 1980's.[61] By combining quality standards and indicators with financial incentives, the system set up in Le Havre is, in principle, well designed to provide quality services to transport users. In 2014, the Chambre Régionale des Comptes however judged the reward and penalty range to be too small, and had recommended EUR 300,000 to EUR 400,000.[62] Furthermore, technical issues with the ticketing system prevented proper accounting of trips, and therefore obscured punctuality indicators (see section 3.3). This was corrected 2013 and the incentive system implemented in 2014.

CODAH worked closely with the transport operator to ensure good preparations for the entry into service. The testing phase allowed the transport operator LiA to familiarise itself with the new system, and in the year that followed experts from the contractor supported LiA in implementing the service in all its technical elements.

Overall, CODAH, AURH, the transport operator, and contractors interviewed all insisted that the project had been delivered in good relationships between actors and that its governance had led to good implementation of the project, however conflicts remain over the final price of the project between CODAH and contractors due to additional payment claims. **The project was designed and managed transparently, however the monitoring and operation of the services have not been effective in the early months of the tramway service.**

4.6 MANAGERIAL CAPACITY

The operation of the services began with some difficulties offering a punctual service, as shown in Figure 19 above. Interviews with the transport operator indeed indicated that an adaptation period was required, as well as professionalisation of the personnel involved. At the same time, the start of the project was marked by the absence of passenger traffic monitoring, due issues implementing the ticketing system. This was explained by one respondent from Systra as being due to the system offered by another company not being fully developed or tested at the time of its implementation. **Over time the services have substantially improved**, **showing good capacity of the operator in professionalising its services.** LiA is particularly attentive to customer satisfaction, which has shown to increase (see figures in section 3.3) and continues to seek solutions to improve.

On the side of the construction contractor, teams were set up to act on multiple construction sites at a time, which would ensure timely completion of the works. CODAH respondents as well as the local urbanism agency assured that the works were carried out properly.

Although a planning and list of indicators was set up in the *ex-ante* phase, project monitoring was not conducted according to planning and to national CBA guidelines, where it was acknowledged that an evaluation of the projects' effects would be conducted three to five years after implementation (between 2015 and 2017). At the time of writing this report, this evaluation for CODAH was planned for 2018.

[61] Domenach, O. (2015). SECTEUR PUBLIC ET SECTEUR PRIVE, GESTION DIRECTE ET GESTION DELEGUEE DANS LES RESEAUX DE TRANSPORTS PUBLICS : LES DETERMINANTS DU CHOIX. Retrieved from: https://utp.fr/sites/default/files/Publications/Gestion-directe-deleguee_Rapport-final_O.Domenach_Janvier-2015.pdf

[62] Chambre Régionale des Comptes Basse-Normandie et Haute-Normandie. (2014). Rapport d'observations définitives de la chambre régionale des comptes de Basse-Normandie, Haute-Normandie sur la gestion de la communauté d'agglomération du Havre (CODAH) – Politique des transports urbains. Retrieved from: https://www.ccomptes.fr/sites/default/files/EzPublish/JF00145094_JF_INTERNET1.pdf

Furthermore, data on tramway passengers' background and travel motivations were not surveyed except in a limited way during user satisfaction surveys by the contractor. This has not allowed an evaluation of the project by the project owners to take place yet.

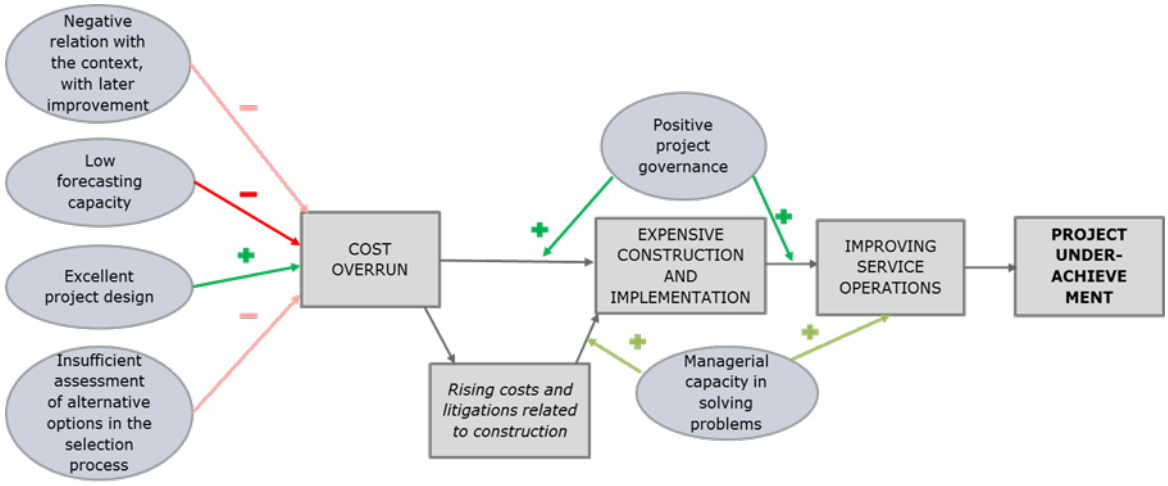
The project implementation benefited from good managerial capacity from all actors involved, who were able to react to unexpected issues, and managed to lead the project to completion according to schedule. Monitoring of the project however was not carried out according to schedule, which delayed a real evaluation of its effects.

4.7 PROJECT BEHAVIOURAL PATTERN

Following the identification of the typical determinants of project performance and the main project outcomes, the final step entails describing the chain of interlinked causes and effect determining the project performance over time.

The behavioural pattern of the project under assessment is provided in the figure below. The round boxes in light blue indicate the projects' determinants, the rectangular boxes in light grey refer to the observed events, the '+' signs next to the green arrows indicate that the factor has positively influenced the project performance, and the '-' signs next to the red arrows indicate that the factor has negatively influenced the project performance.

Figure 22. Behavioural pattern archetype: eclipsed sun.[63]



Source: Authors.

The process for **project selection** was driven by strong political will which steered it towards the most expensive but also most prestigious option of a tramway in the city's centre, but also integrating social cohesion objectives. The comparative assessment of alternative options (bus rapid transit) was not considered in depth, when such option may have fulfilled transport objectives at a lower cost. Implication of the local population and local experts was very important in this process. Good relations with DG REGIO and Regional Managing Authorities in the *ex-ante* phase contributed positively to its selection for ERDF funding. The project was planned with relatively

[63] The project is classified as "eclipsed sun" as it does not fully match any of the stylized patterns identified in the First Interim Report. The stylized patterns must anyway be intended as a theoretical classification which needs be adjusted to real cases. In this case, the investment is an example of a poorly performing project financially due to poor capacity to foresee investment costs and transport trends, but also due to lack of adequate monitoring to evaluate effects. The project is nevertheless seeing positive increases on transport indicators and offers chance of more benefits in the future. Therefore, the project cannot be considered a "rising sun" due to its positive performance with regards to a number of determinants except forecasting capacity. It can thus be labeled as a "eclipsed sun".

weak **forecasting capacity** with regards to passenger demand and project costs, due for the first part to an overestimation of the potential for modal shift and to an underestimation of actual and potential unexpected costs. The projected cost of the project in the *ex-ante* studies was much lower than the actual cost by 20%. On the one hand, the project's **relation with the context** was relatively negative considering Le Havre's lack of traffic congestion and good parking availability. On the other hand, the tramway line was an integral part of broader urban renewal and social cohesion efforts and continues to contribute to it. On its own, the tramway project is unlikely to have significant effects on the city's economic fabric. This is due Le Havre's social and economic conditions which the tramway alone could not change. The **project's design** was excellent, with no aspect of the infrastructure or of the tramway route which could be criticised or led to important issues. Also, the project contributed to various aspects of the service including punctuality, travel comfort, passenger capacity, reduction of crowding, and aesthetic quality. **Managerial capacity** of actors involved has proven to be rather positive: CODAH and the transport operator have been responsive to unexpected issues and led to project to completion in time and according to plans. The project was however not monitored appropriately as per the *ex-ante* schedule and national CBA guidelines. **Project governance** was noted as quite positive by most stakeholders, with a compact and dynamic team set up for managing the project and good interactions between actors (project owner, local urbanism agency, Regional Managing Authorities, and DG REGIO) despite ongoing litigations between some contractors and the project owner over the final costs of the project. Due to the difficulty in the project reaping anticipated benefits in the period of study, we suggest the project follows the pattern of an eclipsed sun. The main source of underachievement is likely to be a mix of exogenous factors with low forecasting capacity.

5 FINAL ASSESSMENT

Based on the different findings produced by the project analysis both in terms of effects generated and measured through the CBA or qualitatively discussed as well as of factors affecting the generation of those effects, the final assessment of the project performance is presented here after along a set of evaluation criteria.

5.1 PROJECT RELEVANCE AND COHERENCE

Le Havre's first tramway line was appropriately designed vis-à-vis urban renewal objectives of the city by refurbishing streets all along the tramway line and providing a modern and sustainable mode of public transport, contributing to the city's attractiveness in a period of socio-economic decline. The project also contributed to improving means of transport to low -income populations, providing and access to the city centre, various services and recreational facilities (including Le Havre's beach). The tramway has proved to be a more attractive transport option than buses for previous bus users and persons with reduced mobility, facilitating travel thanks to new and improved infrastructure adapted for disabled and elderly people. The project also was also attractive in policy-makers' view due to the urban renewal opportunities it offered. The tramway was constructed according to original planning, connecting low income neighborhoods and other residential areas to the city centre and the beach. The tramway also replaced overcrowded bus lines with a system offering higher capacity. The increasing number of public transport users is a clear sign that the project continues to be relevant to efficient and attractive public transport needs in Le Havre.. However, the lack of an ex-ante in-depth assessment of the potential performance of alternative options (bus rapid transit) has not allowed to prove that the tramway project was most appropriate and least costly to achieve transport objectives.

On the negative side, **the aim to encourage a modal shift from private cars to public transport was not taking sufficient account that the city in fact still encouraged car travel due to low congestion and availability of free or cheap parking** (in areas where a fee does apply). This context was expected to change as a result of the tramway yet also affected its performance. In this sense, the city and CODAH may have chosen to implement the tramway system together with stronger actions to incentivise the modal shift.

The project has integrated well in the fabric of the city, and quickly became a leading project in Le Havre's broader urban renewal and transport policy. The tramway project was from its inception, and continues to be, the centerpiece of Le Havre's urban development policy. Today the city and CODAH are still planning multiple projects in coherence with the transport service offered by the tramway. These projects include new housing, leisure and recreational facilities, and redevelopment of public space and of other areas to attract investments, visitors and inhabitants.[64]

Tramway systems were a trending mode of transport in French cities, supported by the State for their environmental performance and appeal to sustainable urban ways of life. As such, the project was also in coherence with national practices and policy objectives.

[64] Le Havre City Hall. (2018). *Les Grands Projets.* Retrieved from: https://www.lehavre.fr/ma-ville/les-grands-projets

5.2 PROJECT EFFECTIVENESS

The results of the CBA, as included in Annex II, **indicate that the project's measurable benefits fall short of the costs from a socio-economic point of view**. The CBA resulted in a benefit to cost ratio of 0.18 which suggests that the financial costs of the project are higher than the quantifiable socio-economic benefits. This is in contrast to the ex-ante evaluation which forecasted a positive result. A number of factors led to this effect, including higher investment costs of the project, lower passenger numbers than predicted and a less pronounced modal shift from private cars to the tram than expected. Also, methodological differences played a role in the different results. For example, the most important socio-economic benefit generated by the project is time savings. The monetary unit used in the ex-ante CBA followed French CBA guidelines and is considerably higher than the unit costs adopted by this study (see the First Intermediate Report); the same applies to social accident costs. However, adopting the values from the ex-ante CBA would also not result in an overall positive outcome. Finally, the ex-ante CBA took a number of effects into account, following French guidelines. In this ex-post evaluation, following a prudent approach, some effects were, which are not considered due to lack of evidence. This includes reduced erosion of paving and reduced shortage of parking spaces (while there has not been a major shortage of parking space before),, both due to former car users switching to the tram.

With 38,461 passengers per day projected in 2017, the tramway has struggled to reach transport objectives of 56,000 passengers per day, likely due to optimism bias with regard to its ability to stimulate a modal shift in Le Havre. However, it is experiencing rising passenger traffic growth by an average of 3% per year and has successfully increased passenger traffic on the entire public transit system. Interview respondents noted that a main source of transport traffic was likely to be induced mobility. A modal shift seems to have occurred to a lower extent than expected, but possibly contributes to traffic gains. In absence of further studies on passengers' travel habits (planned for 2018), these observations cannot be corroborated with a high level of certainty.

The tramway has had immediate effects for citizens related to quality of life, with 'façade-to-façade' renovations bringing aesthetic value to the city, improved quality of service, and facilitated travel. Aesthetic improvements, travel comfort, urban renewal and accessibility of public transport to low-mobility persons could not be captured in the CBA, yet were valued unanimously by stakeholders interviewed. However, the socio-economic context of Le Havre, characterised by declining population trends and relatively high unemployment, still affects its socio-economic development. The introduction of the tramway system alone is unlikely to change this dynamic on its own but should be seen in the context of a broader development policy. It is also important to note that the indicators used in the CBA only partly reflect the socio-economic effects of the project while qualitative assessments are used to include additional aspects such as aesthetic improvements, reduction of crowding, and synergies with recent urban developments. This mix is particularly appropriate, because it allows adopting a wide perspective in assessing long-term effects, while sticking to a prudent approach based on robust facts.

The tramway system was constructed in perfect alignment with intended structural features, and opened within schedule on 12 December 2012. Strong political will, good managerial capacity of CODAH, adequate involvement of experts and of the public ensured that the ambitious construction schedule was met despite the high financial investment costs. As a matter of fact, the project was completed in

time (under three years'), as described further in section 5.3 below on Project efficiency.

Technical difficulties with electronic ticketing in the first year prevented monitoring of punctuality and passenger traffic, and in the year it became functional the data shows that a larger share of the tramways were not circulating on time. The transport operator has however managed to improve performance within two and a half years of service, meaning that the service became reliable as of mid-2015.

Broader and longer-term socio-economic impacts of the project are yet to be measured in upcoming studies from Le Havre's local urbanism agency, although findings of the present study from field visit and interviews show that the tramway is unlikely to have significantly affected the fabric of the city, such as in terms of local economic activity. Overall, the city is seeing a stabilisation of its socio-economic indicators in recent years (unemployment, population), which may be due to quality of life improvements, to which the tramway has certainly contributed.

As the city pursues its urban renewal policy with several major projects in development around the tramway line[65], Le Havre is expected to experience an improvement in economic activity and overall attractiveness. These long-term effects are not directly imputable to the tramway, however they are expected to stimulate the demand of public transport as such they are reflected in the CBA by the increasing number of passengers in the future.

5.3 PROJECT EFFICIENCY

The project has not performed well financially due to much higher investment costs than forecasted. As explained in section 2.2 above, these higher costs are likely to have originated over the entire construction phase due to an accumulation of unexpected costs, and in relation to contractors' billing claims, still subject to litigation procedures. These claims are expected to lead to an increase of EUR 10 to 30 million in the coming years, depending on court decisions. The cost of the system thus bears heavily on CODAH's overall budget. In total, the investment costs amount to almost EUR 540 million (in 2017 present value) instead of the EUR 333 million (in 2009 present value) originally foreseen in the ex-ante studies. The EUR 540 million also include a total of EUR 20 million (nominal) which have not yet been paid to contractors. This amount is currently debated in court with contractors demanding EUR 30 million and the operator willing to pay EUR 10 million.[66]

From a financial point of view, the choice of a tramway rather than bus rapid transit (as considered among alternative options) **was too expensive**, however the project's objective to renew the city's urban environment and reduce local atmospheric pollution would have been unlikely to materialise to a same extent under the alternative option of setting up a service of conventionally (diesel-) fuelled buses in a bus rapid transit system. Unfortunately, the ex-ante studies did not compare the benefits of alternative options to provide more conclusions on the issue.

5.4 EU ADDED VALUE

The application process and the high level of the requirements for accessing ERDF funding were described by the project manager at the time of planning and

[65] These projects include new housing, leisure and recreational facilities, and redevelopment of public space and of other areas to attract investments, visitors and inhabitants. See Le Havre City Hall. (2018). *Les Grands Projets.* Retrieved from: https://www.lehavre.fr/ma-ville/les-grands-projets

[66] Due to the unknown outcome of this procedure the EUR 20 million have been included as mean value in the calculations.

construction as having contributed to an important amount of resources invested in its preparation, contributing to good technical design. The total cost of the project was however not well anticipated in the ex-ante studies and led to an underestimated project cost being presented in the proposal.

The EU contribution to the project goes beyond the provision of funding and also includes providing the strategic framework for implementation of transport projects provided by the ERDF, setting out clear urban development and environmental sustainability objectives. The objectives of the project were indeed in line with EU sustainability and transport objectives. At the same time, optimism bias might have played a role in the ERDF application process by presenting an overly positive list of impacts and a high level of ambition, with quantified objectives which proved difficult to attain.

As reported by interviewed stakeholders, even without **EU funding the project would have likely still been implemented** due to the high political interest from local actors. **.** The financing decision from Regional Managing Authorities drastically reduced the amount of the EU subsidy from the maximum of about EUR 54 million to a sum of EUR 10 million.[67] This amount is therefore unlikely to have significantly affected the financial sustainability of the project. A higher subsidy may have positively contributed to the financial sustainability of the project, however it would not have been unlikely to contribute to avoiding the issues which the project faced during implementation and which led to costs overshoot.

5.5 FINAL ASSESSMENT

In conclusion, Le Havre's first tramway line is an example of a project with important ambitions in terms of urban renewal, attractiveness and social cohesion. The case study does not provide evidence that the project has had important urban renewal impacts. For instance, the price of real estate was not affected by the project. The project had very high investment costs and probably reflect some over ambition in selecting a tramway line over a (likely) cheaper alternative, which tipped the balance of benefits in favour of the costs in the CBA, however the above unquantified benefits should neither be overlooked nor underestimated in their contribution to making Le Havre progressively more sustainable and an attractive place to live. **The project had a broad range of objectives, some of which were ambitious and difficult to achieve,** and **others could not be achieved by the project on its own and would require more time and concerted action to materialise**, such as the shift from private vehicles to tramway in a context of a non-congested city. The project's good insertion within an urban renewal policy is likely to reap new benefits as other projects are developed, creating synergies to realise overarching social cohesion, environmental sustainability and economic objectives. Despite technical difficulties setting up a reliable service, the project's governance has provided adequate incentives to improve the service over time and within a few years of service. Follow-up assessments should be conducted to conclude on the longer-term effects of the tramway line's implementation.

[67] Discussions with the project manager (CODAH), the Regional Managing Authority and DG REGIO could not clarify the reason for this final decision, however it is likely that this decision was taken in order to allow funding for other eligible projects.

Table 8. Evaluation matrix

CRITERION	EQ	ASSESSMENT	SCORE (*)
Relevance	To what extent the original objectives of the examined major project matched: • the existing development needs, • the priorities established at the programme, national, and/or EU level.	Since the beginning the project was not in line with the development needs, but was in line with the priorities established at various levels	2
Coherence	• Are the project components in line with the stated project objectives? • To what extent the examined the project were consistent with other national and/or EU interventions carried out in the same field and in the same area?	Partially consistent	3
Effectiveness	• Has the examined major project achieved the objectives stated in the applications for Cohesion policy support? • Was the actual implementation in line with the foreseen time schedule? • What factors, including the availability and the form of finance and to what extent influenced the implementation time and the achievement observed? • What has changed in the long run as a result of the project (for example, is there evidence showing contribution of the project to the private sector investments)? • Were these changes expected (already planned at the project design stage, e.g., in terms of pre-defined objectives) or unexpected (emerged, for instance, as a result of changes in the socio-economic environment)? • How have these changes matched the objectives set and addressed the existing development needs, the priorities established at the programme, national and/or EU level? • Did the selected project turn out to be the best option among all feasible alternatives?	The project did not achieve the expected objectives which were highly ambitious and might have been influenced by optimism bias..	2
Efficiency	• Are there any significant differences between the costs and benefits in the original cost-benefit analysis (CBA) and what can be observed once the project has been finalised? • To what extent have the interventions been cost effective?	Significant negative differences due to endogenous factors and exogenous factors.	1
EU added value	• What is the EU added value resulting from the examined major project (in particular, could any of the major projects examined, due to its risk profile, complexity or scope, have not been carried out if not for the EU support)? • Did the examined major projects achieve EU-wide effects (e.g. for preserving the environment, building trans-European transport networks, broadband coverage etc.)? • To what extent do the issues addressed by the examined interventions continue to require action at EU level?	Modest EU added value, i.e. the project would have been hardly implemented without the EU support, however, its effects are still uncertain.	3

Note: Scores range from 1 to 5. Source: authors

6 CONCLUSIONS

The *ex-post* assessment of Le Havre's first tramway line has shown that the project has encountered difficulties reaching set objectives due to a lower performance than forecasted in the first few years, to overestimation of its potential and underestimated final cost, and to misalignment of the project with its context. Transport indicators have however improved over time and continue to do so. Furthermore, ongoing development projects in coherence with the tramway line's objectives are likely to create new synergies and improve Le Havre's performance along socio-economic indicators. In conclusion, we draw a number of lessons from this case:

- The project shows that political will can positively steer projects towards good completion. However, and together with the need to meet EU objectives to obtain funding, it may also create an optimism bias to present an overambitious project. Furthermore, this can also create the incentive not to consider more appropriate alternatives as financially advantageous options.
- Le Havre's tramway was expected to contribute to improving socio-economic conditions, particularly in low-income neighborhoods, when in fact other actions would have been necessary to implement at the same time to improve collective performance. These actions are now being implemented and are expected to work synergetically in improving socio-economic conditions. The tramway has become a structuring element of the city's urban renewal policy and can continue to contribute positively to its development, perhaps more so in the future than it has in its first five years of operation.
- Travel habits, in particular private vehicle use, are long term trends which are difficult to change in cities like Le Have where car travel is still prevalent particularly among peripheral citizens. This is particularly the case because car culture is incentivised by ease of travel (low congestion, free or cheap parking where a fee does apply).

ANNEX I. METHODOLOGY OF EVALUATION

This Annex summarises the methodological approach applied for carrying out the project case studies and presented in the First Intermediate Report of this evaluation study. The main objective is to provide the reader a concise account of the evaluation framework in order to better understand the value and reach of the results of the analysis as well as to enable him/her, if interested, to replicate this methodology.[68]

The Annex is divided into four parts, following the four building blocks of the methodological approach (mapping of effects; measuring the effects; understanding effects; synthesis and conclusions) laid down in the First Intermediate Report. Three evaluation questions, included in the ToR, guided the methodological design. They are:

- **What kind of long term contribution** can be identified for different types of investment in the transport field?
- **How is this long-term contribution generated** for different types of investments, i.e., what is the causal chain between certain short term and log-term socio-economic returns from investments?
- **What is the minimum and average time** needed for a given long term contribution to materialise and stabilise? What are these time spans for different types of investments in the transport field?

A I.1 Mapping the effects

The Team developed a classification of long-term effects, with the aim of identifying all the possible impacts of transport investments on social welfare. Under four broad categories, a taxonomy of more specific long-term development effects of investment projects has been developed. The definition of each type of effect is provided in the table below.

Far from being exhaustive, this list is intended to guide the evaluators in identifying, in a consistent and comparable way, the most relevant effects that are expected to be identified and included in the analysis. Additional effects could possibly be relevant in specific cases and, if this is the case, they can be added in the analysis.

In researching all the possible long-term effects of project investments, it is acknowledged that there could be a risk of duplication. In addition, the allocation of some effects under different categories is to some extent arbitrary and thus it may happen that categories overlap. That said, caution will be paid in order to avoid double counting when performing the ex-post CBA.

[68] Specific recommendations which may enable application of the same evaluation methodology to future projects are discussed in the Final Report of this evaluation study.

Table 9. Taxonomy of effects

	DIRECT EFFECTS	DESCRIPTION
EFFECTS ON ECONOMIC GROWTH	Travel time	Reduction in travel time for business travellers, shippers and carriers (including the hours gained because of a reduction of congestion) is a typical positive outcome of transport project, except those that specifically aim at environmental or safety benefits.
	Vehicle operating cost	Vehicle operating cost savings for the travellers (fuel costs, fares) and for transporters of goods (this refers to the distance-dependent transport costs) are relevant if the project aims at reducing congestion and/or the journey distances.
	Reliability of journey time	This means reduced variation in journey times. Reliability benefits are potentially important for many projects, unless journey times are already quite reliable. However, often forecasting models or other information for the impacts on and through reliability are missing (de Jong and Bliemer, 2015)
	Income for the service provider	It includes the revenues (e.g. rail ticket income increase) accrued by the producer (i.e. owner and operators together) as well as the operational cost savings. To some extent it can reflect the previous aspects (i.e. the service fare is increased to reflect a better service allowing for significant time saving for the users) so double counting shall be avoided. This aspect might be particularly relevant for public transport projects or toll road projects, especially if the project is expected to feature significant traffic (generated or induced) or a substantial change in fares.
	ADDITIONAL EFFECTS	**DESCRIPTION**
	Wider economic impacts	It refers to the agglomeration effect on productivity (the productivity of the economy is increased because the project leads to a clustering of economic activities together in a core city which makes these sectors produce more or better goods and services together than before). Agglomeration effects are unlikely to occur for small projects and even for large projects there are specific pre-conditions (see for instance Chen and Vickerman, 2017). Wider economic impacts (agglomeration effects) depend on whether the project makes a potential economic cluster location substantially more accessible. This is only possible if the infrastructure network before the project had important missing links which the project effectively removes.
	Institutional learning	It refers to wider spillover effects that any investment project may bring to the Public Administration and other institutions at national or regional levels in terms of expertise gained by working on large scale projects. Learning may lead to productivity gains by stimulating the improvement of existing technical know-how, improved policy-making, competitive tendering and divert resources towards the most growth enhancing projects.

	DIRECT EFFECT	DESCRIPTION
EFFECTS RELATED TO QUALITY OF LIFE AND WELL-BEING	Travel time	Leisure time saving relates to projects that provide a reduction in travel time for non-business travellers.
	Safety (accident savings)	It relates to the amount of fatalities, serious and slight injuries, damage-only accidents. Safety impacts should possibly be included in all project evaluation.
	Security	Safety of travellers in the vehicle and at stations, platforms and stops, safety of the goods transported (often damaged or stolen). Security impacts are often neglected in project evaluation, but for public transport projects (both urban and intercity) they can be of considerable importance.
	Noise	It refers to the exposure of population to noise measured in dB
	ADDITIONAL EFFECT	**DESCRIPTION**
	Crowding	A reduction of crowding in public transport is mainly relevant for projects that provide significant additional capacity in public transport.
	Service quality (other than crowding)	It refers mainly to the availability of specific service features increasing the journey comfort e.g. smoother movement of the vehicles, more comfortable seats, provision of electricity, Wi-Fi, catering.
	Aesthetic value	This relates to projects that provide infrastructure with positive visual effects (e.g. a beautifully constructed bridge) or when public transport provide a better image in the eye of the public. Also, it refers to projects that lead to a less attractively looking landscape (e.g. constructing high walls).
	Urban renewal	It refers to the spillover effects of urban transport projects on residents (not necessarily users of the project) due to an improved local context and possibly reflected in an increase in real estate values.
EFFECTS ON THE ENVIRONMENT	**DIRECT EFFECT**	**DESCRIPTION**
	Local air pollution	Local air pollutants are typically small particles, NO_x, VOCs and SO_2. The increased/decreased volume of local air emissions is a typical effect of transport projects.
	Climate change	Climate change refers to the volume of greenhouse gases (GHG) emitted by transport infrastructure. The increased/decreased volume of GHG emissions is a typical effect of transport projects.
	ADDITIONAL EFFECTS	**DESCRIPTION**
	Biodiversity	This refers to the reduction of biodiversity through the extinction of species in a specific area. It is not a common effect but it can be relevant in selected cases.
	Water pollution	Emissions of substances, e.g. from the road, into watercourses, that are harmful for people (as drinking water) or for life in the water
EFFECTS RELATED TO DISTRIBUTIONAL ISSUES	**ADDITIONAL EFFECTS**	**DESCRIPTION**
	Social cohesion	It encompasses the allocation of the main benefits over income and social groups
	Territorial cohesion	It encompasses the allocation of the main benefits over central (core) and peripheral areas

Source: Authors

A I.2 Measuring of effects

Because of the variety of effects to be accounted for, a **methodological approach firmly rooted on CBA (complemented by qualitative analysis** when necessary) is adopted in order to grasp the overall long-term contribution of each project.

In terms of their measurement level, the effects can be distinguished into:

A. **Effects that by their nature are already in monetary units** (e.g. transport costs savings). These can therefore be easily included in a cost-benefit analysis (CBA).
B. **Effects that are quantitative, but not in money units, and that can be converted into money units in a reasonably reliable way** (e.g. transport time savings, accidents, air pollution)[69]. These effects can also be included in the CBA.
C. **Effects that are quantitative, but not in money units, for which there are no reasonably reliable conversion factors to money**. We propose not to try to include such effects in the CBA, but to discuss them in a qualitative way together with the overall outcome of the CBA.
D. **Effects that are difficult to measure in quantitative (cardinal) terms, but do lend themselves for ordinal measurement** (a ranking of the impact of different projects on such a criterion can be provided, such as very good, good, neutral, bad, very bad). We propose to discuss these effects in qualitative terms.
E. **Effects that might occur but that are subject to a high degree of uncertainty:** these will be treated as part of the risks/scenario analysis that will be included in the CBA.
F. **Effects that might occur but that we cannot even express in an ordinal (ranking) manner:** they are residual effects that can be mentioned in qualitative description in case study report.

In short, all the projects' effects in A and B are evaluated by doing an ex-post cost-benefit analysis (CBA)[70]. Reasonably, these represent the most significant share of long-term effects. Then the outcome of the CBA (e.g. the net present value or benefit-costs ratio) is complemented by evidence from C and D, while E is used for descriptive purposes. Moreover, qualitative techniques are used to determine why certain effects are generated, along what dimensions, and underlying causes and courses of action of the delivery process (see below).

Section 3 of each case study includes a standardised table in which scores are assigned to each type of long-term effect. Scores ranging from -5 to +5 (-5 = very strong negative effect; 0 = no effect; 5 = very strong positive effect) are given in order to intuitively highlight which are the most important effects generated for each case study.

[69] Methods to establish such conversion factors include: stated preference surveys (asking respondents about hypothetical choice alternatives), hedonic pricing or equating the external cost with the cost of repair, avoidance or prevention or with the costs to achieve pre-determined targets

[70] More details on the approach adopted to carry out the ex-post CBA exercise and, in particular, indications on project identification, time horizon, conversion factors and other features are extensively described in the First Intermediate Report of this evaluation study.

A I.3 Understanding the effects

Once the project effects have been identified and measured, and the causal chain linking different categories of short-term and long-term effects has been investigated, the third building block of the methodological approach entails reasoning on the elements, both external and internal to the project, which determined the observed causal chain of effects to take place and influenced the observed project performance.

Taking inspiration from the literature on the success and failure of projects, and particularly on costs overruns and demand shortfalls, and on the basis of the empirical evidence which develops from European Commission (2012) six stylised determinants of projects' outcomes and their development over time were identified (see table below).

The interplay of such determinants may reinforce or dilute one effect over the other. Moreover, each determinant may contribute, either positively or negatively to the generation/speed up/slow-down of certain short-term or long-term effects. For this reason, it is important not only to understand the role that each determinant has on the observed project outcome, but also their interplay in a dynamic perspective.

In doing this, it is useful to refer to stylised, typical "paths" of project behaviours outlined in the following table. Such patterns capture common stories and reveal recurring patterns of performance, as well as typical problems that may arise and influence the chronicle of events. Case studies test the validity of such archetypes and are used to specify in better nuances or suggest possible variations or additions.

Section 4 of each case study includes standardised tables in which scores are assigned to each determinant. Scores ranging from -5 to +5 are given in order to intuitively highlight which are the most relevant determinants explaining the project outcomes (5 = very strong negative effect; 0 = no effect; 5 = very strong positive effect). Moreover, section 4 of each case study includes a graph describing the project's behavioural pattern, i.e. describing the chain of interlinked causes and effect determining the project performance over time.

Table 10. Stylised determinants of projects' outcomes

DETERMINANT	DESCRIPTION
Relation with the context	It includes the considerations of institutional, cultural, social and economic environment into which the project is inserted, was the project appropriate to this context?; is there a problem that the project can solve?; does the project remain relevant over the years?
Selection process	It refers to the institutional and legislative framework that determines how public investment decisions (and especially those co-financed by ESIF) are taken, i.e. which is the process in place and the tools used to select among alternative projects. The selection process is influenced by incentive systems that can lead politicians and public institutions to either take transparent decisions or strategically misrepresent costs and/or benefits at the ex-ante stage.
Project design	It refers to the technical capacity (including engineering and financial expertise) to properly design the infrastructure project. Under a general standpoint, we can distinguish: • the technical capacity to identify the most appropriate conceptual design, which best suits the need of a specific context. Even when a region really is in need of the project, it usually requires a well-designed project to solve the observed problems. This, in turn, involves that different alternatives are considered and the best option in terms of technical features and strategical considerations is identified; • the technical capacity to develop the more detailed level of design (preliminary and detailed), thus identifying most effective and efficient detailed infrastructure solutions and construction techniques, thus avoiding common pitfalls in the construction stage (such as introducing variants that are not consistent with the original conceptual design) and the risk of cost overruns during the construction phase by choosing inappropriate technical solutions.
Forecasting capacity	It regards the possibility and capacity to predict future trends and forecast the demand level and estimate the technical challenges, thus estimating correctly the required resources (e.g. looking at the dangers of over-predicting demand and under-predicting construction costs). In particular, technical forecasting capacity is related to the quality of data used and forecasting/planning techniques adopted. At the same time, forecasting capacity includes the ability of the project promoter and technical experts not to incur in the planning fallacy (the tendency to underestimate the time or cost needed to complete certain tasks) and optimism bias (the systematic tendency to be overly optimistic about the outcomes of actions).
Project governance	It concerns the number and type of stakeholders involved during the project cycle and how responsibilities are attributed and shared. This is influenced by the incentive mechanisms. If bad incentives exist, this can lead different actors involved in the project management to provide benefits for their members, thus diverting the funds away from their optimal use, or forcing them to delegate responsibilities according to a non-transparent procedure.
Managerial capacity	It refers to the: • professional ability to react to changes in the context/needs as well as to unforeseen; • professional capability to manage the project ensuring the expected level of service in the operational phase. To ensure a project success, it is not enough that it is well planned and designed, but also that the organizations in charge of the management and operations provide a good service to the end users (e.g. ensuring a good maintenance of the infrastructure).

Source: Authors

Table 11. Behavioural patterns archetypes

Behavioural patterns are illustrated by use of diagrams linking determinants and project outcomes in a dynamic way

TYPE
Bright star This pattern is typical of projects where the good predictions made ex-ante (both on the cost side and demand side) turn out to be accurate. Proper incentive systems are in place so that the project actually delivers value for money and success. Even in the event of exogenous negative events, the managerial capacity ensures that proper corrective actions are taken and a positive situation is restored.
Rising sun This pattern is typical of projects which, soon after their implementation, are affected by under capacity issues because of a combination of low demand forecasting capacity, weak appropriateness to the context, and weak technical capacity to design the infrastructure. However, due to changed circumstances or thanks to responsible management and good governance the project turns around to reap new benefits.
Supernova This pattern is typical of projects for which the good predictions made ex-ante (both on the cost and demand side) turn out to be accurate. However, due to changed circumstances or because of weak management capacity and/or governance the project eventually turns out to be unsuccessful.
Shooting star This pattern is typical of projects starting from an intermediate situation and resulting in a failure. This outcome can be explained by a low forecasting capacity affected by optimism bias which yields a cost overrun. Then during project implementation, because of low managerial capacity and/or poor governance (also due to distorted incentives) corrective actions are not implemented, this leading to project failure. The situation is exacerbated if unexpected negative events materialise during the project implementation.
Black-hole This pattern is typical of projects that since the beginning of their life fail to deliver net benefits. This is a result of a combination of ex-ante bad factors (i.e. low technical capacity for demand forecasting, optimism bias, inappropiateness to the local context and bad incentives affecting both the selection process and the project governance) and careless management during the project implementation or bad project governance (e.g. unclear divison of responsibilities, bad incentive schemes).

Source: Authors

A I.4 Synthesis and conclusions

Qualitative and quantitative findings are integrated in a narrative way, in order to develop ten project 'histories' and to isolate and depict the main aspects behind the project's long-term performance. A final judgment on each project is then conveyed in the case studies with an assessment structured along a set of evaluation criteria, as suggested in the ToRs. Evaluation criteria are the following:

- Relevance (were the project objectives in line with the existing development needs and the priorities at the programme, national and/or EU level?);
- Coherence (with other national and/or EU interventions in the same sector or region);
- Effectiveness (were the stated objectives achieved, and in time? Did other effects materialise? Were other possible options considered?);
- Efficiency (costs and benefits relative to each other and to their ex-ante values);
- EU added value (was EU support necessary, EU-wide effects, further EU action required?).

ANNEX II. EX-POST COST-BENEFIT ANALYSIS REPORT

This Annex illustrates the ex-post CBA of the project under consideration, undertaken to quantitatively assess the performance of the project. The methodology applied is in line with the First Interim Report and, more generally, with the EC Guide (European Commission, 2014). This annex aims to present in more detail the assumptions, results of the CBA and the scenario analysis for the project under consideration.

Methodology, assumption and data gathering

In what follows, the main assumptions and the procedure of data gathering are described in detail.

- *Project identification*

  The unit of analysis of this CBA is the project Première Ligne de Tramway de l'Agglomération Havraise (First Tramway Line of Le Havre Agglomeration)

  The project includes:

  - Construction of 13 km of tram line
  - Construction of 23 stops
  - Construction of green spaces and street improvements
  - Purchase of 22 trams

  The project was implemented period is detailed below.

Table 12. Synthesis of the interventions

ACTIVITY	IMPLEMENTATION PERIOD
Preparatory phase (studies)	2004-2014
Land acquisition	2010-2014
Construction works	2010-2014
Supply of rolling stock and other equipment	2009-2014

Source: Authors

- *Time horizon*
  In line with the First Interim Report and the ex-ante CBA, the time horizon for the CBA of the project is set at 30 years (incl. 4 years of construction). Accordingly, the timeframe for the project's evaluation runs from 2009, when the first capital expenditure occurred, to 2038. A mix of historical data from 2009 to 2017 (covering 8 years) and forecasts from 2018 to 2038 (covering 20 years) is used. The 30-years' time horizon matches the technical life of the rolling stock, which is assumed to last 30 years. However, in order to reach the 30 years' technical life a major investment for repairing and renewal of the rolling stock is incorporated, amounting to 33% of the initial investment in the rolling stock (in line with the assumptions of the ex-ante CBA). Replacement costs are also considered for other elements (e.g. signalisation system, technical installations etc.) at certain intervals as estimated in the ex-ante CBA. The calculated residual value accounts for those investments.

- *Constant prices and discount rates*
  In line with the guidelines of the First Interim Report, the CBA was performed using constant prices. Historical data have been adjusted and converted into Euro at 2017 prices by using the yearly average percentage variation of

consumer prices provided by the International Monetary Fund. As for data from 2017 onwards, they have been estimated in real terms (no inflation is considered).

Consistent with the choice of using constant prices, financial and social discount rates have been adopted in real terms. Specifically, inflows and outflows of financial analysis - for both the backward and forward periods of analysis – have been discounted and capitalised using a 4% real rate, as suggested in the EC CBA Guide (2014). With regard to the economic analysis, a real backward social discount rate of 2.55% and a real forward social discount rate of 3.30%, specifically calculated for the Haut Normandy region in France (see the First Interim Report for the calculation), have been adopted.

- *Without the project scenario*
  As mentioned earlier in the report the project constitutes the first tram line in Le Havre which until then has relied solely on buses for public transport. On that basis, the reference scenario for the CBA (Without the project scenario) is a "Business as usual" scenario, which means that no actions are implemented to significantly improve (infrastructure refurbishment), extend (line construction) or modernise (rolling stock and depot improvement) the existing public transport network. Maintenance is only ensured in order to avoid collapse of the system

- *Data sources*
  The analysis relied on data provided by CODAH's financial service and transport and sustainability service, as well as LiA (transport operator), and on the opinions of the experts interviewed. Moreover, information has been gathered from a review of documents available online and on the local press.

- *Technical features*
  The structural features of the tramway system include:

  - A 575 metres long tunnel
  - 7 to 8 metres large tramway platforms, partly grassed, and holding 3 299 eight-metre rail sections. The lawns do not require artificial watering.
  - Tram stations, including furniture, shelters, lighting, information panels, ticket machines.
  - 22 'Citadis' low-floor rolling stocks, each 32.6 metres long and 2.4 metres high, with a capacity for 250 people including 54 seated. The Citadis was designed and built by Alstom Transport.
  - Tramway equipment: high voltage equipment, including the overhead cabling, traction equipment, rectification substations; low voltage equipment, including traffic lighting, operating systems, user information systems, communication systems.
  - Street planning and works, including pedestrian and cycling infrastructure, and car parking. Plants, including 500 new trees were also planted.
  - Depot and maintenance centre comprising vehicle storage facilities (capacity for 22 tramways and 60 buses), workshops, maintenance equipment, cleaning equipment, offices, fuelling station, parking spaces.

- Two park-and-ride facilities at the Grand Hameau terminus in Mont-Gaillard and Schuman station for 350 and 70 vehicles; ten bike-and-ride facilities. All parking is free to LiA travellers.

A II.1 Future scenario

Demand

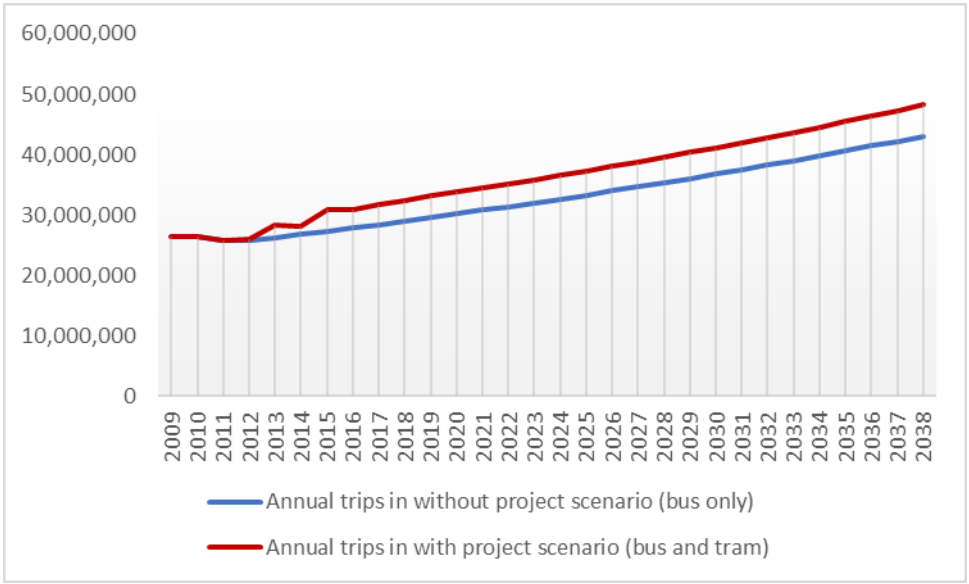
In order to assess the project's performance in the future, hypotheses have been made regarding the future trends of variables. In particular, future costs and benefits have been estimated in relation to the evolution of passengers on the City tramway network. To develop the demand analysis, the original demand and assumptions included in the ex-ante analysis have been revised based on the available information until 2017.

Hence the demand assumptions were developed at the city level, based on the following assumptions:

- For the with-project scenario
  - The total demand of public transport services (bus+tram) was adjusted to the observed values as provided by the City up to 2016;
  - The split between tram and bus passenger is based on available data until 2017 and after that maintained at the same level;
  - The growth after 2017 is based on the ex-ante assumptions, which were considered overall realistic.
- For the without-project scenario, for which no data can be directly observed after 2012 (i.e. the actual project opening)
  - The total demand of public transport services (bus+tram) was projected from the 2012 observed values (before the project opening) based on the annual growth rates assumed in the ex-ante CBA.

The historical and future trend for the with-project and without-project scenarios resulting from the above assumptions is shown in the Figure below.

Figure 23. Demand – historical data (until 2017) and forecasts.



Source: Authors

Source: Authors

In the ex-ante CBA (and based on preceding feasibility studies) a total of 4.3 million generated trips for the first year of operation has been predicted with an increasing trend of overall trips of 2% annual. For the ex-post CBA the actual increase of trips in the first year of operation has been interpreted as incremental trips, also taking into account that the overall trips of the public transport network have remained relatively stable before the first year of operation of the tram.

Table 13. Demand split by previous mode of travel (in trips per year)

YEAR	GENERATED TRIPS	PASSENGER DIVERTED FROM BUS	PASSENGER DIVERTED FROM CAR
2012	0.0	0.0	0.0
2013	2.1	10.5	1.0
2014	1.3	11.6	1.0
2015	3.5	9.8	1.0
2016	2.9	10.6	1.0
2020	3.6	11.5	1.2
2025	3.8	12.7	1.3
2030	4.4	14.0	1.4
2035	4.8	15.5	1.6

Source : Authors estimation

Supply

On the supply side, the information about the changes in the total annual km of service operated by bus and tram has been based until 2017 on observed data and afterwards based on the assumptions made in the ex-ante analysis.

A II.2 Financial Analysis

Investment cost

The investment cost of the project is detailed in the table below. The information on the investment cost was provided by CODAH.

The table below summarizes the breakdown of the investment according to the main cost categories.

Table 14. Investment cost breakdown by project component (EUR)

PROJECT ITEM	NOMINAL VALUE	PRESENT VALUE (€ 2017)
Preparatory phase (studies, design, documentation)	39,188,429	53,310,512
Land acquisition and legal settlements	10,033,920	13,142,567
Construction works	291,315,814	372,647,456
Supply of rolling stock and other equipment	57,174,800	70,986,730
Supervision, project management, information and other costs	22,412,373	29,598,364
Total	**420,125,336**	**539,685,629**

Source: Authors

The above numbers include a total of EUR 20 million (nominal) which have not yet been paid to contractors. This amount is currently debated in court with contractors demanding EUR 30 million and the operator willing to pay EUR 10 million. In the current calculations it is assumed that a total of EUR 20 million (nominal), being the

mean value, will be paid in 2020 due to the unknown outcome of this procedure. This amount has been fed into the calculations with EUR 10 million (nominal) falling under the category "Construction works" and the other EUR 10 million (nominal) under the category "Supply of rolling stock and other equipment". Since no information was provided about the matter in controversy those two categories have been considered to be the most likely to be disputed.

Residual value

Lacking detailed data on investments the same residual value as in the ex-ante CBA has been used as a base. This value has been increased proportionately to the increased CAPEX as compared to the figures used in the ex-ante CBA.

Operating & Maintenance costs

The O&M costs carried by the public transport operator (tram and bus) have been calculated based on data for the variable and fixed annual costs of tram and bus until 2017 and after that escalated based on the estimations used in the ex-ante assessment.

The unit operating costs of bus and tram services have been assessed at the same level for the reference option and for the investment option. Therefore, the incremental operating costs of the project consider changes in the vehicle kilometres in bus and tram services and additional necessary asset renewal and repair needs over the reference period. Cost for maintenance and renewal of the infrastructure is estimated on the basis of the maintenance plans as provided for the ex-ante analysis.

Operating revenues

Project revenues constitute the incremental ticket revenues collected from passengers after the project is implemented. An average revenue per passenger of 0.42 EUR net of VAT is collected per trip. Throughout the project period no price increase is foreseen.

Project's Financial Performance

On a financial basis, the profitability of the project is negative. The Financial Net Present Value (NPV) on investment is equal to EUR -581 million (at a discount rate of 4%, real), with an internal rate of return of -8.57%. Also, the Financial Net Present Value on capital is negative with the level of EUR -451 million and with the internal rate of return for capital of -12.12%. These negative values confirm that the project was in need of EU funding since no private investor would have been motivated to implement it without an appropriate financial incentive. The results of the project financial performance are presented in tables overleaf.

Table 15. Financial performance indicators of the project

INDICATOR	PRESENT VALUE (€ 2017)
FNPV/C	-581 201 478
FRR/C	-8.57%
FNPV/K	-450 791 860
FRR/K	-12.12%

Source: Authors

Table 16. Financial return on investment (EUR)

	Present value	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Operational income	30,225,140	0	0	0	66,605	847,165	521,342	1,428,433	1,197,405	1,399,316	1,453,546	1,482,617	1,512,270	1,542,515	1,573,365	1,604,833	1,636,929	1,669,668
Incremental income from tickets	30,225,140	0	0	0	66,605	847,165	521,342	1,428,433	1,197,405	1,399,316	1,453,546	1,482,617	1,512,270	1,542,515	1,573,365	1,604,833	1,636,929	1,669,668
CAPEX	-539,685,629	-6,997,241	-37,565,823	-145,456,104	-157,461,183	-35,768,300	-16,876,686	0	0	0	0	0	-20,000,000	0	0	0	0	0
Preparatory phase (studies, design, documentation)	-53,310,512	-5,232,500	-14,589,000	-7,650,000	-6,883,000	-2,879,000	-1,954,929	0	0	0	0	0	0	0	0	0	0	0
Land acquisition and legal settlements	-13,142,567	0	-1,990,000	-3,955,977	-1,972,183	-1,013,000	-1,102,760	0	0	0	0	0	0	0	0	0	0	0
Construction works	-372,647,456	0	-11,713,800	-110,489,977	-117,004,000	-29,245,300	-12,862,737	0	0	0	0	0	-10,000,000	0	0	0	0	0
Supply of rolling stock and other equipment	-70,986,730	-13,000	-5,741,800	-18,088,000	-21,687,000	-1,639,000	-6,000	0	0	0	0	0	-10,000,000	0	0	0	0	0
Supervision, project management, information and other costs	-29,598,364	-1,751,741	-3,531,223	-5,272,150	-9,915,000	-992,000	-950,260	0	0	0	0	0	0	0	0	0	0	0
OPEX	-218,115,691	0	0	0	-6,032,561	-5,955,374	-6,664,652	-7,869,477	-7,863,593	-7,990,930	-8,030,424	-8,070,112	-8,109,993	-8,150,069	-8,190,341	-17,470,809	-8,271,474	-8,312,338
Incremental operational costs	-164,645,981	0	0	0	-6,032,561	-5,955,374	-6,664,652	-7,869,477	-7,863,593	-7,990,930	-8,030,424	-8,070,112	-8,109,993	-8,150,069	-8,190,341	-8,230,809	-8,271,474	-8,312,338
Intermediate repairs of the rolling stock	-10,112,471	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Replacement of equipment	-43,357,240	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-9,240,000	0	0
Residual value	146,374,702	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	-581,201,478	-6,997,241	-37,565,823	-145,456,104	-163,427,139	-40,876,508	-23,019,996	-6,441,044	-6,666,188	-6,591,614	-6,576,878	-6,587,494	-26,597,723	-6,607,554	-6,616,975	-15,865,976	-6,634,545	-6,642,670

	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
Operational income	1,703,061	1,737,123	1,771,865	1,807,302	1,843,448	1,880,317	1,917,924	1,956,282	1,995,408	2,035,316	2,076,022	2,117,543	2,159,894
Incremental income from tickets	1,703,061	1,737,123	1,771,865	1,807,302	1,843,448	1,880,317	1,917,924	1,956,282	1,995,408	2,035,316	2,076,022	2,117,543	2,159,894
CAPEX	0	0	0	0	0	0	0	0	0	0	0	0	0
Preparatory phase (studies, design, documentation)	0	0	0	0	0	0	0	0	0	0	0	0	0
Land acquisition and legal settlements	0	0	0	0	0	0	0	0	0	0	0	0	0
Construction works	0	0	0	0	0	0	0	0	0	0	0	0	0
Supply of rolling stock and other equipment	0	0	0	0	0	0	0	0	0	0	0	0	0
Supervision, project management, information and other costs	0	0	0	0	0	0	0	0	0	0	0	0	0
OPEX	-8,353,402	-8,394,666	-71,913,815	-8,477,798	-8,519,669	-8,561,743	-8,604,023	-17,886,509	-8,689,202	-8,732,103	-8,775,213	-8,818,534	-8,862,065
Incremental operational costs	-8,353,402	-8,394,666	-8,436,131	-8,477,798	-8,519,669	-8,561,743	-8,604,023	-8,646,509	-8,689,202	-8,732,103	-8,775,213	-8,818,534	-8,862,065
Intermediate repairs of the rolling stock	0	0	-15,567,684	0	0	0	0	0	0	0	0	0	0
Replacement of equipment	0	0	-47,910,000	0	0	0	0	-9,240,000	0	0	0	0	0
Residual value	0	0	0	0	0	0	0	0	0	0	0	0	146,374,702
Total	-6,650,341	-6,657,543	-70,141,950	-6,670,496	-6,676,220	-6,681,426	-6,686,099	-15,930,227	-6,693,794	-6,696,787	-6,699,191	-6,700,991	139,672,531

Source: Authors

Table 17. Financial return on national capital (EUR)

	Present value	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Inflows	94,459,278	0	0	0	66,605	847,165	521,342	1,428,433	1,197,405	1,399,316	1,453,546	1,482,617	1,512,270	1,542,515	1,573,365	1,604,833	1,636,929	1,669,668
Incremental income from tickets	30,225,140	0	0	0	66,605	847,165	521,342	1,428,433	1,197,405	1,399,316	1,453,546	1,482,617	1,512,270	1,542,515	1,573,365	1,604,833	1,636,929	1,669,668
Residual value	64,234,138	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Outflows	-545,251,138	0	-4,037,874	-17,381,323	-36,835,707	-22,004,633	-28,211,267	-69,766,234	-19,890,566	-26,366,280	-16,382,897	-16,456,950	-16,672,891	-16,850,097	-16,962,187	-26,260,712	-17,046,542	-17,044,033
National subsidies	-91,671,257	0	-2,395,462	-15,817,881	-22,677,619	-6,193,631	-11,747,187	-12,565,928	-3,006,791	-619,948	0	0	0	0	0	0	0	0
Other national contributions	-2,151,430	0	-1,507,273	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OPEX	-218,115,691	0	0	0	-6,032,561	-5,955,374	-6,664,652	-7,869,477	-7,863,593	-7,990,930	-8,030,424	-8,070,112	-8,109,993	-8,150,069	-8,190,341	-17,470,809	-8,271,474	-8,312,338
Capital repayment	-170,028,477	0	-45,752	-853,955	-4,126,007	-5,489,108	-5,524,181	-45,560,527	-5,598,193	-14,590,593	-5,312,241	-5,354,170	-5,397,627	-5,442,668	-5,489,353	-5,537,742	-5,587,900	-5,639,893
Interest repayment	-63,284,282	0	-89,386	-709,486	-3,999,521	-4,366,520	-4,275,247	-3,770,302	-3,421,989	-3,164,809	-3,040,231	-3,032,668	-3,165,271	-3,257,360	-3,282,494	-3,252,161	-3,187,167	-3,091,802
Total	-450,791,860	0	-4,037,874	-17,381,323	-36,769,102	-21,157,467	-27,689,926	-68,337,801	-18,693,161	-24,966,964	-14,929,350	-14,974,333	-15,160,621	-15,307,582	-15,388,822	-24,655,879	-15,409,613	-15,374,365

	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
Inflows	1,703,061	1,737,123	1,771,865	1,807,302	1,843,448	1,880,317	1,917,924	1,956,282	1,995,408	2,035,316	2,076,022	2,117,543	148,534,595
Incremental income from tickets	1,703,061	1,737,123	1,771,865	1,807,302	1,843,448	1,880,317	1,917,924	1,956,282	1,995,408	2,035,316	2,076,022	2,117,543	2,159,894
Residual value	0	0	0	0	0	0	0	0	0	0	0	0	146,374,702
Outflows	-17,024,960	-16,988,759	-80,418,206	-16,877,072	-16,807,239	-16,731,834	-16,653,914	-25,809,268	-16,486,853	-16,406,081	-16,326,766	-16,245,253	-16,165,397
National subsidies	0	0	0	0	0	0	0	0	0	0	0	0	0
Other national contributions	0	0	0	0	0	0	0	0	0	0	0	0	0
OPEX	-8,353,402	-8,394,666	-71,913,815	-8,477,798	-8,519,669	-8,561,743	-8,604,023	-17,886,509	-8,689,202	-8,732,103	-8,775,213	-8,818,534	-8,862,065
Capital repayment	-5,693,788	-5,749,658	-5,807,575	-5,867,617	-5,929,862	-5,994,395	-6,061,299	-6,130,664	-6,202,583	-6,277,152	-6,354,469	-6,434,639	-6,517,769
Interest repayment	-2,977,769	-2,844,435	-2,696,816	-2,531,657	-2,357,708	-2,175,696	-1,988,592	-1,792,094	-1,595,068	-1,396,825	-1,197,083	-992,080	-785,563
Total	-15,321,898	-15,251,636	-78,646,341	-15,069,769	-14,963,791	-14,851,516	-14,735,991	-23,852,986	-14,491,446	-14,370,765	-14,250,743	-14,127,710	132,369,199

Source: Authors

Financial Sustainability

The project investments were co-financed by the EU (ERDF), national contributions and loans. The overall EU co-funding for this project was EUR 10 millionmillion.

The project financial sustainability is presented in the table overleaf.

Notwithstanding the negative financial performance, the operator has been able to ensure the financial sustainability of operations over time. In fact, the sustainability of the project is guaranteed by compensation payments from CODAH.

Articles L2224-1 and L2224-2 of the French General Local Authorities Code (Code général des collectivités territoriales) stipulates that the budgets of public services of an industrial or commercial nature operated under management, leased or conceded by the local authorities, must be balanced in revenue and expenditure while it is forbidden to just pay for budget deficits in a flat rate principle. However, the municipality has the right to fix rules on how and when to transfer money to public services.[71]

[71] See Rapport d'observations définitives COMMUNAUTÉ D'AGGLOMÉRATION DU HAVRE (CODAH) (2014) by the regional court of auditors for more information (https://www.ccomptes.fr/sites/default/files/EzPublish/JF00145094_JF_INTERNET1.pdf)

Table 18. Financial sustainability of the project (EUR)

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Inflows	59,845,000	49,421,784	93,429,275	154,569,353	35,802,273	38,650,016	42,382,385	30,316,196	28,169,264	27,643,546	27,711,617	27,782,270	27,854,515	27,927,365
Total revenues	0	0	0	66,605	847,165	521,342	1,428,433	1,197,405	1,399,316	1,453,546	1,482,617	1,512,270	1,542,515	1,573,365
National subsidies	0	2,395,462	15,817,881	22,677,619	6,193,631	11,747,187	12,565,928	3,006,791	619,948	0	0	0	0	0
Other national contributions	0	1,507,273	0	0	0	0	0	0	0	0	0	0	0	0
Operating subidies	0	3,421,048	0	0	0	0	0	0	0	0	0	0	0	0
EU contributions (ERDF)	0	0	513,394	4,727,129	2,759,477	343,488	2,313,024	0	0	0	0	0	0	0
Loans	47,500,000	30,000,000	65,000,000	115,000,000	0	0	0	0	0	0	0	0	0	0
Versement transport (traffic contribution)	12,345,000	12,098,000	12,098,000	12,098,000	12,098,000	12,098,000	12,098,000	12,098,000	12,098,000	12,098,000	12,098,000	12,098,000	12,098,000	12,098,000
Compensation payments	0	0	0	0	13,904,000	13,940,000	13,977,000	14,014,000	14,052,000	14,092,000	14,131,000	14,172,000	14,214,000	14,256,000
Outflows	-6,997,241	-37,700,961	-147,019,545	-165,586,710	-45,623,928	-26,676,114	-49,330,829	-9,020,183	-17,755,402	-8,352,472	-8,386,838	-28,562,897	-8,700,028	-8,771,847
Initial investments	-6,997,241	-37,565,823	-145,456,104	-157,461,183	-35,768,300	-16,876,686	0	0	0	0	0	-20,000,000	0	0
Replacement costs	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capital repayment	0	-45,752	-853,955	-4,126,007	-5,489,108	-5,524,181	-45,560,527	-5,598,193	-14,590,593	-5,312,241	-5,354,170	-5,397,627	-5,442,668	-5,489,353
Interest repayment	0	-89,386	-709,486	-3,999,521	-4,366,520	-4,275,247	-3,770,302	-3,421,989	-3,164,809	-3,040,231	-3,032,668	-3,165,271	-3,257,360	-3,282,494
Taxes	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	52,847,759	11,720,823	-53,590,269	-11,017,357	-9,821,655	11,973,902	-6,948,444	21,296,013	10,413,862	19,291,074	19,324,779	-780,628	19,154,487	19,155,519
Cumulated chash flow	52,847,759	64,568,582	10,978,313	-39,044	-9,860,699	2,113,203	-4,835,241	16,460,773	26,874,634	46,165,709	65,490,488	64,709,860	83,864,348	103,019,866

	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
Inflows	28,001,833	28,077,929	28,155,668	28,235,061	28,315,123	28,397,865	28,482,302	28,567,448	28,655,317	28,743,924	28,835,282	28,928,408	29,022,316	29,119,022	29,217,543	29,317,894
Total revenues	1,604,833	1,636,929	1,669,668	1,703,061	1,737,123	1,771,865	1,807,302	1,843,448	1,880,317	1,917,924	1,956,282	1,995,408	2,035,316	2,076,022	2,117,543	2,159,894
National subsidies	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other national contributions	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Operating subidies	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EU contributions (ERDF)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Loans	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Versement transport (traffic contribution)	12,098,000	12,098,000	12,098,000	12,098,000	12,098,000	12,098,000	12,098,000	12,098,000	12,098,000	12,098,000	12,098,000	12,098,000	12,098,000	12,098,000	12,098,000	12,098,000
Compensation payments	14,299,000	14,343,000	14,388,000	14,434,000	14,480,000	14,528,000	14,577,000	14,626,000	14,677,000	14,728,000	14,781,000	14,835,000	14,889,000	14,945,000	15,002,000	15,060,000
Outflows	-18,029,903	-8,775,068	-8,731,695	-8,671,558	-8,594,093	-71,982,075	-8,399,273	-8,287,571	-8,170,090	-8,049,891	-17,162,759	-7,797,651	-7,673,977	-7,551,552	-7,426,719	-7,303,332
Initial investments	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Replacement costs	-9,240,000	0	0	0	0	-63,477,684	0	0	0	0	-9,240,000	0	0	0	0	0
Capital repayment	-5,537,742	-5,587,900	-5,639,893	-5,693,788	-5,749,658	-5,807,575	-5,867,617	-5,929,862	-5,994,395	-6,061,299	-6,130,664	-6,202,583	-6,277,152	-6,354,469	-6,434,639	-6,517,769
Interest repayment	-3,252,161	-3,187,167	-3,091,802	-2,977,769	-2,844,435	-2,696,816	-2,531,657	-2,357,708	-2,175,696	-1,988,592	-1,792,094	-1,595,068	-1,396,825	-1,197,083	-992,080	-785,563
Taxes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	9,971,929	19,302,861	19,423,973	19,563,503	19,721,030	-43,584,210	20,083,029	20,279,877	20,485,227	20,694,033	11,672,523	21,130,757	21,348,339	21,567,470	21,790,823	22,014,562
Cumulated chash flow	112,991,796	132,294,657	151,718,630	171,282,134	191,003,163	147,418,953	167,501,982	187,781,859	208,267,086	228,961,119	240,633,642	261,764,399	283,112,737	304,680,208	326,471,031	348,485,593

Source: Authors

A II.3 Economic Analysis

From market to accounting prices

In line with the CBA Guide (2014), the social opportunity cost of the project's inputs and outputs has been considered in the economic analysis. For this purpose, market prices have been converted into accounting prices by using appropriate conversion factors. As for labour, it is worth noting that the shadow wage provided in the First Interim Report for France (0.83 backward) has been adopted to correct past values, and 0.82 has been used to correct future values. The table below summarises the conversion factors applied for each cost item.

Table 19. Conversion factors for input

ITEM	CONVERSION FACTOR	SOURCE
Labour cost under investment costs and operating costs	0.83 backwards 0.82 forwards	Conversion factors for labour as reported in the First Interim Report, Volume I
Standard conversion factors	1 backwards 1 forwards	Conversion factors as reported in the First Interim Report, Volume I
Conversion factor intermediate repairs of the rolling stock	0.847 backwards 0.838 forwards	Own calculations
Conversion factor replacement of equipment	0.983 backwards 0.982 forwards	Own calculations
Conversion factor construction works	0.983 backwards 0.982 forwards	Own calculations

Source: Authors based on cited sources

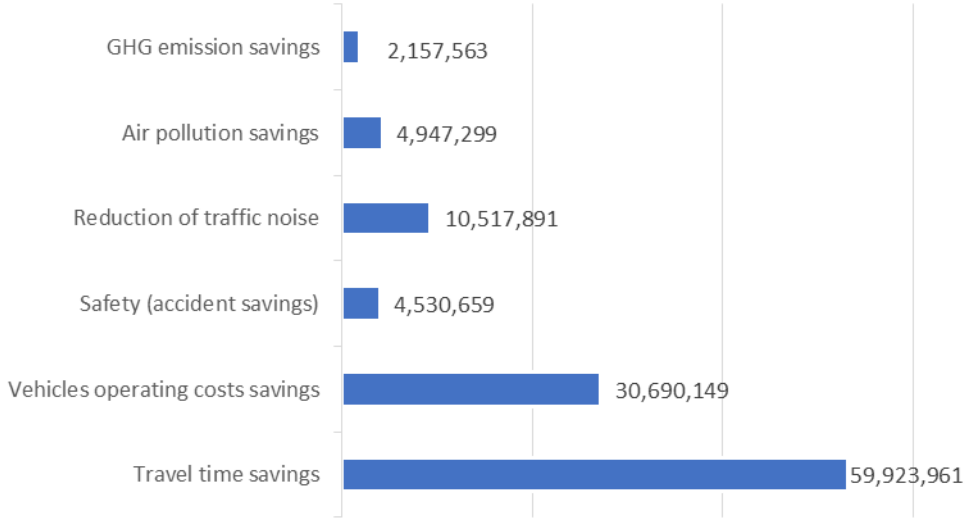
Project's effects

Benefits generated by the implementation of the project can be distinguished into:

- Change in consumer surplus, represented by the time savings;
- Changes in producer surplus, represented by trip cost savings for transport producers other than the public transport operator (the latter being included in the OPEX);

Reduction in negative externalities because of the traffic diverted from road to the tram, including air pollution savings, GHG savings, reduction of collisions and accidents and reduction of traffic noise.

Main socioeconomic benefits (Present Value, EUR)



Source: Authors

In what follows a description of each effect's estimation is provided.

Time savings

The time savings have been calculated for three types of tram users:

- Those having used a car before;
- Those having used the bus before;
- Those which did not use any type of transport before.

The shares of those three categories have been defined based on a feasibility study preceding the project as follows:

- Former public transport users: 78.1%
- Former car users: 15.3%
- New users without former mobility: 6.6%

However, based on insights from interviews which stated that the share of trips deviated from cars has been overestimated the values have been adopted as follows:

- Former public transport users: 85.75%
- Former car users: 7.65%
- New users without former mobility: 6.6%

The average time savings per trip for each category has been provided as well by the feasibility study that has been conducted before the construction of the tramway. The calculations of average time savings have been based on a comprehensive traffic model, taking e.g. into account effects like traffic lights, time for transfer and congestion as well as different trips length. Those assumptions have also been used for the ex-post CBA since the underlying assumptions of the calculations did not vary in a remarkable way and also due to the lack of more recent data.

The unit time cost for France for different trip purposes (commuting, business and other) have been calculated according to the methodology described in the First Interim Report, Volume I.

The travel time savings amount to a total of EUR 60 million and represent the biggest share of all socio-economic benefits coming from the project (53.1%).

Trip cost savings

In line with the approach adopted in the ex-ante CBA, the passenger km diverted form car for the calculation of the trip cost savings was estimated as a fraction (7.65%) of the tram trips. The unit parameters applied for the ex-post trip cost calculation follow the methodology of the ex-ante CBA, escalated to 2017 values, and are based on French national guidelines.

The trip cost savings amount to a total of EUR 30.7 million and have a share of 27.2%.

Air pollution savings

Air pollution refers to emissions of localised air pollutants that are likely to be generated by a transport investment and that negatively impact on human health and ecosystems. The approach followed for the calculation of air pollution savings is in line with the one adopted ex-ante. The unit costs escalated to 2017 values and differentiated by vehicle category (i.e. car and bus) and appropriate for urban area were used for multiplication by the ex-post volumes of vehicle km.

This external benefit represents EUR 5 million and thus approximately 4.4% of the total economic benefits coming out of the project ex-post analysis.

GHG emission savings

The methodology for calculating GHG emission savings is in line with the methodology in the First Interim Report. Savings come from both, reduced vehicle km for cars and buses. The variations of bus kilometres caused by the project has been based on real data until 2017 and projections from there on. For private cars the annual reduction of km provided in the ex-ante CBA has been used which is based on an elaborate traffic model. The GHG emissions per vehicle-kilometre and the unit cost of CO_2 have been based on the First Interim report. The shares of types of private vehicles (i.e. cars, motorcycles, light commercial vehicles, heavy good vehicles) are based on statistics from the French Ministry for an Ecological and Inclusive Transition. For the calculations it has been taken into account that it is unlikely that public transport diverts passengers from heavy good vehicles and thus this vehicle type has not been considered.

This external benefit represents EUR 2.2 million and thus approximately 1.9% of the total economic benefits coming out of the project ex-post analysis.

Reduction of collisions and accidents

The project area is too small to produce statistically significant effects in terms of safety. However, it is assumed that the tram, by reducing car and bus km, positively contributes to the safety of the area.

The effect resulting in decreased number of accidents including injuries and fatalities. The ex-post assessment was made on the basis social accident unit parameters as recommended by the Volume I of the First Interim Report for fatalities, severe injuries

and slight injuries with the data coming from the National Interministerial Observatory for Road Safety and the French Commissioner-General for Sustainable Development.

This external benefit represents EUR 4.5 million and thus approximately 4% of the total economic benefits coming out of the project ex-post analysis.

Reduction of traffic noise

The external cost of noise pollution catches harmful noise emitted by means of transport. In the ex-post CBA noise benefits have been calculated following the methodology of the First Interim Report, which provides noise unit costs for the EU in 2017 values for different modes of transport (car, motorcycle, bus, commercial vehicle and heavy goods vehicle). Different values are provided for day and night, for dense and thin traffic and for urban, suburban and rural settings in form of a matrix. The shares of modes of transport have been calculated based on statistics from the French Ministry for an Ecological and Inclusive Transition, again taking into account that urban transport is unlikely to divert traffic from heavy goods vehicles. The difference between the counterfactual and the present situation for buses and private vehicles have been calculated, respectively, based on the actual numbers (extended by future projections) and based on the feasibility study underlying the ex-ante CBA.

This external benefit represents EUR 10.5 million and thus approximately 9.3% of the total economic benefits coming out of the project ex-post analysis.

Project's Economic Performance

The results of the economic analysis are presented in the table below.

Table 20. Economic performance indicators of the project

INDICATOR	EUR
ENPV	-497 979 694
B/C	0.18
EIRR	-6.29%

Source: Authors

The results of the ex-post Cost-Benefit Analysis indicate that the **project's measurable benefits** fall short of the costs from a socio-economic point of view. Despite the project creates a number of positive effects, they cannot offset the huge investment cost.

It is important to note that the indicators used in the CBA only partly reflect the socio-economic effects of the project. There are intangible long-term contributions that, although observable in an ex-post perspective, may are difficult to translate in monetary terms (for example urban renewal, aesthetic improvements and social cohesion). Although they are expected to be ancillary to direct effects accounted for in the CBA, they may be relevant particularly with respect to a comprehensive understanding of the project performance.

Table 21. Economic return of the project (EUR)

	Present value	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
CAPEX	-459,227,580	-5,809,920	-34,286,250	-141,381,009	-152,616,455	-34,613,060	-16,164,137	0	0	0	0	0	-19,820,000	0	0	0
Preparatory phase (studies, design, documentation)	-38,012,183	-4,342,975	-12,108,870	-6,349,500	-5,712,890	-2,389,570	-1,622,591	0	0	0	0	0	0	0	0	0
Land acquisition and legal settlements	-11,521,166	0	-1,990,000	-3,955,977	-1,972,183	-1,013,000	-1,102,760	0	0	0	0	0	0	0	0	0
Construction works	-324,845,332	0	-11,514,665	-108,611,647	-115,014,932	-28,748,130	-12,644,070	0	0	0	0	0	-9,820,000	0	0	0
Supply of rolling stock and other equipment	-63,390,264	-13,000	-5,741,800	-18,088,000	-21,687,000	-1,639,000	-6,000	0	0	0	0	0	-10,000,000	0	0	0
Supervision, project management, information and other costs	-21,458,634	-1,453,945	-2,930,915	-4,375,884	-8,229,450	-823,360	-788,716	0	0	0	0	0	0	0	0	0
OPEX	-225,541,373	0	0	0	-6,032,561	-5,955,374	-6,664,652	-7,869,477	-7,863,593	-7,990,930	-8,030,424	-8,070,112	-8,109,993	-8,150,069	-8,190,341	-17,304,489
Incremental operational costs	-170,630,625	0	0	0	-6,032,561	-5,955,374	-6,664,652	-7,869,477	-7,863,593	-7,990,930	-8,030,424	-8,070,112	-8,109,993	-8,150,069	-8,190,341	-8,230,809
Intermediate reparis of the rolling stock	-9,127,766	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Replacement of equipment	-45,782,982	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-9,073,680
Residual value	74,021,737	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Socio-economic benefits	112,767,522	0	0	0	51,152	4,238,488	4,295,213	4,455,355	4,572,641	4,819,718	4,920,550	5,023,646	5,128,931	5,236,453	5,346,116	5,458,105
Travel time savings	59,923,961	0	0	0	30,165	2,284,921	2,342,216	2,416,192	2,456,625	2,576,035	2,627,556	2,680,107	2,733,709	2,788,383	2,844,151	2,901,034
Vehicles operating costs savings	30,690,149	0	0	0	15,449	1,170,226	1,199,569	1,237,456	1,258,164	1,319,320	1,345,707	1,372,621	1,400,073	1,428,075	1,456,636	1,485,769
Safety (accident savings)	4,530,659	0	0	0	1,410	149,136	147,465	155,617	164,079	176,003	181,785	187,886	194,193	200,711	207,305	214,116
Reduction of traffic noise	10,517,891	0	0	0	3,309	394,193	383,551	404,212	426,492	455,526	464,636	473,929	483,407	493,075	502,937	512,996
Air pollution savings	4,947,299	0	0	0	505	181,785	165,816	179,600	198,122	216,055	220,376	224,783	229,279	233,865	238,542	243,313
GHG emission savings	2,157,563	0	0	0	315	58,228	56,595	62,279	69,159	76,780	80,491	84,320	88,270	92,344	96,545	100,878
Total	-497,979,694	-5,809,920	-34,286,250	-141,381,009	-158,597,864	-36,329,945	-18,533,576	-3,414,122	-3,290,952	-3,171,212	-3,109,874	-3,046,466	-22,801,062	-2,913,616	-2,844,224	-11,846,384

	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
CAPEX	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Preparatory phase (studies, design, documentation)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Land acquisition and legal settlements	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Construction works	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Supply of rolling stock and other equipment	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Supervision, project management, information and other costs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OPEX	-8,271,474	-8,312,338	-8,353,402	-8,394,666	-68,529,470	-8,477,798	-8,519,669	-8,561,743	-8,604,023	-17,720,189	-8,689,202	-8,732,103	-8,775,213	-8,818,534	-8,862,065
Incremental operational costs	-8,271,474	-8,312,338	-8,353,402	-8,394,666	-8,436,131	-8,477,798	-8,519,669	-8,561,743	-8,604,023	-8,646,509	-8,689,202	-8,732,103	-8,775,213	-8,818,534	-8,862,065
Intermediate reparis of the rolling stock	0	0	0	0	-13,045,719	0	0	0	0	0	0	0	0	0	0
Replacement of equipment	0	0	0	0	-47,047,620	0	0	0	0	-9,073,680	0	0	0	0	0
Residual value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	146,374,702
Socio-economic benefits	5,572,469	5,689,259	5,808,529	5,930,331	6,054,721	6,181,755	6,311,490	6,443,984	6,579,298	6,717,493	6,858,631	7,002,777	7,149,995	7,300,353	7,453,920
Travel time savings	2,959,055	3,018,236	3,078,600	3,140,172	3,202,976	3,267,035	3,332,376	3,399,024	3,467,004	3,536,344	3,607,071	3,679,212	3,752,797	3,827,853	3,904,410
Vehicles operating costs savings	1,515,484	1,545,794	1,576,710	1,608,244	1,640,409	1,673,217	1,706,682	1,740,815	1,775,631	1,811,144	1,847,367	1,884,314	1,922,001	1,960,441	1,999,649
Safety (accident savings)	221,150	228,415	235,919	243,669	251,674	259,942	268,482	277,302	286,412	295,821	305,539	315,577	325,944	336,652	347,712
Reduction of traffic noise	523,256	533,721	544,395	555,283	566,389	577,716	589,271	601,056	613,077	625,339	637,846	650,603	663,615	676,887	690,425
Air pollution savings	248,179	253,142	258,205	263,369	268,637	274,010	279,490	285,080	290,781	296,597	302,529	308,579	314,751	321,046	327,467
GHG emission savings	105,345	109,951	114,699	119,593	124,637	129,834	135,190	140,708	146,393	152,248	158,280	164,491	170,888	177,475	184,257
Total	-2,699,006	-2,623,079	-2,544,873	-2,464,335	-62,474,749	-2,296,043	-2,208,179	-2,117,759	-2,024,725	-11,002,696	-1,830,571	-1,729,326	-1,625,218	-1,518,180	144,966,557

Source: Authors

A II.4 Sensitivity analysis

A sensitivity analysis has been carried out on the key variables in order to determine whether they are critical or not. The procedure requires to make them vary one at a time by a +/-1%, and then to assess the corresponding change in the Economic NVP and IRR.[72] A variable is referred to as "critical" if the corresponding variation in the economic output is greater than 1% in absolute value.

The Authors tested the sensitivity of number of different variables. As a result of the sensitivity test (see table below), the following 2 critical variables have been identified: *annual growth rate of tram trips; annual growth rate of bus trips; annual growth rate of operational costs for tram.*

Table 22. Results of the sensitivity analysis

INDEPENDENT VARIABLE	VARIATION (in % or percentage points) of the ENPV due to a ± 1% variation (or variation in ±1 percentage point)	CRITICALITY JUDGEMENT *
Average vehicle operation cost / km	-0.06%	Not critical
Annual growth rate of tram trips	-1.79 percentage point	Critical
Annual growth rate of bus trips	-0.74 percentage point	Not critical
Annual growth rate of bus offer (kms)	-11.91 percentage point	Critical
Annual growth rate of operational costs for buses	-0.04 percentage point	Not critical
Annual growth rate of operational costs for tram	3.01 percentage point	Critical
Accidents	-0.02%	Not critical
Average time saved (minutes)	-0.12%	Not critical

Very critical: ΔNPV > +5% (or 5 percentage points); Critical: ΔNPV > +1% (or 1 percentage point); Not critical: ΔNPV < +1% (or 1 percentage point).

A II.5 Risk Assessment

The risk assessment has been conducted on the three critical variables as a result of the sensitivity analysis (*annual growth rate of tram trips; annual growth rate of bus trips; annual growth rate of operational costs for tram)* and an additional variable of interest (*annual growth rate of bus trips* which is negatively correlated to *annual growth rate of tram trips*). For the sake of simplicity, it was assumed that the probability distribution of each of these variables is triangular, with the value with the highest probability being the reference one – that is, the "base value" adopted for carrying out the CBA – and the lower and upper bounds being the "pessimistic" and "optimistic" values defined in the scenario analysis.

The analyses have been elaborated using the Monte Carlo simulation technique with 10,000 random repetitions. In brief, at each iteration it is randomly extracted a value from the distribution of each of the independent variables. The extracted values are then adopted for computing the ENVP and IRR. Finally, the 10,000 estimated values of ENPV and IRR are used to approximate the probability distribution of the two indicators.

[72] In case of variables expressed in percentage, the variation applied in this case study is of 1 percentage point.

The risk assessment shows that the expected value of the ENPV is equal to EUR -462.2 million, and that the expected value of the ERR is -5.4% as in the reference case. The probability that the ENPV will become positive and that the ERR will be higher that the SDR adopted in the analysis is almost nil. However, there is nearly 45% and 40% probability that respectively the ENPV and the ERR assume a higher value than in the reference case. Hence, the CBA outputs appear to be robust to future possible variations in the key variables.

Figure 24. Results of the risk analysis for ENPV (left-hand side) and ERR (right-hand side)

CBA Reference value

-497,979,694

Estimated parameters of the distribution

Mean	-462,220,228
Median	-483,114,593
Standard deviation	131,073,624
Minimum	-779,797,464
Maximum	41,790,069

Estimated probabilities

Pr. ENPV ≤ base value	0.451
Pr. ENPV ≤ 0	0.999

CBA Reference value

-6.29%

Estimated parameters of the distribution

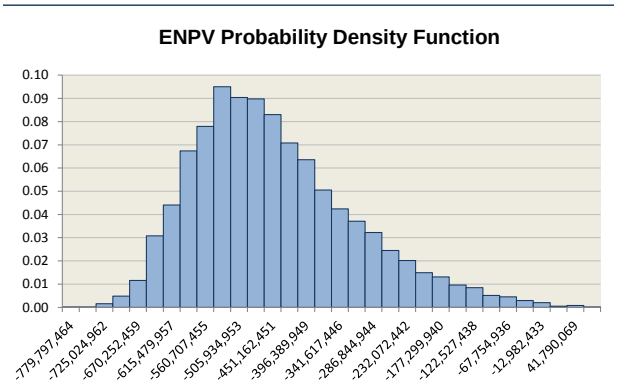
Mean	-5.40%
Median	-5.58%
Standard deviation	3.15%
Minimum	-13.63%
Maximum	3.72%

Estimated probabilities

Pr. ERR ≤ base value	0.408
Pr. ERR ≤ Social discount rate	1.000

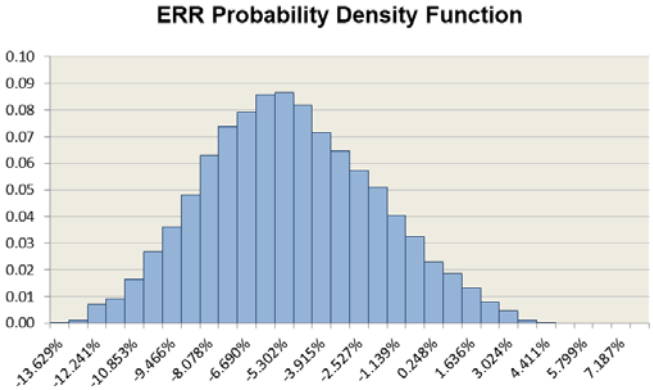
Source: Authors

Figure 25. Probabilistic distribution of the Economic Net Present Value (EUR)



Source: Authors

Figure 26. Probabilistic distribution of the Economic Internal Rate of Return



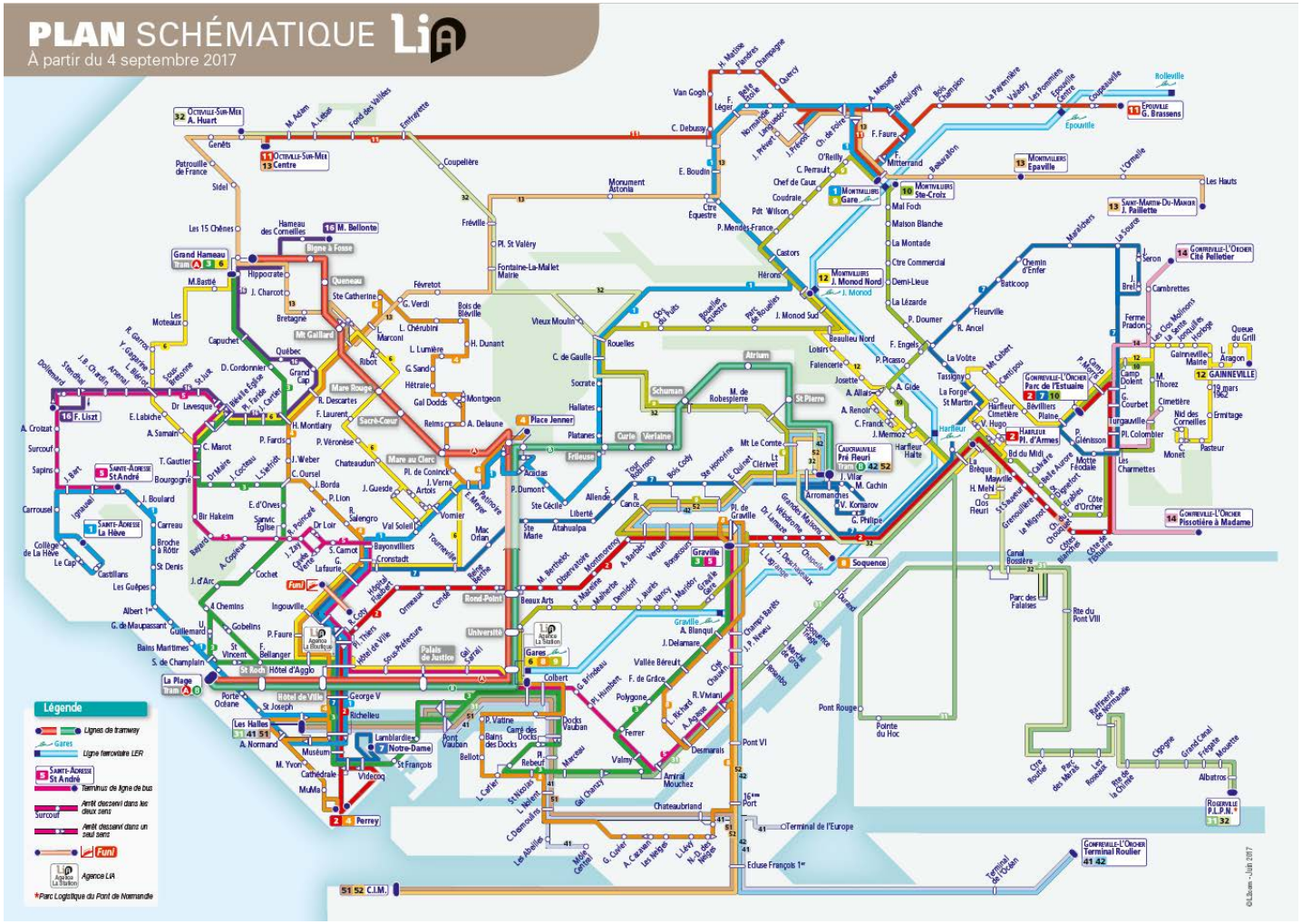
Source: Authors

ANNEX III. LIST OF INTERVIEWEES

NAME	POSITION	AFFILIATION	DATE
Alban Firmin	Finances Director	CODAH	22/12/2017
Alexandre Kauffmann	General coordination of studies and works	Systra	11/12/2017
Antoine Millet	Responsible for the transport services operation	Compagnie des transports de la porte océane "LiA"	22/11/2017
Claude Le Corre	Deputy Director General, Sustainable Development	Le Havre City Hall	23/11/2017
Hélène R. (anonymous)	Shopkeeper	Caucriauville citizen	23/11/2017
Henri P. (anonymous)	Inhabitant	Caucriauville citizen	23/11/2017
Hubert Metge	Director	Systra	16/11/2017
Jean-Louis Mignard	Deputy General Director	CODAH	11/08/2017
Julie Miclot	Director for Europe and International relations	Conseil Régional de Haute Normandie	Multiple emails
Karcher Isabelle	Director, sustainable development	CODAH	22/11/2017
Laurent Roque	Director	Normandy Region	16/11/2017
M. Leroy		CODAH Streets and Parking Directorate	Approached by phone
Magali Ravel-Mansire	Project manager, mobility and intermodality	Normandy Region, Mobility and Infrastructure Directorate	Multiple emails
Marie-Louise J. (anonymous)	Inhabitant	Mont-Gaillard citizen	23/11/2017
Marie-Pierre Haest	Assistant Director	Shopping Mall Mont-Gaillard	23/11/2017
Martine Verbruggen	ERDF Desk Officer Haute Normandie region	DG REGIO	10/01/2017
Murielle Bouchard	Journalist	Normandie-actu	09 and 15/11/2017 approached by email
Philippe Hazard	Diverse roles in setting up the tramway system	Systra	10/01/2018
Philippe JANO,	European contractual policy	Prefect/General Secretariat for Regional Affairs for the Normandy Region	22/11/2017
Sophie Capitaine	Project manager	Agence d'Urbanisme de la Région du Havre et de l'Estuaire de la Seine	22/11/2017
Thierry Lochard	Project manager, mobility and urban projects	Agence d'Urbanisme de la Région du Havre et de l'Estuaire de la Seine	22/11/2017
Véronique Delmas	Director	AtmoNormandie	24/11/2017

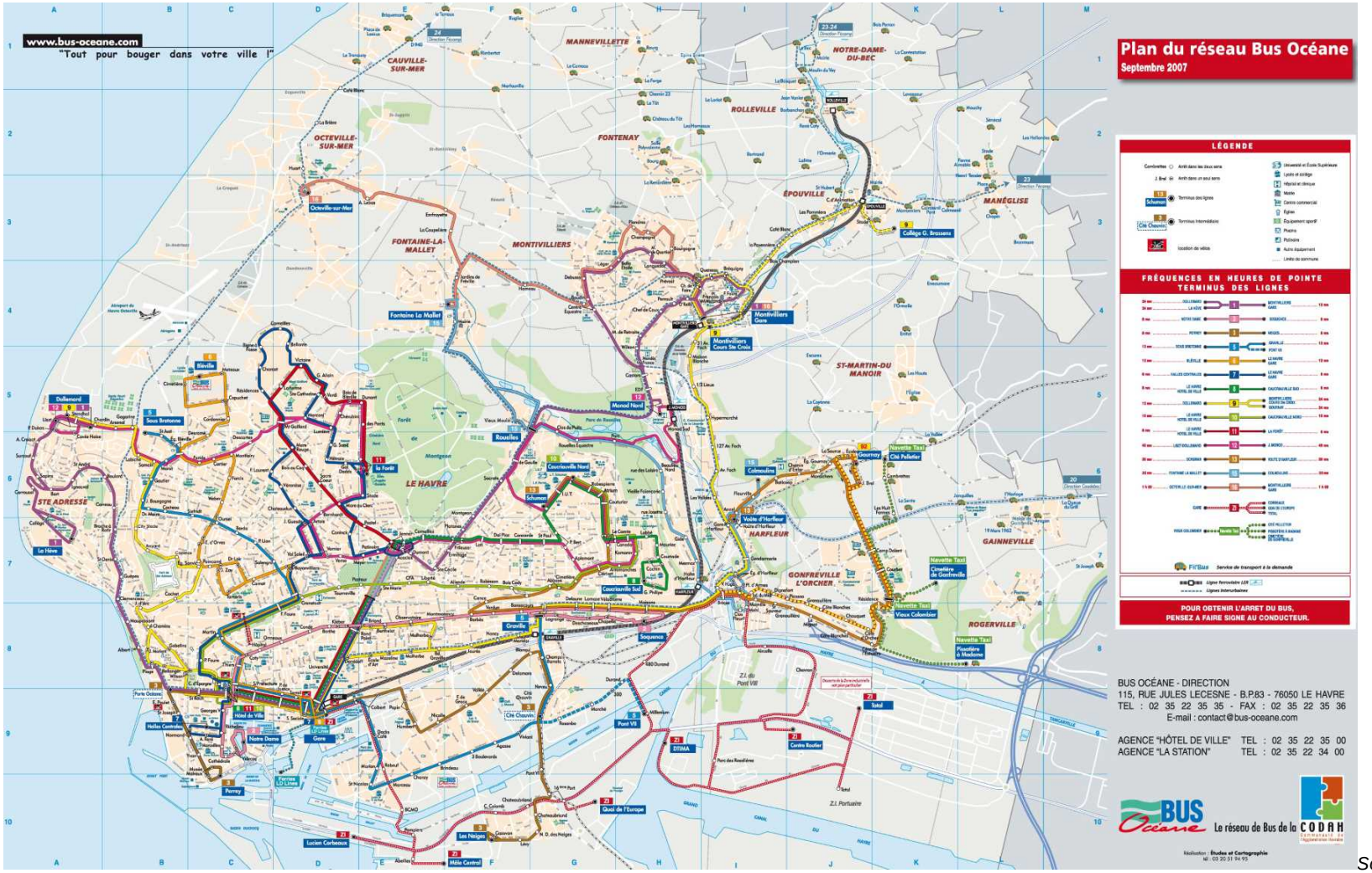
ANNEX IV. ADDITIONAL FIGURES.

Figure 27. Schematic map of LiA transport network in 2017.



Source: LiA. (2017). Retrieved from: http://www.transports-lia.fr/presentation/?rub_code=8

Figure 28. Map of LiA transport network in 2007.



Source: LiA.

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