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

# Naples Metro Line 1
# Vanvitelli-Dante Section
# Urban Railway Project

## Italy

**EUROPEAN COMMISSION**

Directorate-General for Regional and Urban Policy
Directorate Directorate-General for Regional and Urban Policy
Unit Evaluation and European Semester

*Contact:* Jan Marek Ziółkowski

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

*European Commission*
*B-1049 Brussels*

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

Naples Metro Line 1

Vanvitelli-Dante Section

Urban Railway Project

Italy

Directorate-General for Regional and Urban Policy

2020 EN

***Europe Direct is a service to help you find answers to your questions about the European Union.***

**Freephone number** (*)**:**

**00 800 6 7 8 9 10 11**

(*) The information given is free, as are most calls (though some operators, phone boxes or hotels may charge you).

Manuscript completed in 2018



Luxembourg: Publications Office of the European Union, 2020

ISBN 978-92-76-17420-2
doi: 10.2776/93616

This report is part of a study carried out by a Team selected by the Evaluation Unit, DG Regional and Urban Policy, European Commission, through a call for tenders by open procedure No. 2016CE16BAT077.

The consortium selected comprises CSIL – Centre for Industrial Studies (lead partner, Italy), Ramboll Management Consulting A/S (Denmark), Significance BV (The Netherlands) and 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 geographical coverage for the field analysis.

The authors of this report are Francesco Giffoni, Alessandra Caputo and Mario Genco. The authors are grateful to all the project managers, stakeholders and beneficiaries who provided data, information and opinions during the field work.

The authors are grateful for the very helpful insights from the EC staff and particularly to Mariana Hristcheva, Daria Gismondi, Jan Marek Ziółkowski, Jerome Glantenay and other members of the Steering Group. They also wish to thank all the stakeholders who agreed to respond to the team's questions and contributed to the realisation of the case study. The authors are responsible for any remaining errors or omissions.



Cover pictures were provided by Metropolitana di Napoli S.p.A. except the one on the bottom-left side which was retrieved (on 12/04/2018) from the following website: http://napoli.repubblica.it/cronaca/2017/07/18/news/metropolitana_di_napoli_via_libera_all_acquisto_di_10_nuovi_treni_per_la_linea_1-171020076/.

# TABLE OF CONTENTS

## LIST OF ABBREVIATIONS

| | |
|---|---|
| **ANM** | Azienda Napoletana Mobilità (metro service provider) |
| **CBA** | Cost-benefit analysis |
| **CF** | Cohesion Fund |
| **DG REGIO** | Directorate-General for Regional and Urban Policy |
| **EBIT** | Earnings Before Interest and Taxes |
| **EC** | European Commission |
| **ENPV** | Economic net present value |
| **ERDF** | European Regional Development Fund |
| **ERR** | Economic rate of return |
| **ESIF** | European Structural and Investment Funds |
| **EU** | European Union |
| **EUR** | Euro |
| **FPA** | Framework Programme Agreement |
| **GHG** | Greenhouse gas |
| **ICT** | Information and communication technologies |
| **ISPA** | Instrument for structural policy for pre-accession |
| **MCA** | Multicriteria Analysis |
| **NUTS** | Nomenclature of Territorial Units for Statistics |
| **RMS** | Regional Metro System |
| **SDR** | Social Discount Rate |
| **TEN-T** | Trans-European transport networks |
| **TEU** | Twenty-Foot Equivalent Unit |
| **ToRs** | Terms of Reference |

## EXECUTIVE SUMMARY

**This report is the outcome of the ex post assessment of the Vanvitelli-Dante section of metro Line 1 in Naples**, a major urban transport investment project co-financed by the ERDF in the 2000-2006 programming period. The ex post evaluation primarily focuses on assessing the long term effects generated by the project, identifying the key drivers and mechanisms that contributed to producing these effects and its current performance.

The analysis draws from the ex post Cost Benefit Analysis (CBA)[1] and from an extensive set of qualitative evidence, both primary (interviews with key stakeholders and experts were carried out between November 2017 and February 2018)[2] and secondary (technical reports, official reports, press articles, books and academic papers).

### *OVERALL APPROACH AND METHODOLOGY*

The overall approach and methodology followed in this ex post evaluation study is briefly outlined below and more extensively described in Annex I.

The Conceptual Framework delivered in the First Intermediate Report was developed to answer the evaluation questions included in the ToR, and further elaborated in accordance with the study team's understanding. The Team identified **three relevant dimensions of the analysis**:

- **The 'WHAT'**: this relates to the types of long-term effects that can be generated by a transport investment project. The Team classified all the possible effects under four headings: '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 analyses the factors, both external and internal to the project, that have caused the observed effects to take place and influenced the project performance. To this end, the Team identified six stylised determinants of project outcomes (i.e. relationship with the context; selection process; the project design; forecasting capacity; project governance; and managerial capacity). The interplay of these factors and their influence on the project's effects are further analysed to assess the project's final performance.

**The methodology developed to answer the evaluation questions consists of an ex post CBA 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

1 Data, hypotheses and results are discussed in Annex II.
2 See Annex III for a detailed list of interviewees.

ante 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 project's ex post performance and final outcome. It is 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 on assessing the effects that may be difficult to translate into monetary terms.

### *MAIN PROJECT FEATURES*

The Vanvitelli-Dante section of metro Line 1 was started in the mid-1990s by the Municipality of Naples and few years later was at the heart of a sustainable mobility and territorial development strategy at regional level.[3] The new strategy represented a change in perspective compared to the previous public transport policies that proved to be inadequate in addressing the problems of congestion in the city. This section of the metro was part of the Master Plan of Naples, which embodied the idea of a joint transport and land-use programme for putting the city on a sustainable development path. According to this new vision, the project was the first essential step towards improving accessibility in the city by shortening the distances between its hilly area and the historical city centre, reducing traffic on the road network and improving the quality of the public transport service. An additional rationale for the project was the need to regenerate the urban fabric in proximity of the new metro stations, where were located in decaying neighbourhoods. In the view of the policymakers a subway conceived in this way would have contributed to socio-economic development in the catchment area.

**The project consists of the construction of 5 km twin-tunnels** with an average depth of 24m and an average inclination of 5.5%, **five stations and the pedestrian tunnels connecting Line 1 with Line 2** and with **the archaeological museum of the city**. **The project also includes the completion work**[4] to make this extension fully operational. **The total initial investment cost of the project is EUR 474 million**[5] at face value. This figure also includes the cost of the art works. The five stations in the Vanvitelli-Dante section are all *Art Stations,* i.e. built with highly architectural and aesthetic criteria including contemporary works of art both inside and outside the stations.

It is worth mentioning that the scope of the present analysis is different from the one for which the request of funding was prepared in 2000-2006, since it did not include the tunnel excavation, which was part of a previous financing decision. From a functional point of view, however, the tunnels, the stations and the completion work are jointly considered in the CBA since together they justify the materialisation of the benefits.

The excavation and the construction phase took place between 1991 and 1998, the completion work was carried out between 1998 and 2003, while the operational phase started in 2004. **In the programming period 2000-2006, through an ERDF grant**

3 This was called 'Regional Metropolitan System (RMS)'. See later for details.
4 See section 1.3 for details.
5 10% VAT is excluded.

**of EUR 44 million** (50% of the eligible expenditure for completion work), **the European Commission supported the completion work. The EC's final decision to grant assistance to the project was taken in August 2005**[6] when the project was already operating and according to "retrospective" EU assistance (i.e. the project was considered coherent and functionally linked to the existing infrastructures).[7] The remaining 50% of costs related to the completion work was covered by national (35% - EUR 30.8 million) and regional (15% - EUR 13.2 million) public contributions.

### *PROJECT PERFORMANCE*

**Line 1 of the metro is currently the backbone of public transport in Naples.** However, the service delivered is currently below standard due to the insufficient number of trains circulating along the whole of Line 1. This factor dilutes the potential effects of savings in travel time. A mix of determinants including a weak managerial capacity and poor coordination among the major stakeholders could explain the lack of rolling stock. For this reason, **thirteen years on from the start of its operating phase, the assessment of the economic impact of the project yields mixed results and stresses its multi-faceted dimensions**. The overall performance of the project is discussed hereafter according to a set of evaluation criteria.

#### *Project Relevance and Coherence*

**The high relevance and coherence of the project were decisive in ensuring the project's effectiveness.** In 1997 road congestion was a serious concern for Naples. Traffic jams in the city were not only exasperating, but they also were costing Naples dearly in terms of productivity and air pollution.[8] The 1997 Urban Transport Plan - prepared by the Municipality of Naples - pointed out bottlenecks, missing links in the public transport network and lack of interoperability between different transport modes. This was considered as a constraint for the city to embark on a more sustainable development path. The concern was exacerbated by the awareness of an urban infrastructural environment of poor quality, which was damaging the image of Naples. With the goal of creating a single mobility market in the city and implementing an integrated transport and land-use programme, complex mobility infrastructures started coming to light with the Vanvitelli-Dante section, **making the project highly relevant for Naples**. Such infrastructures aimed to rebalance the modal shift towards more environmentally sustainable transport modes, develop new connections and contribute to revamping the urban landscape. The project became part of a wider regional transportation programme with the same objectives. The project was also in line with the EU transport strategy adopted in 2001.

**The project was coherent with other transport investment projects** that were to be implemented in Naples and the surrounding region in the mid-1990s. On the one hand, such interventions aimed to trigger synergies among existing local transport modes. On the other, they also aimed to connect the city to the high-speed railway linking the major cities in Italy thus enabling synergies between local mobility infrastructures and national ones.

6 EC C(2005) no. 5241.
7 See section 2.2 for details.
8 See Naples' Urban Transport Plan (1997, p. 6 and p. 36).

***Project Effectiveness***

**Despite the project having generated both positive and negative effects, the balance between them suggests that the project was effective, the net result was positive** and that the project was able to achieve its objectives. Specifically, as far as the long-term effects generated are concerned, the ex post assessment shows that:

- **The project produced moderate positive results in terms of economic growth**, as confirmed also by the results of the CBA analysis. Despite the current unsatisfactory delivery of the service, the main driver of the net benefit is the time savings for people diverted from the road network, which accounts for 86% of the total benefits generated by the project. This indicates that the metro attracts a sufficient number of people, which makes the project worthwhile for the society. Further positive impacts (not quantified in the CBA) flow from learning benefits related to technical capacities in designing and constructing underground projects integrated with the surroundings in a sustainable way. This bulk of the experience is today exported all over the world.
- **The most controversial results emerged when looking at the impact of the project on people's quality of life and the general well-being in Naples.** The project increased property values and (marginal) safety gains are quantified in the CBA. The infrastructures realised also contributed positively to people's well-being thanks to a generalised positive perception of safety and aesthetic value. Nevertheless, negative impacts and disappointment are related to the quality of the transport service in terms of waiting time, reliability and crowding. High expectations and enthusiasm in the initial phase of the project have translated, over time, into disillusionment, social distrust and high levels of frustration.
- **Environmental sustainability is another goal pursued by the project**. Its implementation has contributed to a reduction in road traffic and this has positively translated into a reduction in air pollution. In addition, the realisation of 'green' infrastructures certainly represents a step towards environmental sustainability, although it is difficult to quantify.
- The expansion of the railway network towards the downtown area and the provision of accessible stations equipped with several lifts and escalator systems facilitating access also for the disabled and the elderly represent a **considerable improvement in territorial and social cohesion.**

It should be borne in mind that **these positive results hold as long as the risk associated with future events that may negatively affect the project is minimised.** In particular, in case of delays in the realisation of the new extensions of Line 1 scheduled for 2022, the hypothesis of an expected increase in the number of passengers made by the evaluators would fall. In this case metro Line 1 (including the segment under assessment) would not benefit from additional traffic generated by the opening of new stops in relevant hubs such as the city administrative centre and the airport. Although to a lesser extent, the same risk would occur in case of delays in the delivery of new trains, whose entry into service is expected between 2019 and 2020. The assumption of an increase in the number of passengers due to an improvement in the service offer would be mistaken.

**The risk assessment suggests that there is a 50% probability that the economic value (ENPV) of the project will fall below its baseline value and a positive probability that the EIRR will fall below the adopted forward SDR, making the project unprofitable from the society viewpoint**.

**Another factor of uncertainty is the financial situation of the service provider ANM** (and the financial sustainability of the Municipality of Naples). At the time of writing, ANM is bankrupt and a financial recovery plan for the company is under preparation for approval by the court of Naples. The rejection of the plan embodies a risk not only for the investment project under evaluation, but also for the entire public transport system in Naples. This risk is not captured by the CBA and adds to the above mentioned sources of risk.

***Project Efficiency***

Under the above baseline scenario, the ex post assessment confirms that **the project is desirable from the economic point of view.** In the face of an investment cost of EUR 753 million (at 2017 prices), the Vanvitelli–Dante section yields the society monetised discounted benefits equal to EUR 1,173 million (the benefit-cost ratio is 1.35) and a positive ENPV of EUR 389 million. The ENPV remains positive although CBA measurable effects were estimated under prudential and conservative hypotheses on the benefits side and even when the impact of higher values for the forward social discount rate are simulated, confirming the robustness of the positive result.[9] The time savings by metro users and the impact on property values in the catchment areas of the stations positively contribute to these results.

It is worth remembering that the purpose of this ex post evaluation is not to compare ex ante and ex post CBAs, and that the results of this assessment are not easily comparable because, even if they rely on the same principles and draw on the established CBA methodology, there are important differences, in particular in the scope of the analysis.

As far as financial sustainability is concerned, ANM receives compensation payments from the Municipality of Naples and the Region of Campania. By drawing from these funds, **ANM allocates the necessary amount of money to the project to guarantee its financial sustainability.** As a matter of fact, in the Vanvitelli–Dante segment, the ticket revenues cover 51% of its operating and maintenance costs, which is above the threshold of 35% set by law.[10] This suggests that the project is operated in an efficient way as far as revenue collection is concerned. Moreover, the analysis of the ANM by business unit,[11] shows that the railway service yields a positive net income confirming the financial sustainability of the whole of metro Line 1 given the current level of compensation payments. However, a concern for the financial sustainability of the urban transport system stems from the financial situation when the company is considered as a whole. Over the years, and for the reasons discussed in Section 4.6 of this report, ANM experienced cuts in compensation payments which penalised services other than railways (e.g. ANM buses business unit records an average annual loss of EUR 25 million). Along with additional aspects, such as, for

[9] For instance, the "value of beauty" was not taken into account (see Box 2) because it may be, at least in part, reflected in other benefits and may not be a pure additional effect. Moreover, the impact of higher values of the SDR on the ENVP were tested to measure potential distortions of the CBA results potentially stemming from a low social discounted rate adopted for Italy. See section AII.5 Sensitivity analysis.
[10] National Law (D. Lgs.) 422/97 and subsequent amendments and integrations.

example, personnel redundancy, this is at the root of the current financially unsatisfactory situation calling for immediate and appropriate measures. Available evidence does not permit us to go further into the causes of ANM's financial insolvency or to figure out how its future may evolve.

***EU added value***

According to the evidence available, the EU added value is probably limited to the role of fund-provider if the focus is only on the Vanvitelli–Dante section. Indeed, the completion of the Vanvitelli-Dante section was co-funded when the project was already in its operational phase and this permitted regional funds to be unlocked and allocated elsewhere. In contrast, by looking at the whole of Line 1, **the analysis of EU added value demonstrates that many activities would not have been performed without the intervention of the EU**. It provided financial support through the ERDF in different phases,[12] enabling the implementation of the whole of Line 1 (including the project under assessment) since the beginning. According to the interviewees (especially those from the Managing Authority and the Municipality) the EU value added was visible in terms of know-how capitalised on previous EU projects, i.e. in how to use public resources to implement an ambitious public transport plan. For instance, they are acquiring an increasingly result-orientation competency in the management of public funds. This potential positive effect is, however, poorly documented.

Notwithstanding the EC commitment and the experience gained by local institutions, the governance structure of the project and its poor managerial capacity are key limitations that undermine its performance during the operational phase. The Commission's role is less evident in the operational phase and, according to the evidence available, materialises under the form of conditionalities for the timing and destination of funds. Although an admonishment by the Commission was sent in June 2017 (after eight years of delays) regarding the completion of the work related to the adjacent sections of metro Line 1, this was not enough to make a difference to the project management.

***MECHANISMS AND DETERMINANTS***

The analysis shows that the following determinants underlie the observed performance of the project:

- A **favourable context** positively contributed to the planning and construction phase of the project and, mainly, to its operational phase. In the mid-1990s the project fitted the real needs of the city in terms of mobility and urban regeneration. Today, the project records a moderately positive performance thanks to a persistent demand for the metro service, despite its rather unsatisfactory quality level. The interventions aimed at revamping the urban environment also represent an added value of the project. Such interventions grasped, at that time, the opportunities arising from ongoing actions by the Municipality of Naples aimed at promoting and disseminating contemporary art in the city.
- The **selection process through which the project was identified as a priority for Naples also represents a positive attribute** of the project. The 'priority status', obtained with the involvement of the major stakeholders,

[12] For details see Section 2.1 or Annex IV.

allowed for the delivery of the completion work on the Vanvitelli-Dante section on schedule. It should be borne in mind that the new course of mobility planning in Naples started in 1997, which is also the starting point for this ex post assessment. This means that any analysis of the events before this date is beyond the scope of this report.[13]

- **The design is an additional positive determinant** of the project. It made the stations functional poles for the city for both work and leisure and impacted positively on the quality of life of people.[14]
- The **forecasting capacity was affected by an optimism bias** and this negatively contributed to the project performance. The ex ante CBA was likely to be affected by an overestimation of benefits and a tendency to be overly optimistic about the completion of the planned interventions at urban and regional level (see Section 4.4 for details).
- This ex post assessment shows that a key determinant of the past, present, and probably, future performance of the project is its **governance structure. Its current arrangement did not help the coordination of the fragmented actions and often conflicting interests** of the many institutions and stakeholders involved in the project. A joint commitment between them and/or a more effective governance structure based on appropriate incentive mechanisms linking the construction phase to the operational one may limit misalignments (in terms of time and budget) between infrastructural investments and the necessary investments to deliver a good transport service.
- **Poor managerial capacity exacerbated the existing governance problems**. The poor managerial capacity negatively influenced the project from at least three points of view. Firstly, the inaccuracy of transport service planning over the years led to an insufficient number of trains. Secondly, more appropriate ex ante mitigation measures to face the risk associated with archaeology would have prevented, at least in part, cost overruns and extremely long delays in delivering the new extensions of metro Line 1. This, in turn, would probably have resulted in an increase in the number of passengers and would have avoided traffic bottlenecks in proximity of the construction sites, which were sources of annoyance for Neapolitans. Thirdly, the actors failed to promptly implement effective actions to face the progressive reduction in funds due to the crisis and to solve the financial problems of ANM stemming from internal management issues and factors external to the company (e.g. the financial difficulties of the Municipality and the crisis itself).

***CONCLUSIONS***

The story of the Vanvitelli-Dante section is strongly intertwined with that of the whole of Line 1, including its performance and generated effects. **The ex post assessment delivers a singular and bizarre story of an urban transport project of great urban regeneration success and unexploited potential for the local public**

13 For instance, several project amendments, delays and disputes occurred during the construction and excavation work on the project were officially approved in 1982 and realised between 1991 and 1998. The discussion of these facts falls outside of the present ex post evaluation. See European Court of Justice: Judgement of the Court of First Instance on 31 May 2005. Similarly, different and alternative project options such as the type of metro to be built (light metro versus heavy metro); different routes, etc.. were discussed in the 1960s and 1970s and this goes beyond the scope of this assessment.

14 Conceived in an economic upturn, the design is currently criticised for the high maintenance costs of the Art stations.

**transport service**. The project generated relevant long-terms effects from the infrastructural standpoint. In contrast, the transport service is currently unsatisfactory to meet the demand for mobility in the city. As quantified in the CBA, the balance of these two aspects is a slightly positive net benefit for society, meaning that **compared to the 1990s** (i.e. when the new urban and regional mobility strategy was conceived), **appreciable results have been achieved, but they are well below the ex ante expectations.**

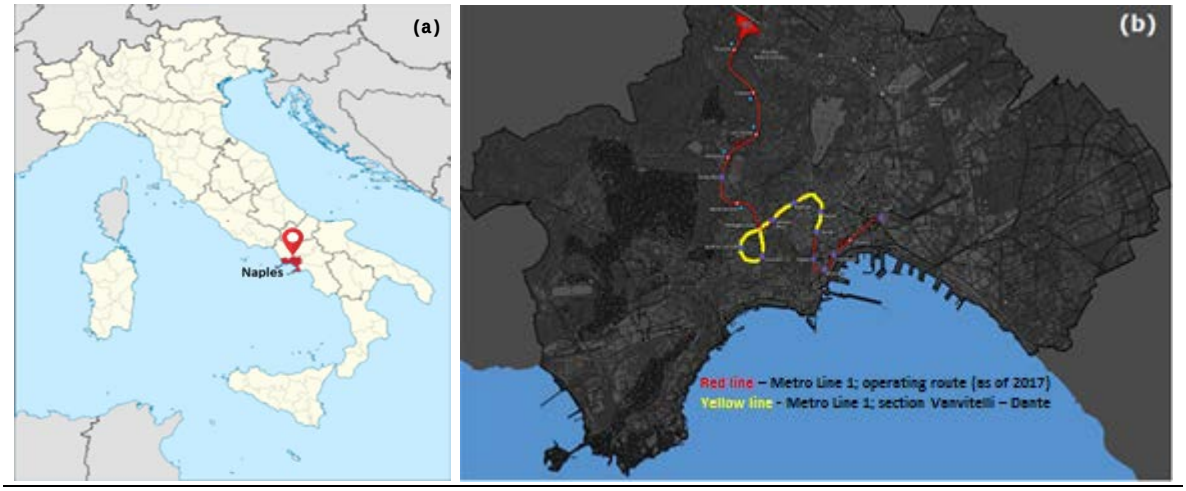
**The key lesson to be learned from this report is that ambitious goals**, such as those that metro Line 1 was expected to achieve, **must be accompanied by exceptional technical and strategic capacities on the part of local institutions and project managers**. While technical capacities were ensured, strategic capacities fell short, especially in terms of planning, coordinating and maintaining on track the challenging implementation of the project. The fact that good pre-conditions did not turn into a satisfying and efficient public transport service reflects a managerial capacity of poor quality at local level. **Similarly, a joint commitment and synergies between uncoordinated actions are necessary to pursue such goals along with a clear political will** by local actors to put more effort into the delivery of a better service to the people. Until now, the weak project governance structure has prevented a strong partnership developing among the key players and such a condition from being satisfied. Moreover, as most interviewees from the different institutions explained, the project was planned according to an excellent urban regeneration vision, while less importance was given to the transport service, which is suffering from a myopic ex ante forward-looking planning. These are the main reasons for the rather poor, or not as good as expected ex ante, performance of the project in terms of the transport quality offered.

Today, the project is shrouded in great uncertainty; however, there is scope for targeted actions to enhance project performance. **The Municipality of Naples, the Region of Campania and the metro service operator ANM** are jointly working in this direction and they have already **agreed actions and strategies to face the current challenges in the local transport sector**. **The success of the project will depend on their commitment to the announced strategies.**

## 1. PROJECT DESCRIPTION

The urban transport project '**Naples Metro Line 1, Vanvitelli–Dante section' concerns the completion work**[15] (i.e. catenary system and electricity supply network, anti-vibration tracks, signalling, spacing and traffic management system; lift and escalator systems) **related to an already existing 5 km tunnel of metro Line 1 in the city of Naples,** capital of the Campania region in the South of Italy (Figure 1a). Planned in 1997 as part of the Naples Urban Transport Plan,[16] **the project aimed to extend,** with five additional stations, **the existing metro Line 1 from the hilly area of Naples,** where hospitals and rich residential and commercial neighbourhoods are located, **to the historic city centre,** located in the lower area of the city (Figure 1b yellow section).

**Figure 1. Naples in the south of Italy and the operating section of Metro line 1 (in red) serving the city of Naples. The Vanvitelli–Dante section is in yellow.**




*Source: Authors. Figure 1b is a modified map. The original one was from the MN Metropolitana di Napoli S.p.A website.*

The primary objective was to improve the quality and quantity of metro services available to citizens and commuters, increase the use of public transport in the city and reduce congestion and its negative consequences on the urban road network. In addition, the project was also planned to regenerate the urban environment by realising stations with highly architectural standards and revamping their surrounding areas.

The project co-funded by the ERDF in the programming period 2000-2006, concerned only the completion work as listed above. However, **in order to have a '*self-sufficient unit of analysis*' and for evaluation purposes, this ex post assessment also includes excavation work, and tunnel and station construction** carried out between 1991 and 1998. The idea is that both tunnels and completion work (i.e. the necessary equipment permitting the trains to run) are essential for the project to produce the expected benefits, independently of how and when they were financed. It makes no sense to analyse the two components separately (see Section 1.3 for a detailed explanation). Accordingly, the total initial investment cost of the Vanvitelli-Dante section amounted to EUR 474 million in

[15] CCI number: 2003IT161PR007.

[16] Approved by the city council on March 18, 1997 with resolutions n. 90 and 91.

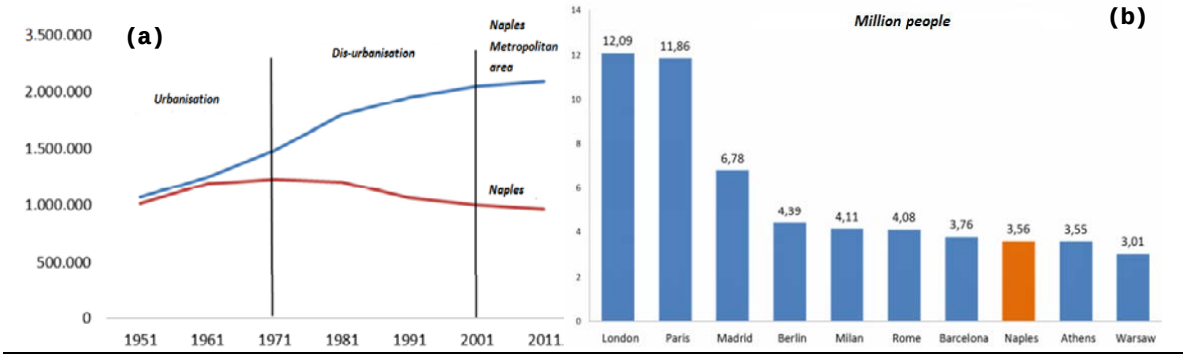
nominal terms (10% VAT excluded).[17] Fully operational since 2004, **all the stations in this segment are 'Art Stations'**, i.e. designed according to high-quality standards from both the functional and aesthetic points of view, **while some of them also include archaeological finds in their exterior and interior parts**.

### *1.1 PROJECT CONTEXT*

With its 970,185 inhabitants, **Naples is the third most populated municipality in Italy**, after Rome and Milan,[18] while the wider Naples metropolitan area has a population of about 3,500,000 (53% of the entire Campania region).

Over the decades, the demographic relationship between Naples and its surrounding area has changed dramatically (Figure 1a). After a period of strong urbanisation, people started to move from Naples to peripheral areas, reaching the current situation in which the 92 municipalities forming the Naples metropolitan area are welded together to generate a single, huge and undifferentiated urban zone centred around Naples. The **Naples metropolitan area is the 8th most populated metropolitan area in Europe**, comparable to Barcelona and Athens (Figure 1b) and **has always been one of the most densely populated areas in Europe.** In 2016 the population density was 2,645 inhabitants/km$^2$ in the Naples metropolitan area and 8,220 inhabitants/km$^2$ in Naples city (the highest in Italy)**.**

**Figure 2. Population dynamics in Naples city and metropolitan area**




*Source: Giorgio Rota report on Naples (2014)*

Located in the less developed part of Italy, **Naples' economy has historically been weak** despite several nationally-promoted industrialisation projects bringing large-scale industrial complexes into the city since the early 1900s. The process of deindustrialisation that occurred during the seventies and the eighties (with a loss of 36% of manufacturing companies and 27% of industrial jobs) changed the economic structure of the city, which, in the middle of the nineties, was largely based on public and private services and commerce, and less on industry and agriculture. Since then, the **Naples area has made significant economic progress**, although unemployment, political instability, organised crime and urban decay have haunted the city and its surrounding area. Today, **Naples' GDP amounts to EUR 50.5 billion,[19] third in Italy**, behind Rome and Milan, **and 26th (out of 115 cities) in Europe.**

**This new course of the Neapolitan economy is confirmed by the fact that overall employment in the city (and in Campania) continued to grow in 2016**

17 For further details see Table 6, Section 1.3
18 (ISTAT, 2017)
19 Giorgo Rota report on Naples (2014; 2016). This equals to about EUR 14,000 per capita.

**compared to 2015.** The annual growth rate was 3.8% in 2016 compared to just 1% in 2015. Growth in employment in the area was higher than the national average (about 1.5%)[20] partly because of the return of workers to the Neapolitan industrial sector after the crisis and partly because of the more sustained trend in services, especially those in trade, hotels and restaurants. The latter represents 5% of the city's GDP and **benefitted from the favourable tourist flows.** In 2016 the number of foreign tourists in Naples and its surrounding area increased by 9% compared to 2015, accounting for 71% of the total number foreign tourists in Campania (Table 1). They were mainly attracted by the historic centre of Naples and by other historical and natural sites located in the surrounding area. Naples city centre is a UNESCO World Heritage Site hosting 448 historical and monumental churches, the highest number in the world for a single city. Moreover, its lies between two notable volcanic regions, Mount Vesuvius and the Campi Flegrei (Phlegraean Fields). The islands of Procida, Capri and Ischia can all be easily reached from the port of Naples. Sorrento and the Amalfi Coast are situated south of the city, while the Roman ruins of Pompeii, Herculaneum, Oplontis and Stabiae, which were destroyed in the eruption of Vesuvius in 79 AD, are also nearby along with the Royal Palace of Caserta.

**Table 1. Number of foreign tourists in Naples metropolitan area versus other provinces in Campania**

| YEAR | NAPLES METROPOLITAN AREA | OTHER CAMPANIA PROVINCES | NAPLES METROPOLITAN AREA | OTHER CAMPANIA PROVINCES |
|---|---|---|---|---|
| | % change on previous year | | Share of the total (%) | |
| **2014** | 6.8 | -7.2 | 73.5 | 26.6 |
| **2015** | 3.0 | 37.7 | 73.0 | 27.0 |
| **2016** | 9.0 | 36.8 | 71.0 | 29.0 |

*Source: CSIL processing of Bank of Italy data (2016, Table a2.5)*

Airport passenger traffic also benefitted from the increase in foreign tourists, which more than offset the reduction in Italian visitors (Table 2). In addition to passengers, air freight traffic also increased by about 6% in 2016 compared to 2015, along with the number of aircraft departing and arriving. Overall, **Naples International Airport, which is part of the core of trans-European transport network**, **has seen stable growth both in the number of passengers and in volume of freight since 2010.**

[20] Bank of Italy (2016).

**Table 2. Passengers and goods flows at Naples International Airport compared to airport traffic in Italy and in the South (Mezzogiorno).**

| AREA | PASSENGERS | | | | NUMBER OF DEPARTING AND ARRIVING AIRCRAFT | TONS OF GOODS* |
|---|---|---|---|---|---|---|
| | 2016 | | | | | |
| | National | Foreign | Stopovers | Total | | |
| Naples | 2,352 | 4,401 | 9 | 6,763 | 55,994 | 9,240 |
| South of Italy (Mezzogiorno) | 25,885 | 13,315 | 64 | 39,264 | 303,886 | 16,472 |
| Italy | 60,094 | 103,945 | 398 | 164,437 | 1,326,702 | 998,142 |
| | % variation with respect to 2015 | | | | | |
| Naples | -2.7 | 18.5 | -49.7 | 10.0 | 5.9 | 5.7 |
| South of Italy (Mezzogiorno) | 3.9 | 10.7 | -22.5 | 6.1 | 4.6 | 3.9 |
| Italy | 2.2 | 6.2 | -15.6 | 4.7 | 3.1 | 7.1 |

*Source: Bank of Italy (2016, Table A2.6). *excluding mail*

**Naples is also a port city.** The Port of Naples, part of the core trans-European transport network, is one of the largest Mediterranean basin seaports. In 2016 the annual traffic capacity was 35.5 million tons of cargo, 872 million TEU[21] containers and around 8 million passengers, of which cruise passengers represented 1.5 million (20%) showing continuous growth compared to 2014 and 2015 (Table 3).

**Table 3. Passenger and goods flows at the Port of Naples. Thousands**

| ITEM | 2014 | 2015 | 2016 | % CHANGE 2014-15 | % CHANGE 2015-16 |
|---|---|---|---|---|---|
| Goods (tons) | 20,124 | 20,996 | 22,397 | 4.3 | 6.7 |
| Containers (TEU) | 431,682 | 438,280 | 483,481 | 6.1 | 9.3 |
| Passengers | 7,191 | 7,594 | 7,868 | 5.6 | 3.6 |
| Cruise passengers | 1,114 | 1,269 | 1,306 | 14.0 | 2.9 |

*Source: Bank of Italy (2016)*

**After many ups and downs, Naples and its metropolitan area are currently experiencing dynamic economic growth**. The productive development of the area has led to an economic structure where tertiary services, trade and high-quality craftsmanship are concentrated within the city of Naples, while its surrounding area hosts the manufacturing industry related to the automotive, aerospace and agri-food. The tourism sector and the maritime economy claim the lion's share in the coastal part of the city and its surroundings.

Over time, **the long-standing, close and dynamic relationship between Naples and its metropolitan area from both the demographic and economic perspectives, has determined massive mobility flows of people and goods in the area.** In 1996 about 510,000 trips took place in the city in the peak morning hours, of which about 250,000 were within the municipal area and 260,000 were

21 TEU stands for Twenty-Foot Equivalent Unit which can be used to measure a ship's cargo carrying capacity. The dimensions of one TEU are equal to that of a standard 20′ shipping container. 20 feet long, 8 feet tall.

commuting trips to Naples from its peripheral area and vice versa (Table 4). Between 1996 and 2011 the number of trips within the city and those from its metropolitan area into Naples increased by 37% and 10% respectively; in contrast, trips to the periphery from Naples decreased by 55% **indicating the increasing attractiveness of Naples compared to its metropolitan area.**

**Table 4. Trips by origin-destination in the peak morning period 7:00-9:30. Absolute numbers and percentage changes**

| TRIP (ORIGIN – DESTINATION) | 1996 | 2001 | 2011 | % CHANGE 96-01 | % CHANGE 01-11 | % CHANGE 96-11 |
|---|---|---|---|---|---|---|
| Within Naples | 249,936 | 330,479 | 342,109 | 32.23% | 3.52% | 36.88% |
| From periphery to Naples | 176,462 | 173,135 | 193,928 | -1.89% | 12.01% | 9.90% |
| From Naples to periphery | 86,338 | 33,731 | 38,880 | -60.93% | 15.26% | -54.97% |
| Total | 512,736 | 537,345 | 574,916 | 4.80% | 6.99% | 12.73% |

*Source: Naples Urban Transport Plan (1997; Table 2.4.1) and Urban Plan of Sustainable Mobility (PUMS) Observatory (2017; Table 3.2)*

Focussing on Naples, in 1996 61% (152,607) of movements within the city were motorised trips by car[22] (Table 5). Public transport covered 39% (97,329) of total trips, of which rail transport accounted for a share of 11% (27,778). **Against a surge in the absolute number of trips in the city between 1996 and 2011** (from 250,000 to 342,000), **the share of rail transport remained stable over time** covering 38,019 trips in 2011; **in contrast, trips by private means of transport** (mainly cars) **dramatically fell to 34%, reflecting a change in mobility demand in favour of public transport,** and specifically towards the rail mode of transport since the use of buses steadily decreased during this period.[23]

**Table 5. Trips within Naples by transport mode in the peak morning period 7:00-9:30. Absolute numbers (N) and percentages (%).**

| MODE OF TRANSPORT | 1996 | | 2001 | | 2011 | |
|---|---|---|---|---|---|---|
| | N | % | N | % | N | % |
| Cars (private means of transport) | 152,607 | 61 | 117,320 | 36 | 115,081 | 34 |
| Bus | 69,541 | 28 | 69,731 | 21 | 60,135 | 18 |
| Rail transport (Railways; underground and funiculars) | 27,788 | 11 | 20,490 | 6 | 38,019 | 11 |
| Other (pedestrian and cycle)* | | | 122,938 | 37 | 128,874 | 38 |
| Total | 249,936 | 100 | 330,479 | 100 | 342,109 | 100 |

***Source**: Naples Urban Transport Plan (1997; Table 2.14) and Urban Plan of Sustainable Mobility (PUMS) Observatory (2017; Table 3.7;3.8; 3.9).* Data are missing for the year 1996*

22 This data also contains motorcycles. The breakdown between cars and motorcycle is not available.
23 It should be said that 1996 data is not fully comparable with 2001 and 2011 data, because the classification of the transport modes surveyed changed during this period. However, all the documents analysed support the evidence of a relevant modal shift towards to public transport in Naples.

### *1.2 PROJECT OBJECTIVES*

**The completion of the Vanvitelli-Dante segment** of metro Line 1 was identified as a priority project in the Naples Urban Transport Plan in 1997. Expected to be completed in five years, it **represented the first step towards addressing two sets of interdependent urban planning problems** from which the city was suffering at the time. The first was related to **mobility and traffic congestion**, the second to **generalised urban decay**, in which mobility infrastructures were themselves elements of urban degradation.

In terms of supply, **by the mid-1990s the rail transport network in Naples** was articulated and wide. However, it **suffered from a limited interconnection capacity between existing urban railway lines.** Six different companies operated the existing lines without an integrated vision of the urban rail transport system and in an un-coordinated manner. There were no interchange nodes between transport infrastructures and stations owned by individual companies, which handled lines designed as point-to-point links, each with its own time schedule, frequency and tariff. Partly linked to the lack of an integrated vision, many railway lines operating in the city were born as regional rather than urban connections. For this reason they crossed many areas of the city with low frequency or without any stops, thus unable to offer a reliable service throughout the day.

**The public bus service also had its own weaknesses.** It was born without an organic design and over time new lines overlapped old ones. The resulting system was a complex of bus lines and a network structure lacking effective connections.[24] Most of the bus routes covered long distances with limited frequency and poor maintenance significantly reduced the number of circulating vehicles.

**On top of that, the urban road network was inadequate to allow a regular flow of passenger and goods vehicles for structural and functional reasons.** 77% of urban roads had an actual width of less than six metres, insufficient to absorb the traffic flows entering the city. The network was also characterised by the absence of a functional hierarchy, i.e. a distinction between roads based on the type of connection to be served (long/short trips within the city, commuting trips between the city and its metropolitan area) and of any type of integration with the urban environment (trade, tourism, recreation, etc.). The consequence was a low average traffic speed during the day, further reduced during peak times. At peak times, one-third of roads were at their maximum mass flow rate and minor accidents resulted in persistent stop-and-go driving conditions. In addition, the level of air pollution from traffic was often above the legally admissible thresholds[25] and interventions to completely stop the circulation of vehicles in the city was an option usually considered.

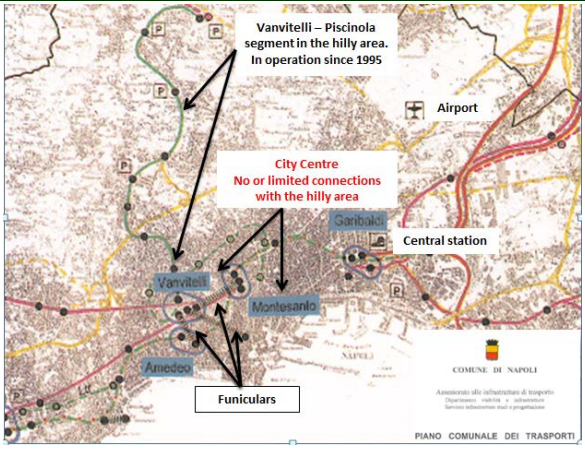
**As for the urban environment, several factors explain the urban decay in Naples in the nineties:** the absence of effective urban plans and regulations for the phase of reconstruction after the devastation produced by the Irpinia earthquake in 1980; the presence of organised crime, the main culprit of illegal building; and the poor quality of local institutions lacking the capacity to effectively monitor and plan territorial development. Such factors caused high density construction and limited accessibility to the city, degraded mobility infrastructures and the inadequate city services that they generated, including congestion problems.

24 From Naples Urban Transport Plan (1997, p. 27).
25 See Naples Urban Transport Plan (1997, p. 29).

In order to partially resolve this situation, **the goals that the project was expected to achieve were:**

- **Improving accessibility to the city centre**. Once completed, the Vanvitelli–Dante project would have connected the hilly area of Naples, where hospitals, commercial and residential areas are still located, with the historic city centre, and more in general with the lower part of the city where the port and the central station are situated. Prior to the project, the two parts of the city were only linked with the thee (still operating) funiculars,[26] which were insufficient to absorb the increasing mobility demand in the city. Moreover, by extending the metro line to Dante, a direct connection would have been created with the existing section of the metro up to the Piscinola/Scampia district, offering accessibility to the core city also to people from north-west suburban areas of Naples (Figure 3).
- **Reducing traffic congestion through a more effective system of connections with existing transport modes.** The increasing accessibility to the city, the supply of a new segment of metro Line 1 and the realisation of new interchange nodes would have led to a relevant modal shift towards the use of collective transport. As a result, the reduction in noise and air pollution from motorised private means of transport and in the number of accidents would have resulted in increased levels of safety.
- **Redeveloping and regenerating the surface areas and the neighbourhoods** in which the five new stations related to the project would have been built;
- **Increasing the quality of the urban transport service offered**, through communication (i.e. rapid identification of a metro station in the city with appropriate signalling and real time and pre-trip user information along with clock-based and easy-to-memorize rail timetables); comfortable, clean, and modern stations, appropriate lighting and high-standards of security and safety.

**Figure 3. Public Transport system in Naples city centre in the mid-1990s.**




*Source: Naples Urban Transport Plan (1997)*

[26] They are called Chiaia, Centrale and Montesanto.

### *1.3 STRUCTURAL FEATURES*

**The urban transport project under evaluation concerns the completion work** (see below) **for an already existing 5 km tunnel part of Metro Line 1** for a total cost of EUR 98.5 million. It was co-funded by the ERDF with a co-financing rate of 50%. Although only consisting of the completion work, **for evaluation purposes and in order to have a self-sufficient unit of analysis in line with EC CBA guidelines**,[27] **the excavation work, tunnel and station construction were also considered part of the investment in this ex post assessment.** The unit of analysis conceived in this way makes the project a broad self-standing intervention that is capable of producing effects independently of other complementary investments in line with the pertinence criterion stated in the First Intermediate Report of the study.[28] Accordingly, this appraisal focuses on all the project components that are functionally connected with the attainment of the objectives, regardless of the scope of the funding decisions for EU assistance. Specifically, the project analysed consists of:

- Construction of 5 km twin-tunnels with an average depth of 24m (max. 44m) and an average incline of 5.5%;
- Construction of five stations, including the requalification of their surroundings: Quattro Giornate, Salvator Rosa, Materdei, Museo and Dante. All of them are *Art Stations* (see Box 1 and Figure 4);
- Construction of the pedestrian tunnels connecting Line 1 with Line 2 at Museo Station and with the Archaeological Museum;
- Completion work:
    - Anti-vibration railway equipment and tracks;
    - Catenary system and electricity supply network;
    - Signalling, spacing and traffic management systems;
    - Civil installations, including escalators and lifts.
- The purchase of rolling stock. Since the new rolling stock will run over the entire metro Line 1, only 20% of its total investment costs was ascribed to the project (see Annex II for further details).

Table 6 compares the cost of the completion work and the cost of the whole metro section as considered in this dossier (i.e. including civil engineering work). Costs related to art and archaeology are included. The Table also includes the apportionment of the cost of new rolling stock imputed to this segment of Line 1.

**Table 6. Investment costs (VAT is excluded).**

| | PROJECT ITEM | NOMINAL VALUE (EUR) | PRESENT VALUE (EUR 2017) | TIME |
|---|---|---|---|---|
| A | Civil works | 375,335,446 | 1,443,726,781 | 1991 – 1998 |
| B | Completion works | 98,526,387 | 249,786,315 | 1999 - 2003 |
| A+B | Total initial investments | 473,861,833 | 1,693,513,09 | |
| C | Supply of rolling stock | 17,745,840 | 15,839,091 | 2019 - 2020 |
| A+B+C | TOTAL INVESTMENT | 491,607,673 | 1,709,352,187 | |

*Source: Authors*

[27] European Commission (2014; p. 31, section 2.5).
[28] In other words, the partition of the project into excavation work and tunnel construction on the one hand, and the completion work on the other would not have been appropriate from the CBA perspective because 'half a bridge is not a bridge' and therefore unable to attain its objectives. On this point see the European Commission (2017; p. 25, section 3.3 and Florio (2014; p. 324).

**Box 1. The Art Stations in the Vanvitelli (excluded)– Dante section**

***Station 1:* Quattro Giornate–Cilea**

Inaugurated in 2001 and designed by the architect Domenico Orlacchio, it is located in the homonymous square. Similarly to the square, the station and its artwork commemorate the historical episode of 'Le Quattro Giornate di Napoli' (the four days of Naples) during which the Neapolitan population rebelled against the Nazi militias (27–30 September 1943).

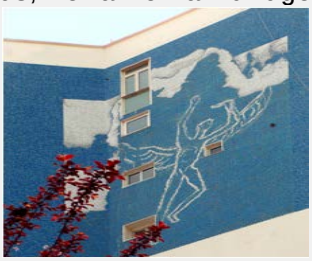
*The female warriors – MARISA ALBANESE*

*The male warriors – SERGIO FERMARIELLO*

*Exit – BALDO DIODATO*

***Station 2:* Salvator Rosa**

The station has been in operation since 2001 and was designed by the Alessandro Mendini atelier. Mosaics characterise both the exterior and interior of the station. The buildings surrounding the station were transformed into urban artwork with mosaics on the external facades. The station area also hosts a playground area, where three playable games (tic-tac-toe, the labyrinth and the bell) are located on a mosaic floor and other recreational sculptures. The garden outside the station hosts archaeological finds, i.e. a Roman bridge and a nineteenth-century neoclassical church.



*The Icarus' Flight – Mosaic - MIMMO ROTELLA*

*Archaeological finds (neoclassical church)*

*The subway is safer – PERINO & VELE*

***Station 3:* Materdei**

Opened in 2003, the station was designed by the Alessandro Mendini atelier. With its opening, the surrounding area was revamped by transforming it into a pedestrian area, enriched with green spaces, new urban amenities and artwork such as sculptures, mosaics and serigraph paintings.

*Twelve key portraits- INNOCENTE*

*Non-geometric form #8 - SOL LEWITT*

*Something drink – ANNA GILI*

***Station 4:* Museo**

Museo (museum) station was designed by the architect Gae Aulenti, and opened in 2003. The station is connected to Piazza Cavour where the Archaeological Museum of Naples in located. The architect decided to turn the Museo station into a 'gateway' for the museum, installing two of the most famous images from the Archaeological Museum collections on the station concourse: the Farnese Hercules (figure below) and the l Carafa head. The station also hosts archaeological relics and it is a good example of integration between civil engineering and archaeological research. The external part of station looks like a series of Pompeian red and Vesuvius stone buildings that evoke the architectural style of the Archaeological Museum through colours and materials. The interiors are made of glass and steel.

*Museo Station - Interior*

*The Farnese Hercules – ACADEMY OF FINE ARTS OF NAPLES*

*The athletes – MIMMO JODICE*

***Station 4:* Dante**

Designed by the architect Gae Aulenti, it is located in the homonymous square and was opened in 2002. The project restructured the square at surface level, which was designed according to its eighteenth-century plan and transformed into a pedestrian area. Most of the artwork in the station is inspired by the Italian poet Dante Alighieri.

*Universe without bombs, kingdom of flowers. 7 red angels – NICOLA DE MARIA*

*Intermediterranean – MICHELANGELO PISTOLETTO*

*Dante Station - Interior*

*Source: Authors. Photos were provided by the Region of Campania and MN Metropolitana di Napoli.*

**Figure 4. Examples of Urban regeneration and in the Vanvitelli–Dante segment of Metro Line 1 in Naples.**


*Source: Authors. Photos were provided by the University of Naples Federico II*

# 2 ORIGIN AND HISTORY

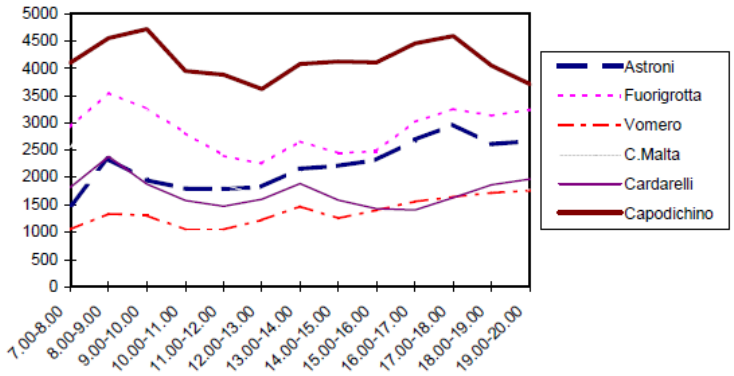
## *2.1 BACKGROUND*

**In the mid-1990s Naples was facing both traffic problems and urban environmental degradation**, which were hampering the process of transformation of the city towards a sustainable development path.

**As far as mobility was concerned, the city was so congested that it was snared in a semi-permanent gridlock from early morning to late in the evening** and the same concept of peak times was questioned (Figure 5). As explained above and according to the Municipality of Naples, the cause of this situation was an inadequate and unreliable existing public transport system in the city, which was insufficient to absorb the increasing demand for mobility.

Along with mobility issues, **Naples was also characterised by a general urban decay** and degraded mobility infrastructures negatively contributed to this poor quality landscape (Figure 6).

**Figure 5. Daily traffic flows on the main arterial roads in Naples**




*Source: Naples Urban Transport Plan (1997)*

**Figure 6. Mobility infrastructures as elements of urban decay and degraded areas in Naples.**

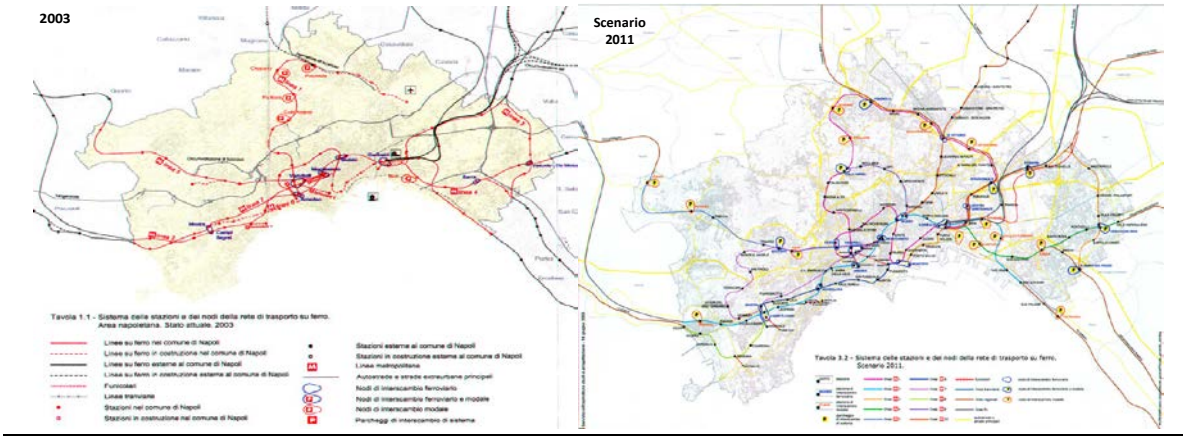
*Source: The Naples Metro Project in the Italian and European context. PPT Presentation by Prof. Cascetta (February 19th 2013, Faculty of engineering, University of Naples Federico II, Naples)*

**The extension of Metro Line 1 to the city centre with the Vanvitelli–Dante segment conceived in the Naples Transport Plan in 1997 was the starting point to addressing these problems.** Afterwards, in agreement with the Region of Campania, **the project under assessment was integrated in a new, ambitious and wider transportation programme** started in Naples in 1997, extended to the Naples metropolitan area in 2000 with the so called '*Plan of the 100 Stations*' and

further extended **to the whole Campania region with the Regional Metro System (hereafter, RMS) project in 2001**[29] (Figure 7). The Urban Transport Plan approved by the municipality Naples in 1997 and its extension in the RMS project were designed to solve the above mobility and urban environmental issues in Naples and its surroundings.

> ***In the interventions already carried out, in those under construction and in those planned, we read the goal of transforming the construction of a public transport infrastructure into a concrete opportunity for architectural redevelopment and urban planning for the city.*** *(Source: interviewee from the Municipality of Naples)*

**Figure 7. Evolution of the railway transport system in the region of Campania. Actual scenario as of 2003 vs. objective scenario as of 2011.**




*Source: Plan of the 100 Stations, Municipality of Naples.*

At the time of planning, the RMS project (including the Plan of the 100 Stations) was conceived to be a highly integrated, accessible and interconnected network, with new stations and the renewal of existing ones. Specifically, it aimed to extend the regional railway network from 1,179 km in 2000 to the projected 1,349 km in 2015 (an increase of 14%). Over the same period, the RMS was also expected to increase the number of new or upgraded stations by 30%, from 340 to 467, with the purchase of new rolling stock.

In order to achieve these objectives, **a two-fold temporal perspective was adopted in the planning process. At the first planning level**, **the objective was to identify** an overall shared vision of the future urban mobility system together with a set of **priority projects to be completed in the mid-term (5 years).** They were a set of ready-to-start, new infrastructures to be presented as representative of the new mobility planning approach in the city. This was to be planned together with improvements in service quality, new timetables and integrated fares that could be implemented in a relatively short time and could gain wide consensus among travellers and stakeholders. **The second planning level included projects to be implemented in the long-term (10-15 years).** It included less mature and more controversial interventions that were left to be implemented in subsequent stages on the basis of more refined technical and economic feasibility studies. At the city level

29 The Plan of the 100 Stations and the RMS are closely linked to each other and share the same objectives. They are two sides of the same strategy with the difference that the first is managed by the Municipality of Naples and the second by the Region of Campania.

and only regarding Metro Line 1 (i.e. excluding interventions related to the segments of regional railways crossing the city), **the completion of the Vanvitelli-Dante segment was identified as a priority project.**

Therefore, the RMS was conceived to promote an integrated and inter-modal public transport system in the region. This was in line with the European transport policy,[30] which at the time stressed the importance of shifting the balance between modes of transport, eliminating bottlenecks and placing users at the heart of transport policy. A number of these challenges were echoed in the planning documents at the national and regional level.[31] Planned to be completed in 2015 and being the largest project in local railways in Italy for over a decade, the RMS investment programme is still ongoing at both the city and the regional level, with some parts in the completion phase.[32] According to some studies[33] the RMS interventions shifted the mobility behaviour of people towards the railway transport mode and were the main cause of the modal shift observed in Naples between 1996 and 2011 (see Section 1.1;Table 5).

Beyond mobility issues, **the Urban Transport Plan in 1997 and its extensions also embedded interventions for the urban regeneration of the areas surrounding new and existing stations.** The new extensions of the metro lines in Naples and the wider RMS project were conceived together with the Plan of the 100 Stations[34] according to the philosophy that transport and land-use are integrated and a joint planning effort was necessary.[35] Two types of integration were pursued. The first was the integrated transport system as described above; the second was related to land-use interactions such as, among others,[36] the change in land values around the stations and the contribution of the stations to the urban quality of the surrounding areas. The project of wide, bright and smart places would have made the use of public transport more pleasant and attractive. The introduction, inside and outside the stations, of artistic elements such as sculptures, innovative building materials and contemporary artwork would have transformed mobility terminals into functional poles for the city for both work and leisure. In the same vein as a planning and design movement known as '*Station Renaissance*'[37] which started in Europe in the

30 Commission White Paper – 'European transport policy for 2010: time to decide' [COM(2001)370]. This set the framework for investment in transport over the 2000-2006 programming period.

31 Regional OP of Campania, programming period 2000-2006, Axis IV 'Networks and Service Hubs, Measure 6.1 'Integrated Regional Transport System'. National OP, programming period 2000-2006, Transport Sector - Axis IV 'Networks and Service Hubs.

32 For details see the Naples Urban Plan (1997); the Plan of 100 Stations; Cascetta and Pagliara (2008); Cascetta and Pagliara (2013); Cascetta and Cartenì (2014).

33 Among others, Cascetta and Pagliara (2013); Cascetta and Cartenì (2014).

34 With the construction and expansion of numerous metro lines in 2000 the municipality of Naples developed the project 'Stations of Art' (also known as The Plan of the 100 Stations, i.e. the Master Plan of the city), through which it intended to entrust the design of the metro stops to well-known contemporary artists and architects. Then, with a resolution (dated 19 May 2006 Number 637), the Region of Campania issued guidelines to be applied to the design and construction of future stations.

35 The importance of this interaction relies on a two-way relationship: each technological innovation in transport is likely to encourage both people and industry to change their location to take advantage of the improved mobility; similarly, each change in land development (e.g. houses, factories, offices and shops) is likely to influence the demand for travel and ultimately the provision of new transport infrastructures and services. See Cascetta et al. (2008) for more insights on this subject.

36 See Cascetta et al. (2008) and Cascetta and Pagliara (2008) for details.

37 The planning and design movement known as 'Station Renaissance', which started in Europe in the eighties with the aim of constructing and upgrading railway stations to high architectural standards and of satisfying passengers' expectations with respect to landscape, aesthetic and functional station spaces, as well as the introduction of a new image of railway travels. Examples of 'Station Renaissance' abound both in Europe and worldwide. They are in Paris (e.g. The Arts et Métiers and Auber stations), London (e.g. Westminster Underground and North Greenwich stations), Stockholm (e.g. Stadion and T-Centralen stations) Rotterdam (e.g. Metrostation Wilhelminaplein station). Similarly, in the United States the new approach to station design has been coded in the 'Context Sensitive Design for Railways'. High architectural

eighties, the '*Art Metro*' in Naples would have witnessed a combination of mobility, urban and art planning. **Today, there are 15 so-called '*Art Stations*'**, 11 along Line 1 and four along Line 6. Designed by about 100 of the most famous architects from all over the world, the Art Stations host about 200 contemporary art works that enrich both the interior and exterior of the stations. **The first Neapolitan experience in building them was in the early 2000s when the stations in the Vanvitelli-Dante section were constructed** (see Box 1 in Section 1.3).

Related to art and cultural aspects, there are important considerations about **archaeology**. Dating back to more than 2,700 years and thanks to the massive holes and tunnels needed for stations and tracks along Line 1, archaeologists unearthed several finds that added new insights into the history of Naples. Previously unknown aspects of the Greco-Roman, Byzantine, Angevin, Aragonese and later topography were uncovered along with unexpected discoveries[38] (Figure 8) making **metro Line 1 and its stations an important archaeological site at local and national level.**[39]

**Figure 8. Some archaeological finds during excavation work for metro Line 1 in Naples**

*The Roman Church in Salvator Rosa area*

*The Roman (Imperial Age) harbour in Municipio station*

*Castel Nuovo – Aragonese aspects*

*Source: Authors.*

Bringing together **engineering, architecture, arts and archaeology makes metro Line 1 a best practice acknowledged worldwide for its mobility infrastructures and urban quality**, receiving, over the years, many awards (Table 7). Moreover, the good integration between art and archaeology has made metro Line 1 a museum for citizens and tourists, increasingly attracted by the metro stations.[40]

> ***Also called 'The Metro of the Three As - Architecture, Arts and Archaeology - the construction of the Naples underground was planned to offer an opportunity to rethink urban planning and over time it has become the main instrument of urban and social transformation of the city*** *(Source: interviewee from Metropolitana di Napoli S.p.A.).*

standards can also be found in a number of metro stations in other countries such as in China (e.g. Hong Kong Wan Chai Station or Shanghai South Railway Station), Singapore (Expo Station) and Taiwan (Kaohsiung Central Station).

38 They include: remains of a Roman church and bridge in the area of Salvator Rosa (in the Vanvitelli-Dante section); a temple complex that has bolstered the importance of the little-known Isolympic Games, a Hellenic-style contest instituted by the glory-hungry Roman emperor Augustus; the Roman harbour near the current port of the city; the Angevin neighbour around "Castel Nuovo" and the Aragonese area underneath the Angevin.

39 Russo et al. (2017).

40 De Risi (2016), La Metropolitana delle tre "A". A Napoli la trasformazione delle stazioni da luoghi di degrado a simboli d'arte, Logistica e Mobilita – il giornale dell'Ingegnere, no. 1-2 January/February 2016. See also Cerrone (2010); Times (2002).

**Table 7. Awards received by the Art Stations of Metro Line 1 in Naples.**

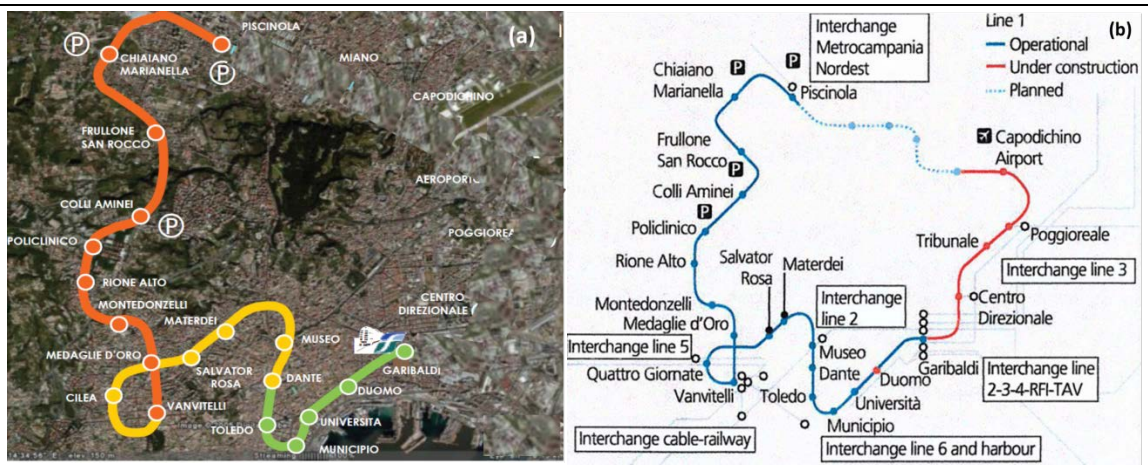
| DATE | AWARD | INSTITUTIONS/PLACE |
|---|---|---|
| June 2001 | INTERNATIONAL AWARD FOR ARCHITECTURE 'DEDALO AND MINOSSE' ALLA COMMITTENZA DI ARCHITETTURA | Province of Vicenza (Italy); Ala-assoarchitetti Association in Vicenza (Italy) |
| February 2002 | INTERNATIONAL AWARD FOR ARCHITECTURE 'IL PRINCIPE E L'ARCHITETTO' | Municipality of Bologna (Italy); Europolis Association in Bologna (Italy) |
| September 2002 | Invitation at BIENNALE DI VENEZIA for the exhibition of the New Art Stations design along the Line 1 | Biennale of Venice exhibition – Venice (Italy) |
| May 2003 | AWARD FOR ARCHITECTURE 'MEDAGLIA D'ORO (Gold Medal)' PER L'ARCHITETTURA PER LA COMMITTENZA PUBBLICA' | Triennale of Milan exhibition – Milan (Italy) |
| April 2009 | MOST INNOVATIVE APPROACH TO STATION DEVELOPMENT, Metros 2009, London – UK | Metros 2009 congress – London (UK) |
| November 2012 | MOST BEAUTIFUL EUROPEAN STATION to the Toledo station. Materdei station, in the Vanvitelli-Dante segment, ranked 13th | Daily Telegraph (UK) |
| September 2013 | EMITARES LEAF INTERNATIONAL AWARD to the Toledo Station as 'Public building of the year' | |
| February 2014 | MOST IMPRESSIVE UNDERGROUNG STATION IN THE WORLD to the Toledo Station | CNN (USA) |
| November 2015 | INTERNATIONAL TUNNELLING AND UNDERGROUND SPACE ASSOCIATION AWARD to the Toledo Station for 'Innovative use of underground space' | Italian Tunnelling Society (SIG) – Italy |
| April 2016 | Naples won the competition held in San Francisco (USA) to host the WORLD TUNNEL CONGRESS in 2019 entitled 'Tunnels and underground cities – engineering and innovation meet archaeology architecture and art'. | Italian Tunnelling Society (SIG) – Italy |

*Source: Authors based on MN Metropolitana di Napoli S.p.A. data*

## *2.2 FINANCING DECISION AND PROJECT IMPLEMENTATION*

In order to better understand the implementation of the project and the context in which the financing decision was taken, it is useful to look at the whole of Metro Line 1 (Figure 9).

**Figure 9. Metro line 1 serving the city of Naples: operating, under-construction and planned segments (2017).**




*Source: Figure 9a is from Mandolini and Viggiani (2017; Figure 1a). Figure 9b is from Russo et al. (2017; Figure 1)*

**Planned and designed to be constructed in functional lots, Line 1,** also known as the '*metropolitana collinare'* (hilly subway), **was the first underground in Naples.** It connects the city's major transport interchanges and Naples' most densely populated urban zones and is the cornerstone of the city's transport system. The key milestones of the whole of Metro Line 1 and of the Vanvitelli-Dante segment are reported in detail in Annex IV of this report.

Although the current ring route as shown in Figure 9b was part of the Naples Urban Plan of 1997,[41] **Line 1's history dates back to the sixties and since the beginning the Municipality of Naples entrusted both its design and the construction to MN Metropolitana di Napoli S.p.A**.[42] Between 1975 and 1977 a draft of the Metro Line 1 project from the hospital area to central station was approved and in December 1976 the first stone was laid. Since then, the progress of work has been conditioned by the availability of funds. In 1980 the construction of Vanvitelli station started. In this phase, the EC contributed by funding 33% of the cost. Because of an earthquake in the same year and the lack of funds, the work was interrupted and in 1984 the Municipality took out mortgages for its continuation. Further delays were due to construction issues related to the Neapolitan subsoil, cavities and geology, and to the consolidation of buildings adjacent to the infrastructure under construction.

**The first 8 km of track were progressively opened between 1993 and 1995** (the orange route Vanvitelli-Piscinola in Figure 9a) with additional funds provided by the EC, the Italian government and the Municipality. In this segment, the metro goes up to the mountain to reach its highest point in the hospitals area (268 m above sea level at the entrance to the Policlinico station) and then descends again (mainly along a viaduct) to the terminus (126 m at Piscinola).

**The metro reached the historic city centre with the Vantitelli-Dante section fully operational since 2004** (the yellow section route in Figure 9a is the project under assessment). In this section the metro line runs in a loop down towards the city centre through a steep (5.5%) and tightly curved tunnel (160°) to reach the Salvator Rosa station via Quattro Giornate up to Dante station located in the historic city centre and interchanges with line 2 at Museo Station. The stations in this segment represent the first Neapolitan example of *Art Stations*.

The urban transport project '*Naples Metro Line 1, Vanvitelli–Dante, section completion work'* (CCI number: 2003IT161PR007) was co-funded under the Campania Regional Operation Programme ERDF 2000–2006.[43] The total eligible expenditure amounted to EUR 88 Million and the **EC granted ERDF assistance for a total of EUR 44 million at a co-funding rate of 50%.** National and regional contributions covered the remaining 50% of the eligible expenditure. The ERDF co-funding request was issued by the Managing Authority in August 2003, while **the EC's final decision to grant assistance to the project was taken in August 2005,**[44] **when the project was**

41 The original project was slightly modified. The rationale behind the current ring route was the possibility of recovering excavation work and infrastructures already available from past projects. Among other amendments, the Forcella station was eliminated as too close to Garibaldi station; while the Municipio station in the harbour area was added.

42 The company was established in 1972. See Annex IV for details.

43 Axis VI 'Networks and Service Hubs, Measure 6.1 'Integrated Regional Transport System', Action C 'Completion of the Regional Metro System'.

44 EC C(2005) no. 5241. The Italian Ministry of Economy and Finance financially supported the project as well. Italian Ministry of Economy and Finance Resolution no. 9735 19/03/2004.

**already in operation**. **The decision to co-fund the project was based on the fact that the project was functionally interconnected and coherent with previous operating segments of Line 1 and the RMS**[45], as well as in compliance with EC Council Regulation No. 1260/1999, laying down general provisions for Structural Funds, and in particular pursuant to Article 26, concerning issues related to the approval and implementation of projects.

**The eligible public expenditure included certified expenses from January 2000**, and therefore covered by committed ERDF funds for the programming period 2000-2006. In addition to the 2000-2006 ERDF grant for the completion work, in the past the EC also granted ERDF assistance for the excavation work of the metro with two different financing decisions. In 1988 assistance amounted to EUR 40.5 million (50% of the eligible public expenditure) and in 1989 it was EUR 41 million (35.22% of the eligible public expenditure).

**The subsequent section** (green line in Figure 9a) **was progressively opened between 2011 and 2015**, **but there are still some sections under construction** (e.g. Duomo station and part of the entrance tunnels in Piazza del Municipio – Figure 9b). This segment is a 5 km twin-tunnel extension connecting the historic city centre, the harbour area and the university area with central station where the metro interchanges with regional railways and national high-speed train lines.[46] As planned in 2005 by the Municipality, work was expected to be completed by 2008–2010.[47] Delays and cost overruns were essentially due to archaeology[48] and construction difficulties during excavation in the proximity of layers of groundwater. Indeed, in this segment, the metro goes down to great depths (up to 40/50 metres below ground level) and sophisticated technologies were used for the construction of the twin-tunnels (including ground freezing for the excavation underneath layers of groundwater[49] and to create large and bright environments contrasting the onset of feelings of claustrophobia).

**A 4 km long extension project linking the central station to Naples international airport is currently underway, planned to be completed by 2020** (red line in Figure 9b). Looking further ahead, there are plans to link the airport

45 The project was co-funded when it was already in its operational phase by applying "retrospective EU assistance". Retrospective support represents the award by a Managing Authority of EU assistance to an operation that has already incurred expenditure from national sources or is already complete before the EU assistance is formally applied for or awarded. Although there is no explicit legal provision prohibiting retrospective EU assistance, the Commission does not recommend this practice as it represents a high risk area. For instance, operations retrospectively selected for co-financing are often initiated or carried out without having been expressly linked to the objectives of a programme and to specific legal requirements linked to EU assistance. As a result, they entail a high risk of non-compliance with the relevant Union and national rules. For this reason the Commission issued rules for the application of retrospective EU assistance. For details see “Guidance note to the COCOF on the treatment of retrospective EU assistance during the period 2007-2013” [COCOF_12-0050-01-EN] and the Commission Staff Working Paper “Analysis of errors in Cohesion Policy for the years 2006-2009: actions taken by the commission and the way forward”

46 Università station was inaugurated in 2011, Toledo in 2012, Garibaldi in 2014 and Municipio in 2015. Duomo station is currently under construction and its inauguration is scheduled for 2019 at the latest.

47 Municipality of Naples, DG-Infrastructures, Public Works and Mobility. Chronology of Metro Line 1 Development (March, 2017). See also ex ante cost-benefit analysis "Completamento delle opere civili e realizzazione delle opere tecnologiche della linea 1 Tratta Dante (esclusa)-Municipio (inclusa)-Garibaldi (inclusa)-Centro Direzionale (esclusa)" POR 2000-2006 Region of Campania.

48 The Roman harbour near the current port of the city, the Angevin neighbourhood around “Castel Nuovo” and the Aragonese age remains were found in the in this segment in the proximity of Municipio and Duomo stations.

49 Russo at al. (2017)

station to the Piscinola terminus, **creating a complete ring route by 2022** (broken light-blue line in Figure 9b).[50]

**As of 2017 the operational section of Metro Line 1 runs from the north-west district of Naples to central station along 18.8 km with 18 stations** (yellow continuous line in Figure 10). When the ring route will be completed, Line 1 will be integrated into the city transport network, including metro Line 6, which is under construction as well (light-blue broken line in Figure 10).

**Figure 10. Metro lines 1 (yellow) and 6 (light blue) integrated into the Naples transport system.**


*Source: Authors. The original map is from "Da Vitruvio alla Metropolitana di Napoli". PPT presentation by Prof. Cascetta at the conference "In Onore di Santa Barbara", held in Naples on December 1st 2017.*

### *2.3 CURRENT PERFORMANCE AND OTHER INVESTMENT NEEDS*

**Line 1 of the underground is the backbone of the public transport system in Naples**. **However**, **the service currently offered is of an unsatisfactory quality.** Admittedly, palpable progress has been made with respect to the past, but there is still significant unexploited potential related to transport service development. This view is shared by all the interviewees and discussed in press articles, although with different nuances and specifications.

Line 1 meets the mobility demand of around 100,000 passengers per day (30,000 in the Vanvitelli-Dante segment) with a frequency ranging from 10 minutes at peak times to 14 minutes in the evening and a commercial speed of 32 km/h.[51] According to press articles and interviews collected in the field, including not only the stakeholders, but also representatives of the local population, **the current frequency is low and inadequate to meet the current demand for mobility in the city**. This is confirmed when the frequency and other performance indicators of Line 1 in

50 In December 2013, the CIPE (Interministerial Committee for Economic Planning) approved a EUR 650 million loan for the Garibaldi – Airport route, planned to be completed within 2020. The Piscinola/Scampia – Airport segment will allow Line 1 to close and to form a complete ring, under the supervision of the Region of Campania, which contributed with EUR 50 million approved in April 2017.

51 Source: ANM website. The annual number of passenger was about 43 million in 2017. In the segment Vanvitelli – Dante it was about 15 million in 2017.

Naples are compared to the performances of similar services operating in other European and Italian cities (Table 8 and Table 9).

**Table 8. Metro frequencies at peak times in some European cities**

| CITY | FREQUENCY AT PEAK TIMES (MINUTES) | OPENING HOURS (WORKING DAYS) | COST OF AN ORDINARY URBAN TICKET (EUR) |
|---|---|---|---|
| London (UK) | 2 min | 5:00 AM – 00:00 AM | EUR 5.30 |
| Paris (FR) | 2 min | 5:30 AM – 1:15 AM | EUR 1.80 |
| Madrid (ES) | 2 min | 6:00 AM – 1:30 AM | EUR 1.50 – 2:00 |
| Milan (IT) | 2 min | 5:35 AM – 00:30 AM | EUR 1.50 |
| Turin (IT) | 2 min | 5:30 AM – 00:30 AM | EUR 1.50 |
| Barcelona (ES) | 3/4 min | 5:00 AM – 2:00 AM | EUR 2.15 |
| Rotterdam (NL) | 3/4 min | 5:30 AM – 00:00 AM | EUR 3 |
| Rome (IT) | 3/5 min | 5:30 AM – 11:30 PM | EUR 1.50 |
| Athens (GR) | 3/5 min | 6:00 AM – 10:00 PM | EUR 1.00 |
| Brescia (IT) | 4 min | 5:00 AM – 00:00 AM | EUR 1.40 |
| Berlin (D) | 5 min | 4:00 AM – 1:00 AM | EUR 2.50 |
| Hamburg (D) | 5 min | 4:30 AM – 1:00 AM | EUR 1.45 |
| Genova (IT) | 6/7 min | 6:00 AM – 9:00 PM | EUR 1.50 |
| Naples (IT) | 10 min | 6:00 AM – 11:00 PM | EUR 1.10 – 1.60 |
| Catania (IT) | 10 min | 6:40/7:00 AM – 9:00 PM | EUR 1.00 |

*Source: Data are from the websites of listed metro service providers. Naples data are from the ANM website as of January 2018*

**Table 9. Performance indicators of metro services in some Italian cities.**

| CODES | CITY | NAPLES | GENOA | ROME | TURIN |
|---|---|---|---|---|---|
| (A) | Length of metro network (km) | 46.2 | 14.4 | 81 | 26.8 |
| (B) | Trains at peak times | 16 | 12 | 60 | 50 |
| (C) | Coaches*/km | 5,612,885 | 1,049,337 | 41,532,924 | 11,221,840 |
| (D) | Trains/km | 1,063,709 | 552,282 | 6,922,154 | 2,805,460 |
| (C)/(A) | Ratio between coaches/km and length of metro network | 121,491 | 72,871 | 512,752 | 418,725 |
| (D)/(A) | Ratio between train/km and length of metro network | 23,024 | 38,353 | 85,459 | 104,681 |
| (B)/(A) | Ratio between trains at peak times and length of metro network | 0.35 | 0.83 | 0.74 | 1.87 |

*Source: *1 UDT consists of 2 coaches (2017). Data provided by ANM.*

**The limited number of trains is the main cause of the poor performance of the Naples metro.** Circulating trains are often halved to achieve a higher, although still insufficient, frequency, generating overcrowded platforms, delays, malfunctions and even stoppages of the transport service (Table 10). This situation is worsened by the obsolescence of the trains (most of them date back to 1982),[52] which are often relegated to the depot for maintenance. **Additional concerns relate to:**

52 The public transport of Line 1 is carried out by 51 traction units (UDT). 45 UDTs were built in 1982 and 6 UDTs in 1999. Each traction unit consists of two coaches. In normal conditions, a train consists of 3 or 4 traction units (see Naples Urban Plan of Sustainable Mobility – PUMS p. 62).

1. **the limited working time of the metro** (Table 8) **and the reduction in operating costs of the service.** They are consequences of ANM's financial problems;
2. **delays in the delivery of ongoing work due to archaeology issues.** While the former cause protests among users and disputes between the Municipality and the metro operator ANM, the latter cause inconvenience and traffic congestion in the city due to extended construction times;[53]
3. **the delivery of the planned work that will complete the ring route of Line 1 by the 2022 deadline** (see Section 2.2). Delays will postpone the connection of the existing operating route of Line 1 with additional important hubs in the city. This is likely to negatively impact on the number of additional potential users of the metro.

Added to that, there are concerns related to the current financial situation of the service operator, as described in detail in section 4.6.

**Table 10. The performance of metro Line 1 service as reported by press articles.**

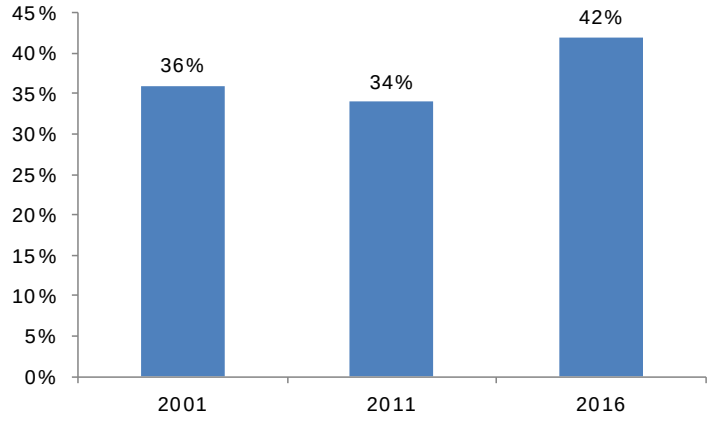
| DATE | ORIGINAL PRESS ARTICLE | ENGLISH TRANSLATION |
|---|---|---|
| 1st Dec 2015 | AIDACON LA DIFESA DEI CONSUMATORI WWW.AIDACON.IT<br>CLASS ACTION PER RISARCIRE I DANNI DEL TRASPORTO PUBBLICO A NAPOLI | Class action in Naples to reimburse users for the damage caused by the public transport |
| 9th Oct 2017 | ANSA Campania<br>Treni in ritardo, caos su linea 1 Napoli<br>Difficoltà accesso a stazione, bus tra Garibaldi e Piazza Dante | Late trains, chaos on Line 1 in Naples |
| 25th Oct 2017 | NAPOLITODAY<br>Metro, lunghe attese e malori: Linea 1 e 2 nel caos<br>Problemi, nell'ora di punta, per entrambi i vettori su ferro che attraversano la città | Metro in Naples, long waits and sudden illnesses: Line 1 and 2 in chaos |
| 6th Dec 2017 | IL MATTINO.it<br>Napoli, è caos metropolitana: sospese corse sulla linea 1 | Naples, Metro in the chaos: Line 1 suspend rides |
| 7th Dec 2017 | CORRIERE DEL MEZZOGIORNO<br>Metro, nuovi blocchi e polemicheE il sindaco mette l'Anm nel mirino<br>De Magistris: disagi? Chiedete a chi gestisce l'azienda. La chiusura delle funicolari di notte sul tavolo del prefetto | Metro, more stops and disputes. The Mayor blames ANM |
| 14th Dec 2017 | CORRIERE DEL MEZZOGIORNO<br>Trasporti: stop funicolari e metro, guasti a catena e passeggeri infuriati<br>Linea 1 ferma per tre ore, vetture sovraffollate, un anziano si sente male. Oggi scioperano i tassisti | Public transport in Naples: funiculars and the metro stop. Recurring malfunctions infuriate passengers |
| 28th Dec 2017 | R.it<br>Trasporti, il blocco di San Silvestro a Napoli<br>Salta il tavolo Comune-sindacati: il 31 dicembre niente mezzi pubblici dalle 20, servizi a metà il primo gennaio | Public transport in Naples stops New Year's Eve. No agreement was reached between the Municipality and trade unions to guarantee the service after 8 pm. |
| 18th January 2018 | CORRIERE DEL MEZZOGIORNO<br>Napoli paralizzata, è caos trasporti: bloccati metropolitana e autobus<br>Linea 1 ferma su tutta la tratta, protesta dei dipendenti della Samir che hanno impedito ai pullman di uscire dai depositi. Il Comune: «Azione ingiustificata e illegittima» | Naples paralysed, it is transport chaos: blocked underground and buses |

53 As explained above, in 2005 the Municipality of Naples expected the completion of the work up to central station to be completed by 2008–2010.

*Source: Authors. News collected until mid-January 2018.*

On top of that, **the unsatisfactory metro service is negatively impacting on public transport demand in the city**. Sector experts[54] and some interviewees agree that metro system failures, delays and train breakdowns may discourage people from using public transport and, as a result, trigger a vicious circle by contributing to a return to the use of private means of transport. As a matter of fact, the share of trips with cars within the city of Naples started to increase again between 2011 and 2016 (Figure 11).

**Figure 11. Share of trips with private means of transport in Naples.**




*Source: Authors. 2001 and 2011 data are from the Naples Urban Plan of Sustainable Mobility (PUMS) Observatory (2017; Table 3.2). 2016 data are from Naples Observatory PUMS http://www.osservatoriopums.it/napoli. Last access January 2018.*

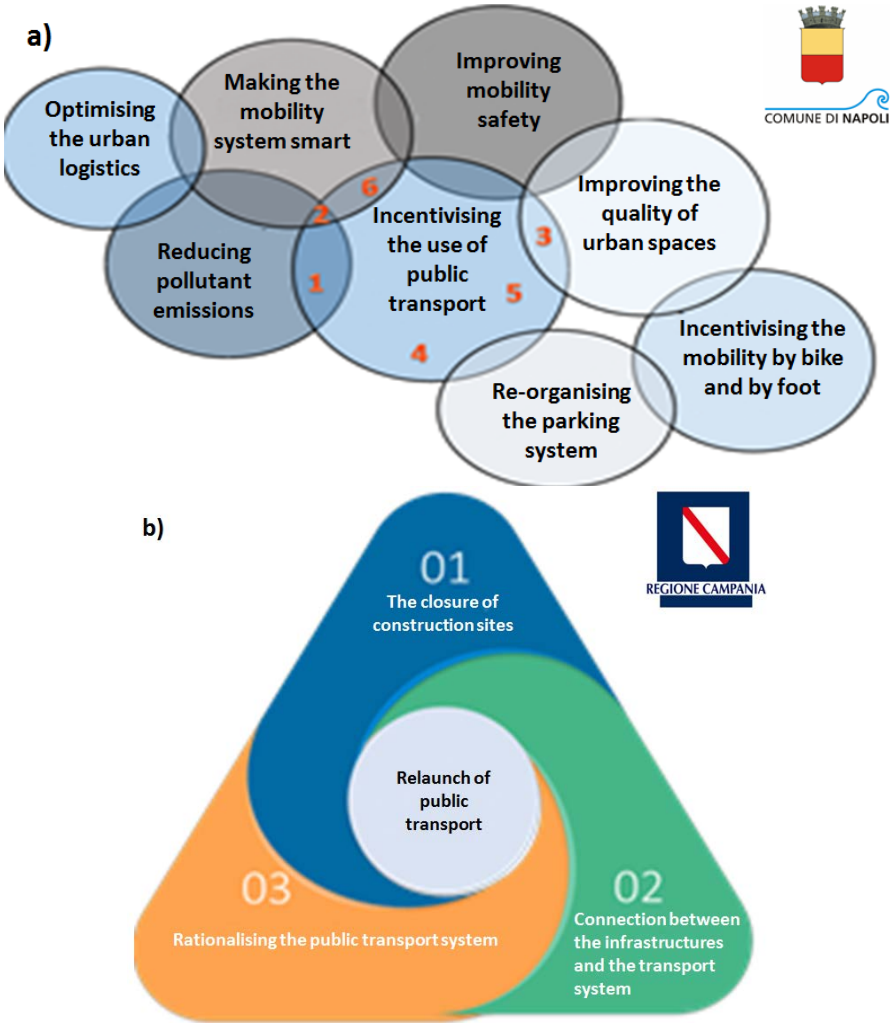
**As a response to the current situation** and to the expected increase in demand as further extensions of Line 1 and the RMS are developed, **FPAs[55] were signed in 2015 and 2016 between the national government and regional and local authorities. The strategic objective was to re-launch the metro service and the broader public transport network in Naples and in the Campania region**. At municipal level, the new strategy is based on six strategic objectives: 1) The realisation of new lines; 2) Renovating the rolling stock (buses and trains); 3) The completion of underground lines; 4) Revising the existing public service utilisation contracts to make them more effective; 5) Reducing ticket evasion (especially on buses); 6) Making the public transport network smarter by reinforcing the existing connections and creating new ones (Figure 12a). This strategy is in line with the regional one based on three pillars: 1) The completion of existing metro construction sites; 2) A more balanced connection in terms of dedicated funds between the infrastructures and the public transport service; 3) A more efficient and effective public transport service in the region connecting railway, road, bus and maritime networks with each other (Figure 12b).

**As far as the metro is concerned,** this agreement permitted the purchase of **20 new trains for a total investment of EUR 198 million.** They will be available in

54 Financial analysis of ANM 2011 – 2016; General considerations (p. 15). Document provided by ANM. See also D'Acierno et al. (2013).
55 Framework Programme Agreements (Accordi di Programma Quadro).

the near future[56] allowing for an average frequency of five minutes at peak times, in line with other European cities.

**Figure 12. The municipal (a) and the regional (b) strategies to improve the public transport system.**




*Source: Author's translation (ITA-ENG) from official documents. Figure (a) is from a PPT (dated 8 September 2017) by Prof. Calabrese, head of the DG - mobility, infrastructures and public works of the Municipality of Naples. Figure (b) is from a document prepared in 2016 by the Regional Committee on Transport, Public Works and Urban Planning of the Region of Campania.*

56 The contract for 10 new trains was already signed in 2016 between the Municipality of Naples and the Region of Campania. The delivery of the first train is scheduled by the end of 2019, while that of the last train is planned for December 2020. The total investment amounts to EUR 98 million and was financed by the Regional OP 2007-2013. Among other interventions, an investment of EUR 20 million for two additional new trains was planned in the 'Patto per Napoli', an agreement signed in 2016 between the Municipality of Naples and the Italian government. The remaining eight trains will be financed by a mortgage of EUR 80 million that the Municipality of Naples took out with EIB in 2017. See for further information: Press article, Napoli fanpage.it, 7.01.18. https://napoli.fanpage.it/comune-di-napoli-maxi-mutuo-da-150-milioni-per-comprare-i-treni-della-metro/. Press article, La Repubblica, 18.07.17 http://napoli.repubblica.it/cronaca/2017/07/18/news/metropolitana_di_napoli_via_libera_all_acquisto_di_10_nuovi_treni_per_la_linea_1-171020076/

# 3 DESCRIPTION OF LONG-TERM EFFECTS

In what follows a discussion about the main long-term effects produced by the project is presented. First, a summary of the effects produced along the four categories of effects identified in the First Interim Report is briefly reported (i.e. economic growth, quality of life and well-being, environmental sustainability, distributional issues). Then, the most significant ones are discussed and supported by available evidence.

## *3.1 KEY FINDINGS*

**Evidence suggests** that the Vanvitelli-Dante section of the metro Line 1 has generated **positive results in terms of economic growth, which remain, however, below expectations**. Several interdependent factors have significantly reduced the prospects for potential benefits (both measurable and non-measurable) stemming from a faster and more reliable connection to downtown Naples (see below for details).

**Mixed results emerge from the quality of life and well-being perspective.** Good results in terms of increased property values, appreciable safety gains and noise reduction from traffic decongestion were quantified in the CBA. Among the non-measurable effects and, in addition to these effects, the aesthetic quality of the infrastructures realised is positively perceived by the public. In contrast, great disappointment emerges when people are called to express a judgement about the quality of the service delivered, in particular in terms of reliability. High expectations and enthusiasm in the initial phase of the project has translated, over time, into disillusionment, social distrust and high levels of frustration, with negative effects prevailing over more positive ones.

> ***The metro Line 1 in Naples is a jewel that runs in the city but does not work as it is expected to do*** *(Source: interviewee from the Region of Campania)*

Effects on **environmental sustainability** are mainly related to traffic decongestion and to the resulting reduction in air pollution. As the CBA and interviews suggest, **positive effects are visible, but much more was expected**. The current unsatisfactory performance of the metro and the mobility behaviour of Neapolitans, still based on the use of private means of transport, are negatively conditioning the magnitude of this effect.

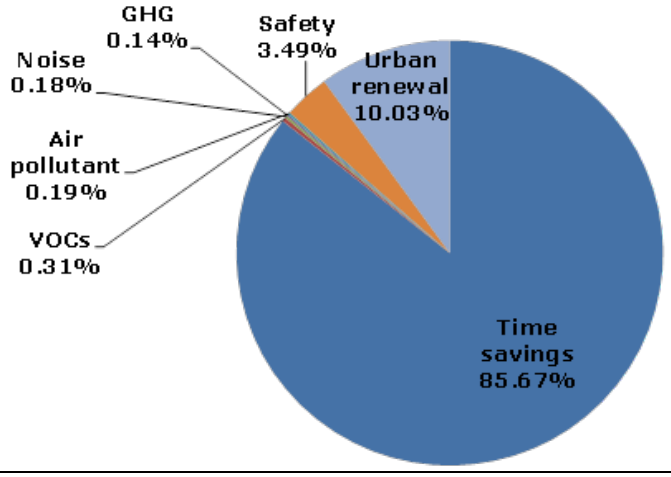
**As for distributional impacts**, **the high accessibility of metro stations and train platforms** to all kinds of users is ensured by appropriate signalling, escalators and lifts. This **positively contributed to social cohesion**. Similarly, the Vanvitelli-Dante extension of Line 1 also **increased territorial cohesion** by making access to the city centre easier than before project implementation.

The baseline scenario of the CBA[57] indicates that **the project yields a positive socio-economic net present value** (ENPV) equal to EUR 389 million,[58] an economic internal rate of return (EIRR) of 3.24% (against the applied discount rates of 1.37% backwards and 2.14% forwards) and a benefit–cost ratio of 1.35. **This proves its effectiveness and value for money from society's viewpoint**. The quantified

57 See Annex II of this report.
58 Expressed in 2017 prices.

benefits and their breakdown as a share of the total amount of benefits generated by the project are shown in Figure 13.

**Figure 13. Main socioeconomic benefits (percentage of total benefits).**




*Source: Authors.*

**It is, however, worth noting that these results are valid given the current state of play and knowledge about future scenarios, including the forecasts made about the future number of passengers.** The expected increase in the number of passengers and the improvement in the transport service delivered as assumed in the CBA strongly rely on the extent to which the delivery of new trains and the construction work of the new extensions of Line 1 respect the scheduled plan. The uncertainty related to these events is captured by the risk analysis, which indicates that the project is currently highly volatile (i.e. the project's EIRR is likely to fall below its baseline value with a probability of 50% and below the forward social discount rate with a probability of 4%. Similarly, the ENPV has a 50% probability of falling below the baseline value). Above all, there is the uncertainty linked to the future of the service operator. Future scenarios may range from a situation in which the project collapses to successful perspectives should the main stakeholders put into practice the announced strategies.

The CBA is supported by a qualitative assessment for non-measurable impacts as well as wider effects stemming from the project. Together, they contribute to an overall and comprehensive assessment of the project.

Table 11 shows the strength assigned to all the identified impacts (both measurable and non-measurable) of the project according to a judgement criteria ranging from –5 to +5 (see below). Details of their magnitude, further discussion and descriptions are presented in the following sub-sections; while, the time and spatial scale of these impacts are discussed in Table 13 at the end of this chapter (Section 3.7)

**Table 11. Strength of effects (the effects highlighted in green are those included in the ex post CBA)**

| CATEGORY | EFFECT | STRENGTH* |
|---|---|---|
| **Economic growth** | Travel time | 5 |
| | Vehicle operating cost savings (trip cost savings) | 2 |
| | Reliability of journey time | 2 |
| | Income for the service provider | N.R. |
| | Wider economic impacts (extra tourist attraction) | No data |
| | Institutional learning | 5 |
| **Quality of life and well-being** | Safety (accident savings) | 3 |
| | Security | 4 |
| | Noise | 1 |
| | Crowding | -1 |
| | Service quality (other than crowding) | -4 |
| | Aesthetic value | 3 |
| | Urban renewal | 4 |
| **Environmental sustainability** | Local air pollution | 1 |
| | Climate change | 1 |
| | Biodiversity | N.R. |
| | Water pollution | N.R. |
| **Distributional issues** | Social cohesion | 5 |
| | Territorial cohesion | 5 |

*Note: * the strength score reflects the weight that each effect carries compared to the final judgment of the project. In particular:*
*-5 = the effect is responsible for the negative performance of the project;*
*-4 = the effect provided a negative contribution to the overall performance of the project;*
*-3 = the effect contributed in a negative way to the performance, but was outweighed by other positive effects;*
*-2 = the effect has a slightly negative effect on project performance;*
*-1 = the effect is negative, but almost negligible within the overall project performance;*
*0 = the effect has no impact on project performance;*
*+1= the effect is positive but almost negligible within the overall project performance;*
*+2 = the effect made a slightly positive contribution to the project performance;*
*+3 = the effect contributed in a positive way to the performance, but was outweighed by other positive effects;*
*+4 = the effect provided a positive contribution to the overall performance of the project;*
*+5 = the effect is responsible for 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*

### *3.2.1 Measurable effects*

**The Vanvitelli-Dante section of metro Line 1 generated positive effects in terms of economic growth, although not as significant as expected ex ante.** By connecting the hilly part of Naples to the historic city centre, it has offered a real option for previous car and bus users to reduce their travel time in this part of the city. According to the ex post CBA (see Annex II), about 67% of the actual passengers in this section of the metro were previously bus passengers and the remaining 33% were previously car users. On average, the project cut the journey time by buses

(cars) by about 30 minutes (20 minutes).[59] This brought some additional benefits related to the reduction in vehicle (car) operating costs, which in Naples amount, on average, to EUR 0.19 per km. The ex post CBA embeds both these effects. The reduction in travel time represents about 85.6% of the total benefits,[60] while the VOCs are 0.3%.

### *3.2.2 Non-measurable effects*

The provision of a good and faster connection between the uptown and the city centre not only translated into efficiency benefits resulting from time savings, but also in **reliability gains** for the metro users. Citizens living, working or crossing this part of Naples and those commuting from the outskirts in the northern area of the city benefit from the increased reliability of their journey (compared to the previous situation where cars and buses remained stuck in traffic) assured by the current frequency of the metro of 10 minutes at peak times. This increased reliability is, however, negatively influenced by the current lack of trains, which often causes delays and defaults in the metro service.

**In terms of institutional learning, the project produced mixed results, which need to be investigated from several and different angles.**

Although the effects cannot be fully attributed to the Vanvitelli–Dante stretch under evaluation,[61] it should be acknowledged that this project generated significant positive spillover effects in terms of know-how and capacity development, which positively contributed to subsequent interventions and extensions of Line 1. Indeed, the new planning and programming course of the Naples urban transport policy started precisely from the Vanvitelli–Dante section.

The Transport Plan approved by the Municipality of Naples in 1997 (and the RMS) proposed **an innovative approach to planning and designing transportation systems,** which is today **acknowledged as a successful experience in Italy and worldwide.** The approach was based on three parallel and interlinked processes:[62]

- A dynamic decision-making process, i.e. divided into subsequent stages where compromises and trade-offs between achievable and realist objectives were taken into account at each step (e.g. the two-fold temporal perspective mentioned above). This multi-step approach is cognitive in nature in the sense that actors learn about solutions and their effects from the output of previous decisions and monitoring activities (see below);
- A stakeholder engagement process, involving the major project stakeholders, was implemented to achieve a broader consensus among parties on the projects to be implemented. The European Commission, the Italian government, the Italian Ministry of Transport and Infrastructures, the Regional government and the local authorities were among the institutional stakeholders. Other groups of stakeholders comprised users affected by the project both directly (e.g. rail and public transport users' associations) and

59 According to the Municipality of Naples, the Metro takes about 12 minutes to travel from Dante to Vanvitelli and vice versa.
60 The value of benefits in time saving relies on the assumption that 85% of passengers are commuters and 15% are other type of passengers (breakdown by travel purpose).
61 It is likely that learning and capacity building effects due to the spreading of a know-how related to the construction of the metro are attributable to the Line 1 as a whole.
62 Cascetta et al (2015).

indirectly (environmental associations, local communities, media and financial institutions);

- A technical analysis process based on statistical and mathematical models was implemented for performing feasibility studies to compare different options, for instance, to conflicting objectives (e.g. increasing accessibility and budget constrains),[63] for promoting discussion with stakeholders and for reducing administrative and realisation times as well as implementation costs (e.g. fewer project variants and fewer delays for lack of consensus).

**Institutional learning, at least in the investment planning and design phases, relies on having managed a complex and multi-agent decision-making process**. In this process, political, technical and communication abilities have been implemented in order to design transport solutions that were consistent with each other and to divert resources towards the most growth-enhancing projects. At the same time, the stakeholders' consensus was maximised also by revisiting the use of quantitative models for promoting discussion among parties, that is, beyond their traditional applications of mere evaluation tools.

Strictly related to learning effects in the investment planning and design phases, metro Line 1 (including the Vanvitelli–Dante section) also required high technical skills in the construction phase. **The engineering and technical complexity of deep excavation in hostile environments** (i.e. very densely urbanised areas with poor subsoil conditions and existing structures of monumental and historical value listed by UNESCO as a World Heritage Site) addressed a number of issues[64] and the design of a cutting-edge programme of monitoring[65] that **contributed to the improvement of existing technical know-how for sustainable underground construction at international level**. Although several amendments occurred during construction work and interferences in tunnel excavation due to important archaeological finds arose, the Naples experience was acknowledged worldwide as a good integration between innovative underground engineering, station architecture and heritage conservation. Because of this, in 2016 Naples won the competition held in San Francisco (USA) to host the World Tunnel Congress in 2019 beating London and Istanbul. At the 2019 congress, knowledge gains from the Naples experience (i.e. advances in design, construction, and safety of tunnels and underground space) will be discussed and shared among the major experts in this field.

**Additional wider economic effects** come from the fact that the **Art Stations have become an extra tourist attraction for the city**. The involvement of architects and artists to interpret the interior spaces and entrances to the stations according to the peculiarities of the surrounding environment along with a sightseeing programme of the city via Line 1 have certainly increased Naples' already recognised attractiveness with obvious economic benefits.

63 As an example, the work at the Museo station required the realisation of the interchange tunnel connecting Line 1 with Line2, improving the overall accessibility of public transport in the city.
64 They include: the choice of an adequate support system, the definition of the sequence of construction phases, the computation of the stresses in the structural members, and the evaluation of the magnitude and distribution of ground displacement connected to the construction phases and to possible changes in groundwater pressure due to the excavation (Mandolini and Viggiani, 2017).
65 This includes the measurement of: (i) the displacement of existing buildings, (ii) the displacement at ground surface following the excavations, (iii) the displacement of the retaining structures, (iv) any changes in the groundwater regime, (v) the forces in the anchors used to support excavations (Mandolini and Viggiani, 2017).

### *3.3 EFFECTS ON THE QUALITY OF LIFE AND WELL-BEING*

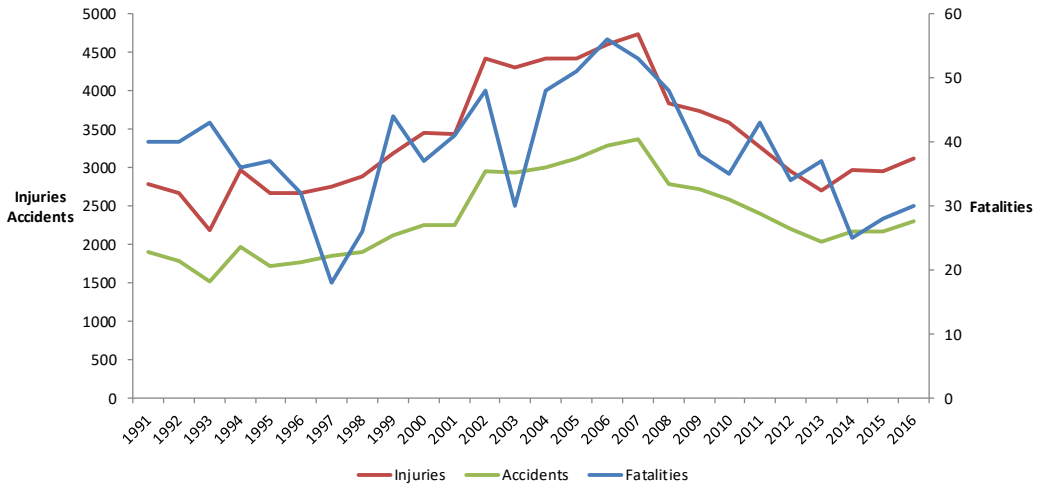
The quality of life and well-being are understood here as the capacity of the project to affect social development, the level of social satisfaction, the perception of users and those of the whole population.[66] As in the previous section, the effects on the quality of life and well-being are broken down into measurable and non-measurable impacts.

#### *3.3.1 Measurable effects*

Fully operational since 2004, **the Vanvitelli–Dante section has had a positive impact on safety and noise reduction**. It has contributed to a modal shift in favour of the metro by reducing surface traffic. Therefore, positive externalities can be measured in terms of the reduction in the number of accidents (including injuries and fatalities) and in noise pollution.

The trend in the number of roads accidents in the city of Naples over the period 1991–2016 is shown in Figure 14. Although this decreasing trend is not fully attributable to the section under assessment, Figure 14 supports the idea that the wider the supply of urban railways, the lower the number of road accidents in the city.[67]

**Figure 14. Road accident trend in Naples over the period 1991-2016.**




*Source: Authors based on ISTAT data*

The quantification of the safety benefit in the ex post CBA relies on information gathered from the ex ante CBA, which provides data on the number of avoided accidents by type (i.e. injuries, accidents, fatalities) every 1 million circulating cars in Naples. Starting from this data, the safety benefit was quantified as EUR 41 million per year, equal to 3.6% of the total value of socio-economic benefits generated by the project (see Annex II for details).

66 See the First Intermediate Report.

67 The figure only shows a small dip in fatalities in 2004, while actual decreases in injuries, accidents and fatalities come after 2007. This dynamic can be explained by two facts (see Naples Urban Plan for Sustainable Mobility 2016 for details): firstly, the railway system in Naples started expanding in 2004 with, among others, the Vanvitelli-Dante section and between 2011 and 2014 with the opening of the metro Line 1 section reaching the central station. This would have contributed to the reduction in accidents shown in Figure 14. Secondly, in the years after 2007, the crisis reduced traffic. The crisis generated unemployment and, thus, the number of commuters using cars to go to work decreased. This resulted in a reduced number of accidents. Available data do not allow us to calculate to what extent the reduction in accidents is due to crisis or to the expansion of the railway network in the city; however, several documents support the idea that the investment in the public railway transport system in Naples contributed to reducing road accidents (Naples Urban Plan for Sustainable Mobility 2016; ACAM, 2010; Cascetta and Pagliara, 2008).

The benefit from the reduction in noise was valued according to the idea that the project reduces the daily density of traffic by inducing people to take the metro instead of a private car (see the First Intermediate Report). This benefit accounts for 0.18% (EUR 2.1 million) of the total economic benefits.

**The realisation of the project also increased property values.** The urban rail investment along with the requalification of the areas surrounding the stations increased the attractiveness of locations near the stations and enhanced their accessibility. The land-use and the economic impact on property values in the stations of Quattro Giornate, Salvator Rosa, Materdei, Museo and Dante between 2001 and 2008 was quantified in the ex post CBA by combining real estate data provided by the Municipality of Naples and data provided by the University of Naples Federico II.[68] The impact of urban regeneration interventions linked to the five railways stations under assessment was valued at EUR 117.7 million (10% of the total benefits).[69]

The high architectural and aesthetic standards of the Art Stations have raised concerns among the public about the efficiency (related to the allocation of public resources) and the effectiveness of such a choice for a public investment whose primary objective is to transport people. The need to provide answers to such concerns has prompted the stakeholders[70] to assess **the impact of the stations' aesthetics on travellers' behaviour in terms of their additional willingness-to-pay with respect to standard stations** (see Box 2). The '*value of beauty*', in terms of average willingness-to-pay, was valued to be EUR 0.43 per person, meaning that a commuter is willing to wait up to seven minutes for a train, or to spend 10 minutes more to reach a highly aesthetic station. While these results add value to the project from the well-being point of view, **the choice was not to include this willingness-to-pay as an additional benefit in the ex post CBA to avoid double-counting issues.** After all, the main implication of these findings is that the catchment area of highly architectural stations is greater than the traditional one and this should be reflected in a higher number of passengers who pay for a ticket.

68 Pagliara and Papa (2011). The property value changes were estimated by comparing the dynamics of prices in the stations' catchment areas with that of specified control areas.

69 The positive impact of transport projects on property values may depend on several factors ranging from the type of land use, the type of railway service, the distance to the station, and so on (see e.g. Mohammad et al., 2013). In the case of Naples, at least two channels can be identified. The first one is that the real estate market is sensitive to gains in accessibility (e.g. distance to the station). The higher the accessibility of an area, the higher the demand for real estate in that area, the higher the prices. This effect may capture benefits related to the time-savings and may be a reflection of time-savings already measured. The second channel refers to a pure urban regeneration impact. The real estate market is very sensitive to urban qualification, independently of the realisation of a transport project (see e.g. Gargiulo and de Ciutiis, 2010 and Nesticò and Bencardino, 2016 for the case of Naples). In Naples the realisation of Metro Line 1 was accompanied by an important requalification of the urban areas near the stations from the outset, justifying an additional effect from urban renewal along with that of pure time-savings (Papa and Pagliara, 2011).

70 Cascetta and Cartenì (2014).

### Box 2. The value of beauty

In order to investigate on the hedonic value associated to the architectural/aesthetic quality of the Art Stations, in 2012 the engineering department of the University of Naples Federico II carried out a study based on a revealed preferences (RP) survey addressed to a selected sample of railway travellers moving between the two following routes:

HQSR – High Quality Railway Stations comprising the rainbow regional line and Naples metro line 1 (opened in 2003) (red route in the Figure below);

TRS – Traditional Railway Stations comprising a traditional regional line and the traditional Naples metro line 2 (blue route in the Figure below).

The originality of the experiment was that the selected rail network included old and new rail lines and some Origin–Destination (O–D) pairs with two possible routing options corresponding to different architectural standards, everything else being almost equal. Therefore, it was likely to allow the researchers to isolate the effect of the architectural/aesthetic quality of the stations from other characteristics potentially affecting the willingness-to-pay. The survey was carried out three years after the new (art) rainbow line was opened and 10 years after Naples metro line 1 was opened (Dante station). The time lapse since opening was such as to exclude any significant 'novelty effects' for the choice of the HQSR routing option. 128 students and 107 commuters were sampled in the RP survey and all trips included in the sample were round trips without any intermediate stops.

The main conclusion of the study was that the average perceived value of station quality amounted to 35 Euro cents/trip for students and to 50 Euro cents/trip for commuters (+43%), showing a higher value of station quality for female travellers (+33% more than their male counterparts, or to spend nine minutes more to reach a highly architectural station, given the same average utility). A commuter was willing to wait up to seven minutes more, or to spend 10 minutes more to reach a highly aesthetic station. The study also suggested that the catchment area of a highly architectural station was greater than a traditional one (+99% of travellers more than traditional ones) (Figure b below).

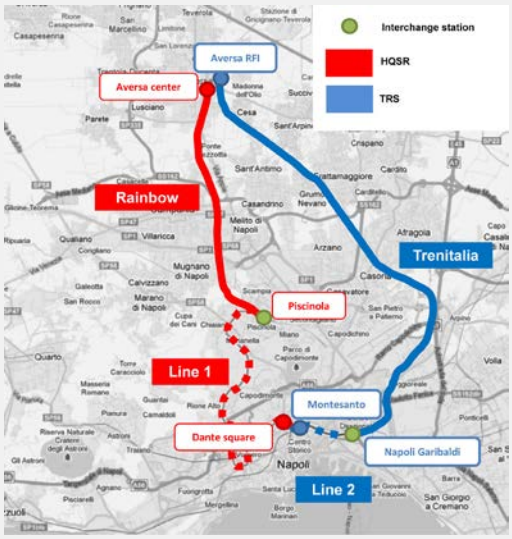



Figure (a). Origin–destination pairs with two rail alternatives in the Aversa–Napoli corridor.

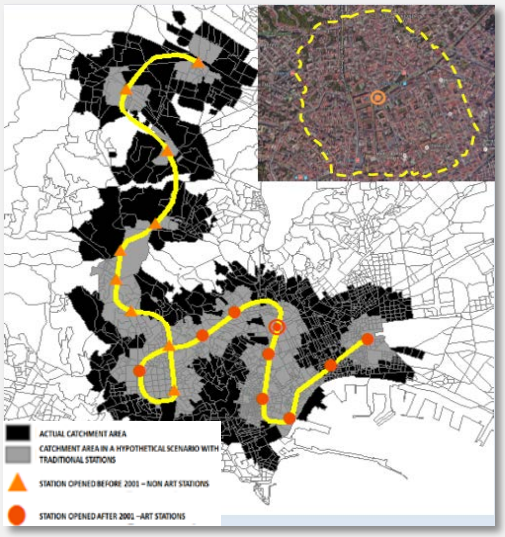



Figure (b). Catchment areas of Art stations vs. traditional stations.

*Source: Authors. Figure (a) is from Cascetta and Cartenì (2014; Fig. 1, p. 45). Figure (b) is from "Da Vitruvio alla Metropolitana di Napoli". PPT by Prof. Cascetta at the conference "In Onore di Santa Barbara", held in Naples on 1 December 2017.*

### *3.3.2 Non-measurable effects*

As reported in the press and documented by interviewed representatives of NGOs, Naples inhabitants widely agreed that the construction of the metro, including the segment under assessment, has significantly improved their living conditions by increasing accessibility and connectivity to the city centre. They also agreed, however, that **the quality of service needs to be assessed from two perspectives: one related to the structural and functional quality of the stations and infrastructures and the other to the quality of the transport service.** While the first one positively impacts on the quality of life of the people, the second produces a negative effect.

As emerged from the interviews, **people perceive the new stations as extremely secure**. Besides being built according to the most up-to-date quality standards in force at the time of construction,[71] terminals were equipped with systems for monitoring and controlling the areas inside and outside the stations operated by permanent staff.[72] This increases the perception of security in a city with high rates of reported petty crime against passengers. **The new stations are perceived to be smart and green as well.** The ICT technologies conceived to provide information to users (real-time and pre-trip) and the use of recycled or recyclable materials along with energy saving systems for lighting and the indoor air-conditioning system, clearly impact on the functionality of the infrastructure. A minor complaint is about the absence of mobile phone service coverage in the terminals, this is, however, currently under construction. **Eye-friendliness** concerns the technical and aesthetic aspects of the project infrastructure and **significantly influenced metro users' attitudes and the Neapolitans' behaviour from different aspects.** First, elegant, comfortable, clean and modern stations along with the improvement in the context in which they were designed enticed users to assume, to certain extent, correct behaviour (e.g. reduction of vandalism damage); second, the permanent contemporary art exhibitions along the exposed archaeology finds transformed the metro stations into an '*obligatory museum'* where people enjoy art pieces as they pass through transit spaces that they would have had to cross in any case, increasing users' interest and familiarity with art and the history of Naples.

**The quality of infrastructures is not reflected in an equally satisfactory quality of the public transport service.** With the exception of the integrated fare system that made travelling easier by interfacing different modes of transport, **public opinion, citizens and press articles continuously raise criticisms about the quality level of the service delivered.** Too low frequencies negatively impact on transit waiting time, its reliability and journey comfort. Sometimes, the excessive crowing of trains and platforms at peak times is the cause of sudden illness felt by users and even interruptions in the service. The reduced service time schedule is an additional weakness of the project that creates inconvenience for Neapolitans and tourists who want to enjoy the city in the evening. Complaints also concern the malfunction of information monitors providing travel information in normal and critical conditions and the lack of air conditioning systems in the trains due to their

71 Among others, twin-tunnel design, modern systems of lifts and/or escalators, sophisticated and cutting-edge anti-fire system and optimum illumination systems even in case of emergency. On this point see: Region of Campania - Regional Council resolution n. 637/19.05.2006 – Transport and Mobility Area n. 14. Approval of guidelines for the designing and construction of the RMS stations.

72 These systems include warning systems for users in case of aggression or theft and monitoring and alarm systems to detect illicit introduction of weapons and suspicious objects into the stations.

obsolescence. All this generated a tangible sense of social distrust and disillusionment in the city that emerged when talking to people and also resulted in protests and legal class actions against public and private managers of the metro. **In conclusion, an unsatisfactory service negatively reflects on project performance.**

### *3.4 EFFECTS ON ENVIRONMENTAL SUSTAINABILITY*

The relationship between the project and the environment is twofold. On the one hand, the project has contributed to a reduction in road traffic and this is a measurable effect. On the other, the '*green*' infrastructures certainly represent a step towards environmental sustainability, even if this is difficult to quantify. Both measurable and non-measurable impacts are discussed in the next sections.

#### *3.4.1 Measurable effects*

Since its first operating year, the Vanvitelli-Dante segment of Line 1 has offered passengers an alternative to buses and private vehicles with a positive impact on road traffic. As a result, appreciable impacts in reducing air pollution and greenhouse gas (GHG) emissions have been achieved, as stop-and-go traffic is the most negative for the environment. According to the project CBA (see Annex II), the reduction of air pollution and GHG emissions are worth, respectively, 0.19% and 0.14% of the total socio-economic benefits corresponding to EUR 2.2 million and EUR 1.6 million each.

The reduction in pollutant emissions is particularly relevant for Naples, a city densely populated with high levels of air pollution because of mobility behaviour still based on private motorised means of transport. Studies carried out in 2016[73] calculated that the motorisation level in the city is 55 cars per 100 inhabitants corresponding to 529,460 cars. Although this figure is in line with other comparable Italian cities, Naples has a higher number of old and polluting types of car. Table 12 shows that Naples is the city with the highest share (30%) of cars belonging to the Euro 0 class in the whole Campania region (20%) and in Italy (11%). According to the Municipality of Naples[74] this generates between 20% and 25% of total air pollution in the city. The situation would have been even worse in the absence of the project.

**Table 12. Cars by Euro Class in 2014.**

| AREA | EURO 0 | EURO 1 | EURO 2 | EURO 3 | EURO 4 | EURO 5 | EURO 6 | NOT-KNOWN | TOTAL UNITS |
|---|---|---|---|---|---|---|---|---|---|
| Naples | 30% | 5% | 16% | 15% | 24% | 9% | 0.3% | 0.2 | 529,460 |
| Naples Metropolitan Area | 23% | 6% | 17% | 17% | 26% | 10% | 0.3% | 0.2 | 1,717,338 |
| Region of Campania | 20% | 6% | 18% | 18% | 27% | 10% | 0.3% | 0.1% | 3,335,372 |
| Italy | 11% | 4% | 15% | 18% | 33% | 18% | 0.8% | 0.06% | 37,080,753 |

*Source: Naples Urban Plan for Sustainable Mobility 2016, Table 4-25.*

#### *3.4.2 Non-measurable effects*

**The highly architectural and technological solutions adopted for the metro terminals boast additional attributes in favour of the sustainability of the**

[73] Naples Urban Plan for Sustainable Mobility 2016 (PUMS, p. 2).
[74] Naples Urban Plan for Sustainable Mobility 2016 (PUMS, p. 2).

**environment**. Energy saving systems have a limited impact on the emissions and consumption of natural resources, preserving them, as much as possible, for future generation.

### *3.5 EFFECTS RELATED TO DISTRIBUTIONAL ISSUES*

The distributional impacts of the project are related to both social and territorial issues.

**The project positively contributed to social cohesion** by improving the extent to which different groups of people can benefit from the transport service. Easy accessibility to the stations and the train platforms is ensured to all kind of users (e.g. elderly and disabled) thanks to services available both outside and inside the stations. A diffused and easy-recognisable communication and orientation system in the city, using visual, acoustic or personalised signs (e.g. info points) enable people to effortlessly reach the stations and once inside them, 68 escalators/lifts and moving walkways facilitate users' approach to platforms situated up to 44 metres deep. Within the stations, the signage system (including blueprints, characteristics of the architectural space and the location of the art works) is clear and tidy so that all types of user can move autonomously and enjoy all the services offered by the structure. Moreover, the project also connected the hospital situated in the hilly area of Naples to the city centre.

**The Line 1 Vanvitelli-Dante extension also improved territorial cohesion**. It connects the hilly area of the city with the historic city centre in downtown Naples enhancing the previously scarce penetration of the metro in the city and increasing the few interchange possibilities with the other existing lines.[75] Moreover, through this intervention, the city centre was also connected to the suburban areas north-west of Naples and to the suburban/regional railways operating in that area. Without prejudice to the positive assessment of the project related to territorial cohesion, on one occasion an interviewee complained that the stops were too concentrated in this segment of the metro line and not equally distributed across the city, to some extent limiting accessibility to the transport service in more distant neighbourhoods.

### *3.6 TIME AND SPATIAL SCALE OF THE EFFECTS*

The construction of the Vanvitelli-Dante section was completed in 2003; however, being part of a wider urban (and regional) railway network, **most of the project's effects, especially those related to the transport service, have not yet stabilised despite** the time that has elapsed since opening. The current lack of trains and the ongoing construction of the additional segments of Line 1 are strongly limiting the transportation potential of the operating sections.

Further extensions to Line 1 are expected in the coming years (by 2022 at the latest), which are likely to increase the number of users by connecting the North outskirts of the city with the most important hubs of the city[76] in a closed loop of a total length of 27 km with 27 stations. Additional benefits from the increase in the number of

[75] This includes, among others, the easy connection with line 2, which crosses the city from East to West. Every day about 22,000 people make use of the tunnel connecting Line 1 to Line 2 at Museo station, allowing users to reduce the interchange time. The figure of 22,000 refers to 2009. Between 2003 and 2009, the number of passengers that interchanged between Line 1 and Line 2 by using the interchange tunnel increased by 40%. (ACAM, 2010; Chapter 5; p. 96).

[76] For instance: the hilly area, the historic centre, the central station, the administrative district and the airport.

passengers are expected from the development of the RMS, which will link regional railways with those in Naples thus improving the access to the city.

Additionally, sector experts agree that such transport developments at city and regional level are likely to bring efficiency gains to the entire city, mainly related to agglomeration and productivity effects stemming from better accessibility and interconnectivity. However, the magnitude of this effect and its attribution to the Vanvitelli-Dante segment is uncertain.

Table 13 provides a current assessment of the time-scale of the effects discussed above and the level at which they have already materialised or are expected to materialise (i.e. local, national or global level). As previously stated, the future of the project is highly uncertain and further positive or negative developments may still occur.

**Table 13. Timing and spatial scale of the effects**

| CATEGORIES OF THE EFFECTS | SHORT RUN (1-5 YEARS) | LONG RUN (6-10 YEARS) | FUTURE YEARS | COMMENTS |
|---|---|---|---|---|
| Economic growth | + | ++ | +++ | Time savings, reduced congestion, VOCs, increasing reliability has been positive, but they are lower than expected and not yet stabilised. In the future can produce positive impacts at local and at regional level.<br>Institutional learning represent significant, positive, and long-term effects generated. They are now stabilized effects, which were experienced first at local level by both private and public actors and afterwards transferred at national and global level by the huge amount of research and academic publications produced in the fields of transport and urban planning and related conferences. |
| Quality of life and well-being | +/- | +/- | ++ | Safety and noise reduction are not a stabilised effects; in contrast the effect on property values is exhausted. Good level of satisfaction of citizens for the quality of infrastructures, but the transport service needs to be significantly improved. Major influences are expected at local level. |
| Environmental sustainability | + | ++ | +++ | Reduction of air pollution has not fully materialised. Positive impact of the new green infrastructures on the environment. These are effects mainly experienced at local level; however, the reduction of GHG emissions marginally contributes to the global environment sustainability. |
| Distributional issues | +++ | +++ | +++ | Positive effects in terms of social and territorial cohesion have already been achieved. No further important impacts are foreseen in the future. |

*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. This section also discusses the interplay between the identified determinants.

**Table 14. Determinants of project outcomes**

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

*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*

Metro Line 1 was expected to improve public transport in the city and the urban transport system and to enhance the image of Naples, which in the nineties suffered from urban decay, and to significantly impact on the social and cultural behaviour of people.

**The context in which the project was developed was highly favourable and appropriate,** in the sense that the **expected impacts were not only within reach, but were perceived as urgent needs by citizens and local institutions, alike**. During the second half of the last century, very limited investments were made to expand and/or upgrade the existing railway network in Naples. These efforts followed an uncoordinated process in which decisions were taken by individual transport companies, thereby limiting an integrated vision of the urban railway system. The lack of an efficient urban transport network was an acute problem for Naples, a city with expansion prospects and a territory that was entering, after deindustrialisation, a new phase of its economy based on services. Conscious of these needs, the Municipality of Naples issued a new planning approach, which was laid out in the Urban Transport plan of 1997 and started with the Vanvitelli-Dante extension of metro Line 1. In agreement with the Region of Campania and with other local institutions, the Naples plan was included in the *Plan of 100 Stations* and the RMS project at regional level. These plans also shared the common objective of enhancing the architectural and urban environment of both central and peripheral areas of Naples. The idea was to regenerate the squares where the stations were located and to eliminate the degradation often caused by existing terminals by upgrading and opening new stations

of high qualitative and aesthetic standards. Therefore, being planned at a time of network expansion, **the technical and the institutional context was positive for the project**.

**The social and cultural contexts were propitious as well.** Along with the existence of a high demand for mobility, since 1995 the Municipality of Naples has been promoting the knowledge and dissemination of contemporary art in the city (see Box 3). The Art Stations, whose aim was to combine the use of public transport with the 'compulsory' exposure of users to contemporary art were conceived in this context and following the *'Station Renaissance'* movement that had started in Europe some years before. In conclusion, favourable prerequisites for the success of the project existed and they were the key factors for the timely implementation of the Vanvitelli-Dante section of Line 1 (i.e. completion work).

**Box 3. The Art Stations in the Naples cultural context.**

Contemporary art has been widely disseminated in Naples since 1995. At that time, the mayor of the city promoted a project called 'the Annals of the Arts' and other related initiatives addressed to Neapolitans, who were not very attracted by this kind of art. For this reason, contemporary art works were exhibited in popular spaces, such as the most important square in Naples called Piazza Plebiscito. Since then, the square has become an 'art square' hosting the art pieces by famous artists (see figure below). The idea of combining contemporary art with transport infrastructures was born in 1995, during the excavation works of the Vanvitelli-Dante section of the metro and was officially embedded in the 'Plan of the 100 Stations' developed by the Municipality of Naples in 2000. With the construction and expansion of numerous metro lines also at regional level, with resolution no. 637 of 19 May 2006, the Region of Campania issued guidelines to be applied to the design and construction of future stations.

Francesco Erbani, a journalist from 'La Repubblica' explained the reasons leading to the choice of constructing the Art Stations:

*'A subway also means stations: why limit yourself to purely engineering solutions and not turn these places into valuable architectural and art objects encouraging people to increasingly use the public transport? Why not enrich a great public service with aesthetic values, combining functionality and eye-friendliness? These were the questions that circulated within the public administration offices during the planning of the transport network.*

The Salt Mountain – MIMMO PALADINO.

Piazza Plebliscito, Naples.

Bronze Heads – REBECCA HORN

Piazza Plebliscito, Naples.

*Source: Authors The quotation is from Wikipedia.*

### *4.2 SELECTION PROCESS*

In relation to the context and for the reasons that are discussed below, **the selection phase of the project made a positive contribution to the performance of the project**.

The implementation of the transport programme in Naples and that of the wider RMS programme in Campania, including the definition of each phase, was supported by a twofold prioritisation mechanism. **The underlying logic of the selection process was to maximise the social benefits (e.g. improve the transportation services as soon as possible) given the existing physical constrains** (e.g. already operating lines or segments of the metro) **and optimising the available budget** (as explained in Section 2.1). This new approach was in contrast to the previous approach of defining comprehensive and immutable choices to be realised in an indefinite interval of time without indicating any priority.[77]

**The new approach also tried to maximise consensus among stakeholders** thanks to their involvement since the planning phase and the selection of priority interventions within the railway transport strategy at urban and at regional level. The process of stakeholder involvement was based on five steps.[78] The first step was the identification of stakeholders. For the railway transport programme, the major institutional stakeholders included the European Commission, the Italian government, the Italian Ministry of Transport, the Italian Parliament and the Region of Campania. Users, both direct and indirect, local communities and the regional and local transport operators were all considered. 'Listening' was the second level of this process. Preliminary meetings with stakeholders were organised to outline objectives, times, methodologies and also requests and problems. A number of meetings with different stakeholders were organised during the design phase as well. The third step of stakeholder involvement was 'information'. Information to the public was given in printed documents. For instance, posters were used to convey general information about the project or to announce the opening of new stations (Figure 15). Local radio and television were also used intensively to promote the project. The fourth and fifth steps consisted of 'consultation' and 'participation'. Technical meetings with the Municipality of Naples and the Transport Committee of the regional Council were organised to discuss the transport issues related to the project.

77 Naples Transport Plan (1997; p. 14).
78 See Cascetta and Pagliara (2013).

**Figure 15. Example of posters announcing the opening of a new station in the Vanvitelli–Dante section.**


*Source: Cascetta and Pagliara (2013; Figure 3 and Figure 4). On the left-hand side: Poster prepared for the opening of Dante station – The slogan: In Naples an art-based metro. On the right-hand side: Poster for the opening of the corridor linking Museum station with the Archaeological Museum. The slogan: Arts meet.*

### *4.3 PROJECT DESIGN*

Designed to face the city's two main problems of transport needs and urban degradation, **the project design is complex from a technical point of view and praise is alternate with criticism when talking to people.** This holds true for both the whole of Line 1 and for the specific segment under assessment.

The new integrated mobility approach and the new design culture have made the project a best practice acknowledged worldwide. Engineers, famous architects and artists from all corners of the globe made visionary decisions regarding the geometry, materials and ICT applications used to embed the stations in the surrounding environmental context (including archaeology) and to optimise space utilisation inside the stations. The safety, smartness, greenness and the eye-friendless of infrastructures are all necessary ingredients that have put the city on a course of sustainable mobility.

Parallel to the concept of the infrastructures, the design of excavation work addressed a number of complicated technical and engineering issues[79] that contributed to knowledge advances in tunnel construction. The matter becomes particularly complex if deep excavations are inserted into a densely urbanised and historic environment such as Naples. Today these advances are recognised as a successful experience by experts in the field.[80]

**Criticisms of the project design relate mainly to costs.** Some people complain that some stations are over-sized for their real needs and aesthetic criteria often prevail over the functional ones. The enormous size of some stations entailed a high investment that was probably unnecessary even taking into account the view that considers the stations a natural location for cultural and social events. Table 15 compares the construction cost per kilometre of some underground worldwide. The Line 1 in Naples is only comparable with the segment of Line C in Rome crossing the

79 Such issues include: the extraordinary depth and slope of the tunnels, the geotechnical characteristics of the terrain and the choice of an adequate support system, the computation of the stresses in the structural members and the evaluation of the magnitude and distribution of ground displacements connected to the construction phases and to possible changes of groundwater pressures connected with the excavation.
80 See the World Tunnelling Congress 2019. http://www.wtc2019.com/

Coliseum area and the historic city centre of the city. The latter, is considered one of the most expensive undergrounds in Europe for archaeological related issues.[81]

> ***Metro Line 1 is a great historical-artistic-cultural-transport heritage that has been built at 'great' costs as well*** *(source: interviewee from the Region of Campania)*.

**Table 15. Capital costs per route-kilometre for selected urban rail projects.**

| | COST/KM (EUR 2017, MILLION) | OPENING YEAR | LENGTH KM |
|---|---|---|---|
| **Rome** **Line C San Giovanni – P. Venezia section** | 295 | In progress | ?? |
| **Naples Line 1*** ** | 175 - 230 | 1993 | 18.8 |
| **Naples Line 1 Vanvitelli-Dante section**** ** | 105 | 2001-2003 | 5.03 |
| **Naples Line 6** ** | 172 | 2011-2019 | 5.50 |
| **Rome** **Line C** | 172 | 2014 | 24.7 |
| **Barcelona** **Line 9/10** | 162 | 2016 | 47.8 |
| **Euro Tunnel ***** ** | 161 | 1994 | 50 |
| **Paris** **Line 14 Meteor** | 155 | 2007 | 9.2 |
| **Milan** **Line M4** | 133 | In progress | 15.2 |
| **Milan** **Line M5** | 127 | 2013 | 12.6 |
| **Vienna Stage 1*** | 118 | 1984 | NA |
| **Berlin U-Bahn*** | 110 | NA | 4.6 |
| **Lausanne** **Line M2** | 95 | 2008 | 5.9 |
| **Turin** **Line 1** | 82 | 2005 | 9.6 |
| **London Victoria* Line** | 79 | 1968-69 | 15.8 |
| **Madrid** **Line 12 MetroSur** | 45 | 2003 | 40.9 |
| **Italy benchmark**** | 133 | n.a. | n.a. |
| **World benchmark**** | 90-120 | n.a. | n.a. |

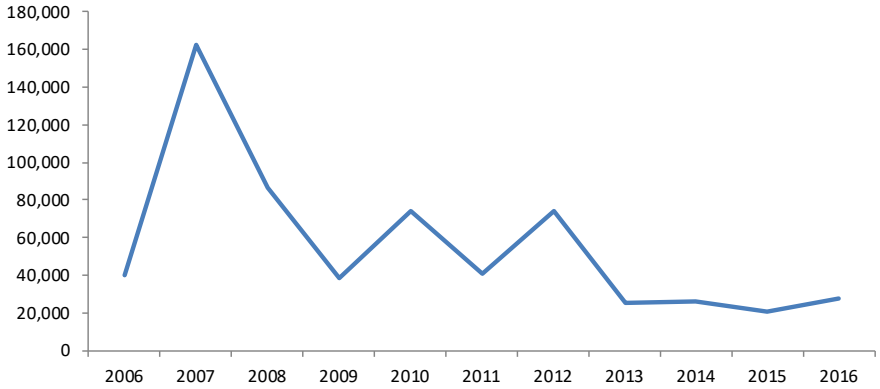
*Source: Authors' calculations based on data from *Flyvbjerg et al (2008).**https://rometheimperialfora19952010.files.wordpress.com/2011/07/rapportometroc.pdf. *** Authors' calculations based on Cascetta presentation for the World Tunnelling Congress, **** Authors' calculations based on investment costs data provided by the Region of Campania and km data provided by ANM S.p.A.***** Authors' calculations based on Ricard Anguera(2006), "The Channel Tunnel—an ex post economic evaluation", Transportation Research Part A: Policy and Practice, Elsevier*

81 http://napoli.repubblica.it/cronaca/2017/05/11/news/metro_linea_1_costi_esorbitanti-165161959/

The cost of art deserves a separate discussion. According to the MN Metropolitana di Napoli S.p.A. (the contractor in charge of designing and building the infrastructure) the art work represents, on average, a share of 4% (EUR 156 Million)[82] of the total construction costs of Line 1, which is judged negligible compared to the total cost of the project that would have been supported in any case.

Conversely, the maintenance costs are shown in Figure 16.[83] Between 2006 and 2016 these costs amounted to EUR 616,000, including ordinary and extraordinary maintenance. Works of art are indeed subject to considerable environmental stress conditions, due to the microclimate of the stations, to the ferrous powders produced by the friction between the wheels of the trains and the tracks, to the transit of the travellers and to vandalism. Since 2006 the maintenance of art works in the stations has been guaranteed by a 3-year renewable agreement between ANM, MN Metropolitana di Napoli S.p.A. and Naples Fine Arts Academy.[84]

**Figure 16. Costs for the maintenance of art in the Vanvitelli (excluded)–Dante section over the period 2006–2016. Euro.**




*Source: ANM data and ANM note on the maintenance of artwork on Line 1.*

On top of that, the service provider ANM complains about the maintenance of the artwork equipped with technological systems. Some artwork is equipped with lighting and technological components (e.g. light boxes, neon tubes, LED systems, video installations), whose maintenance is outside the agreement with the Academy of Fine Arts and all the costs weigh on the ANM balance sheet.

**Overall, it can be said that the design is a positive 'attribute' of the project.** Good professional capabilities and visionary capacity were pivotal in the design phase of a project. They also act as enablers to start the construction phase. The decision-making process underlying the project design can be associated with a '*hiding hand*' at work,[85] committing sufficient resources and prestige to the project such that it was seen as a good reason to rely on the success of this flagship operation despite all the potential risks and criticisms the initiative was exposed to.

82 Source: "Da Vitruvio alla Metropolitana di Napoli". PPT by Prof. Cascetta at the conference "In Onore di Santa Barbara", held in Naples on December 1st 2017. Art includes the art works inside and outside the stations and the fees of architects and artists. Based on data provided by the Region of Campania, the cost of the art for the Vanvitelli-Dante section represents a share of 2.5% of the total construction costs, i.e. equals to EUR 11 million.
83 The Figure only refers to the maintenance costs of art in the Vanvitelli–Dante section. The Vanvitelli station is excluded.
84 The agreement was renewed already twice, once in 2009 and another time in 2012. In 2015 MN Metropolitana di Napoli S.p.A. did not renew the contract.
85 Hirshman (2014).

### *4.4 FORECASTING CAPACITY*

Forecasting capacity is understood here as the capacity to predict future trends and forecast the demand level.

Several quantitative tools, including *ad hoc* forecast models for transportation networks, CBA and multi-criteria analysis were used for the ex ante feasibility and the overall assessment of the project and the whole RMS.[86] Many studies and publications are available on the ex ante assessment of the RMS, whose judgment goes beyond the scope of this report.

From the narrow perspective of the project under evaluation, **two main points need to be mentioned**. **The first is that the ex ante CBA of the Vanvitelli–Dante section**[87] **suffers from a problem of project identification.** The estimation of the generated benefits, the forecast of the most important variables and the underlying hypotheses (e.g. estimation of passenger demand, diverted passengers, construction schedule, etc.) as well as the stated objectives are related to the whole and wider RMS preventing any assessment of the capacity to predict future trends and developments regarding this segment of metro Line 1. This identification problem was also pointed out by the European Court of Auditors for both Line 1 and Line 6.[88] Experts from the European Commission also stressed that **the forecast models used to predict the demand for the metro relied too much on the availability of rolling stock** and therefore produced over-optimistic scenarios. This represents the second weakness in the forecasting capacity.

### *4.5 PROJECT GOVERNANCE*

At the time of writing, several bodies (either directly or indirectly) have different competencies in the development, delivery and management of metro Line 1 (and the project under assessment). They are (see Figure 17):

- the Municipality of Naples is the beneficiary of the project and owner of all the infrastructures and the rolling stock;
- the Region of Campania is responsible for the planning and development of the RMS and has contributed financially to the development of Line 1 and the purchase of the rolling stock. More importantly, it distributes national funds to the transport service at regional level among the local service operators, including the compensation payments for ANM.
- MN Metropolitana di Napoli S.p.A. is the contractor in charge of designing and building the whole of metro Line 1. Established in 1972 by the most important Italian companies in the tunnelling and underground construction work segment, it is a private company entrusted with a public tender by the Municipality of Naples for the construction of the underground railway in 1976. Since then, no other public tenders have been issued by the Municipality for the selection of its contractor.[89]
- ANM S.p.A. is the company that operates the public transport service in Naples (metro, funiculars, buses and parking) and it is responsible for the maintenance of the infrastructures. The company is 100% owned by the

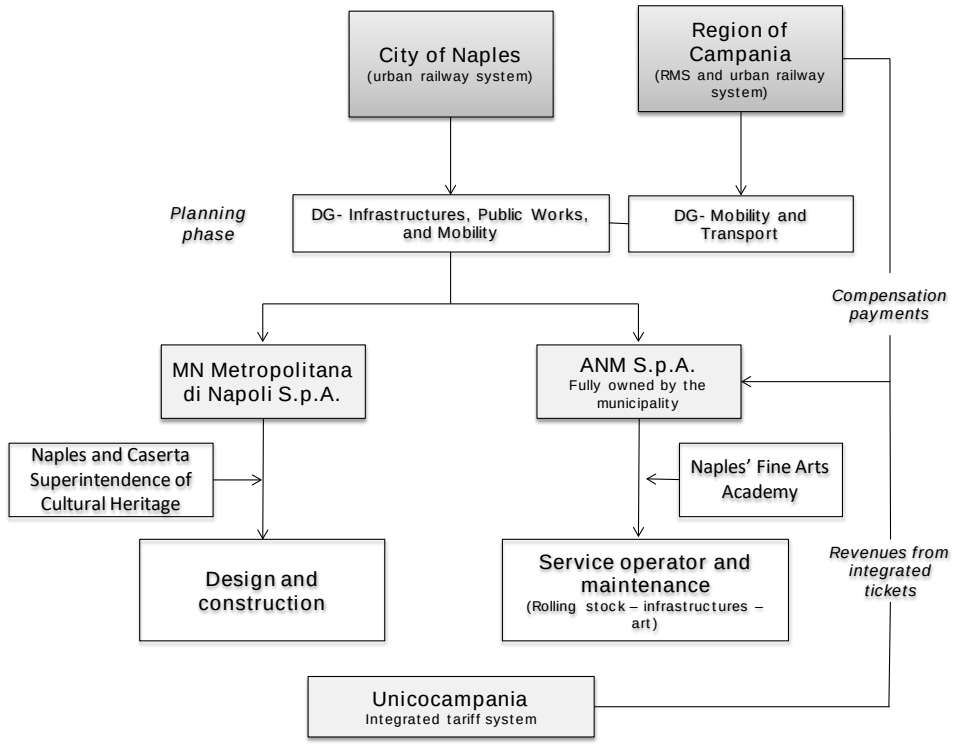
86 Cascetta et al. (2015).
87 Ex-ante CBA section Vanvitelli – Dante. "Metropolitana di Napoli Realizzazione della tratta Vanvitelli – Dante VALUTAZIONE ECONOMICA" provided by the Region of Campania.
88 First decision of the European Court of Auditors of 04/05/06 – June 2012. Line 1 (COD. 67/100061/100062) and Line 6 (COD. 100052) of Naples' underground - Annex N.1.
89 Municipality interview. See also the Annex IV.

Municipality of Naples and operates the transport service through an annual public service utilisation contract. Established in 1995 to operate the bus network in Naples, in 2013 the Municipality merged the companies Metronapoli S.p.A. (concessionaire of metro Lines 1 and 6 and the funiculars) and Napolipark (concessionaire of the city's parking facilities) into ANM, establishing a single, large company in charge of the entire public transport system in the city. The mission of the company was to achieve full integration between road and rail transport, re-launch local public transport and promote sustainable mobility in the city.

- the UNICOCAMPANIA consortium consists of 14 regional transport companies and it is in charge of the management of the integrated tariff system (see Section 2.1). Specifically, the consortium distributes the revenues from integrated tickets among the companies.
- Naples Fine Arts Academy carries out the maintenance of the contemporary art work inside and outside the stations. ANM S.p.A. and MN Metropolitana di Napoli S.p.A. (the latter up to 2015) have financed the art maintenance since 2006 through 3-year contracts with Naples Fine Arts Academy.
- The Naples and Caserta Superintendence of Cultural Heritage carries out the archaeological investigations and related interventions.

**Because of the large number of parties involved, each of them with their own specific and different mandates and objectives**, the incidence of fragmented actions or conflicts of interests is high. Often **the ultimate effects were a situation of difficult and unconstructive interaction and impasse when urgent matters occurred.** For instance, a long-running dispute exists between the Region of Campania and ANM about the size of compensation payments (see below); while confused and overlapping responsibilities for the poor quality of the transport service exist between the Municipality of Naples and ANM. There is a shared opinion among the interviewees that, on many occasions, this situation jeopardized the delivery of the metro transport service.

**Figure 17. Governance structure of Metro Line 1 in Naples**




*Source: Authors*

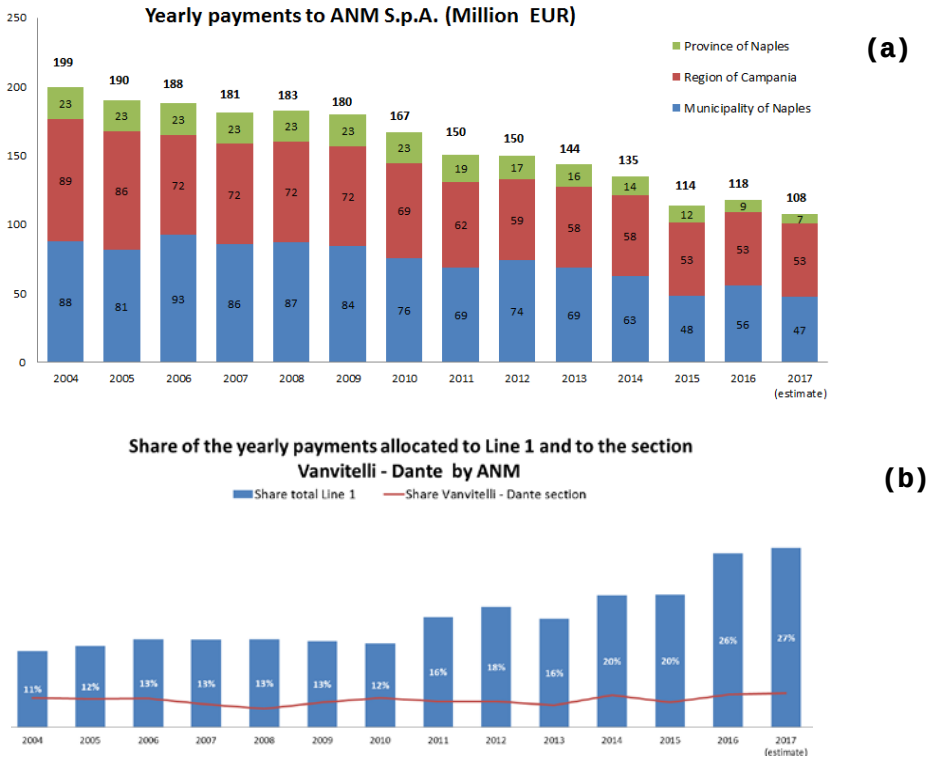
Moreover, a fragmented sharing of responsibilities did not result in a common vision towards a strategic direction and did not support effective coordination among the parties in aligning the construction phase with the operating phase. **An institutional player with a strategic role and integrated vision from construction to service operation was missing.** For instance, the current procurement relationship between the Municipality of Naples and MN Metropolitana di Napoli S.p.A. (contractor for the design and construction of the metro) has been in force since 1976 and it is shaped as an old and traditional procurement contract for public works, which prevents the involvement of the contractor in the project's operating phase. According to the current scheme, after the completion of civil works by MN Metropolitana di Napoli S.p.A., the infrastructure is entirely managed by the service operator (ANM) and no mechanism of smooth risk transfer between the two phases and operators exists (such as, for example, those of some PPP schemes[90]).

**The financial sustainability of the project is guaranteed by annual compensation payments to the service operator (ANM) by the Municipality of Naples, the Province of Naples and the Region of Campania** (Figure 18a). Once received, ANM allocates a share of such payments according to the financial needs of this specific segment (red line in Figure 18b). In 2017 ANM received EUR 108 million in compensation payments and 27% was allocated to Line 1 (Figure 18b). As shown in the figure below, while the total amount of money transfers to AMN decreased over time (-45% between 2004 and 2017), the resources absorbed by Line 1 increased as new segments were opened. According to ANM, the continuous cuts to compensation payments by the Region and the Municipality over the years and the lack of necessary additional funds for public transport in the city is jeopardising the financial

90 For instance, DBF or DBFO contracts are based on incentive mechanisms in which payments to the project developer for the investment recover are linked to charges paid by the end users or to regular payments by the public entities.

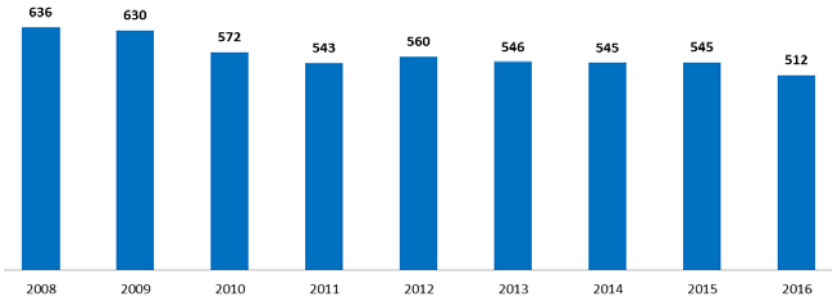
sustainability of the project and the entire local transport network. On the other hand, the Municipality and the Region complain about cuts in funding for public transport at a national level by the Italian government (which is the cause of the cuts at local level – Figure 19) and the inefficient management of the available resources by ANM. On the latter point, ongoing disputes about the procedures for calculating a fair amount of compensation payment exist between ANM and the Region of Campania,[91] whose analysis goes beyond the scope of this assessment.

**Figure 18. Compensation payments to ANM.**




*Source: Authors on data provided by ANM, the Municipality of Naples and the Region of Campania*

**Figure 19. Money transfers from the Italian Government to the Region of Campania (Million EUR)**




*Source: Authors on data provided by the Region of Campania*

In the light of this evidence, it is clear that **this governance structure is ill-suited** to achieving a good level of transport service and to triggering robust collaboration and coordination among the involved parties. In contrast, **it creates stronger**

[91] According to the resolution n. 964/2010 of the Regional Council, the compensation payments addressed to ANM are calculated on the basis of a unitary cost of EUR 11.02 vehicle/km (vehicle = 2 coaches) for an annual production of 6 million coach/km. ANM complains the fact that level of production the unitary costs is EUR 13.68 vehicle/km. On the other side, the Region of Campania blames ANM to be inefficient.

**incentives for promoting and focussing on infrastructural work rather than planning and regulating the service related to the operation of the infrastructures**. The result is that while great efforts and resources were spent on investing in infrastructures, the quality of service provision was often disregarded. Instead, this logic needs to be reversed by laying down the conditions to be satisfied in order to have an efficient transport service and a strong partnership between the transport operator and the construction of infrastructures under stronger political coordination.

### *4.6 MANAGERIAL CAPACITY*

Public transport in Naples is managed by the ANM. The ANM network (Table 16) is embedded in a wider public transport system, whose operators and management are described in Table 17.

**Table 16. ANM S.p.A. in figures**

| **EMPLOYEES: ABOUT 2,500** | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Rail transport** | | Road transport | | Connection facilities | | Maintenance and other facilities | |
| **Line 1** | 18 km | Buses | 467 | Interchange nodes | 9 | Metro depot | 1 |
| **Line 6** | 2.2 km | Trolley buses | 59 | Escalators and lifts | 212 | Buses and tram depot | 7 |
| **Funiculars** | 3.2 km | Tram | 42 | Parking facilities | 21 | Repair | 4 |
| **Vehicles/km** | 6 million | Urban lines | 93 (360 km) | Parking spaces | 29,000 | Electric stations | 6 |
| **Passengers/day** | 180,000 | Suburban lines | 19 (111 km) | | | | |
| **Passengers/year** | 56 million | Vehicles/km | 15 million | | | | |
| | | Passengers/day | 200,000 | | | | |
| | | Passengers/year | 63 million | | | | |
| | | Catchment area | 400 $km^2$ | | | | |

*Source: ANM S.p.A. website and ANM data.*

**Table 17. Public transport in Naples city and metropolitan area: management and operators.**

| **The public transport network in Naples and in its surrounding area consists of 2 metro lines, 4 funicular railways; 4 urban railway lines, 8 extra urban railway lines, 3 tram lines, 7 trolley lines and about 200 urban and suburban bus lines. Four companies operates this network in an integrated manner.** | |
|---|---|
| anm azienda napoletana mobilità s.p.a. | *ANM S.p.A.* operates the lines 1 and 6, the 4 funiculars (Mergellina, Chiaia, Centrale and Montesanto), the urban bus network, and the parking facilities in the city. The company also operates the interchange nodes between different railways lines, and the public lifts at Acton, Sanità and Chiaia, which have connected the hilly area of the city with the lower part since the 19th century. |
| TRENITALIA GRUPPO FERROVIE DELLO STATO ITALIANE | *Trenitalia S.p.A.*, the primary train operator in Italy owned by the Italian Government, operates the railway line crossing the city from East (San Giovanni Barra) to West (Puozzoli). This line is a regional railway crossing the city for about 15 km and it is known in the city as metro line 2. |

| | |
|---|---|
| EAVsrl Ente Autonomo Volturno Socio Unico Regione Campania | *EAV (Ente Autonomo Volturno) S.r.l.*, entirely owned by the Region of Campania, is entrusted the management of the regional and provincial buses public transport in the provinces of Naples, Benevento and Avellino. In the city of Naples, EAV operates the suburban railway lines Circumvesuviana (linking Naples to Sorrento gulf and Pompeii); Cumana (connecting the city centre to Pozzuoli, crossing the Flegrea cost) and the Circumflegrea line (connecting the city centre to the western part of the city after crossing the north of Naples). Some segments of the Circumvesuviana and Circumflegrea lines are known as metro lines 3, 4 and 5. |
| COMPAGNIA TRASPORTI PUBBLICI Napoli ctp | *CTP (Compagnia Trasporti Pubblici di Napoli*) is the concessionaire for tram and bus services in the suburban area north of Naples. The company was established in Brussels in 1881 as Societé Anonyme des tramways à vapeur de Naples and become Compagnia Trasporti Pubblici di Napoli in 1978. Since 2015, the Company is owned by the public entity "Città metropolitan di Napoli". |
| UNICO CAMPANIA | **The tariff system is managed by *the Consorzio Unico Campania*, a company that brings together 14 public transport companies in the region of Campania (including those operating in Naples), that adhere to the integrated fare system. The integrated (bus and rail) fare system was born with the RMS project and allows passengers to travel within the Region with a single ticket. Consorzio Unico Campania supplies both integrated tickets (called TIC – Integrated Ticket Campania) and operators' individual tickets only valid on the route / line of that operator.** |

*Source: Authors. Companies information are from the respective websites.*

Along with the weaknesses in the governance structure, **the poor quality of the managerial capacity is an additional key factor that is negatively contributing to the success of the project**. Several issues emerge when people are called to explain the unsatisfactory transport service delivered by the metro and stakeholders often blame each other.

**The current lack of trains may be the consequence of a rather vague programming phase and a lack of coordination among major players.** Looking back, one can ascertain the absence of any clear financial planning addressed to service provision. The last purchase of trains occurred in 1993, while the last train delivery was in 2005. At that time Line 1 was 13.3 km long, going from north-west Naples to the city centre, passing through the hilly area. The number of trains was sufficient to ensure an adequate frequency for the existing number of passengers. In 2011 new segments were opened and in 2014 and the line reached a length of 18.8 km increasing the number of passengers. Only at this point did the Municipality of Naples become aware of the need for additional trains to satisfy the new needs and the complex administrative procedures (e.g. call for tender, earmark the necessary budget) for the purchase of new trains were activated.[92] Twenty new trains are expected to be delivered in the coming years, the first of which by the end of 2019 (see Section 2.3). In the meanwhile, the whole of Line 1 will remain under-exploited.

**The management of the financial aspect of the project is an additional issue to be analysed.** It is worth noting that this project and metro Line 1 in general (along with its Art Stations) was conceived during a period of economic upturn, when public financial constraints were not as stringent as they are today. Therefore, on the one hand, the project was negatively influenced by the financial crisis, an event impossible to predict in the planning phase. On the other hand, and beyond the crisis, since the beginning of the project **stakeholders have often had difficulties in guaranteeing**

92 Naples' Urban Plan of Sustainable Mobility (PUMS) Observatory (2016); Summary relation page III.

**the continuity of the necessary funds for the completion and the maintenance of the planned work reflecting their poor managerial capacity.** This, in turn, was reflected by an implementation phase of the planned work that still proceeds with far longer lead time than expected.[93] Interviewees stressed the underestimation of the time and cost by key stakeholders.

**Closely linked to the previous point is the fact that archaeological explorations accompanied the building work of the Naples metro stations** and, of course, had their own impact on the performance of the project both at infrastructural and service level. **The assessment of the managerial capability to address archaeological issues produced mix results.** The Naples experience represents a real integration of the worlds of transport, engineering and heritage conservation. From this point of view, the Naples experience represented a change in perspective, where opportunities from archaeology were maximised and to be replicated in other parts of the world. On the other hand, cost overruns and ongoing construction delays mirror an archaeological risk not properly mitigated (ex ante). Although archaeological investigations were embedded in the metro project since its planning phase, archaeological related issues, such as unexpected discoveries and the low degree of "*latitude*" [94] of the project are the main causes of the temporal misalignment (up to 10 years for some stations) between scheduled work deliveries[95] and their actual state of play. Beyond increases in costs, delays generate two additional problems: the first is the postponement in opening the stations, which negatively influences the performance of the whole metro line; the second is that construction sites generate surface traffic congestion.

> ***Archaeology causes delays in the schedule of at least 40%. When something is discovered we call the Superintendence of Cultural Heritage, with which we have a daily contact. Often, amendments to the projects are carried out and this requires time*** *(Source: interviewee from Municipality of Naples)*

Delays and penalties (and even litigations) could have been avoided if there had been more in-depth preventive archaeological investigation, better adaptive planning based on a greater sensitivity in both the transposition of results from preventive archaeology and during construction, along with a more adaptive management of the procurement process.

**The financial insolvency of the service provider ANM, 100% owned by the municipality of Naples, in bankruptcy as well, is an additional key determinant of the current state of play**. The poor quality of the transport service, reduced working hours and even interruptions of the metro are often the cause of conflicts between the local authorities.[96] ANM is currently involved in a delicate restructuring phase and an industrial plan for its renaissance is under an arrangement

93 Naples' Urban plan for Sustainability Mobility – PUMS; Summary, p.II.
94 Following Hirschman (2014), latitude is the characteristic of a project that permits the project planner and operator to mould it, or to let it 'slip', in one direction or another enabling adjustments for unforeseen circumstances. The several ex-post amendments of the project reveal a highly disciplined project, that is with a latitude very restricted.
95 Among others, Duomo, Municipio, Università stations. Resolution of the City Council n. 4464/2005. See also Municipality of Naples, DG- Infrastructures, Public Works, and Mobility. Chronology of Metro Line 1 Development (March, 2017).
96 Press article, Corriere del Mezzogiorno, 17.12.17 Available at http://corrieredelmezzogiorno.corriere.it/napoli/cronaca/17_dicembre_07/metro-nuovi-blocchi-polemiche-sindaco-mette-l-anm-mirino-14a55e52-db%E2%80%A6

scheme to be approved by the court of Naples. Future scenarios range from bankruptcy to the launch of a significant improvement in the transport service in the near future with new financial assets and a new strategy aimed at financial recovery (e.g. rationalising costs, fighting ticket evasion, attracting new customers).[97] Anecdotal evidence about the causes of ANM's insolvency emerged during the interviews. The recent merger process in which the company was involved, personnel redundancy (and related inefficiencies), the reduction in funds for public transport at local and national level, along with the increased maintenance costs of both the rolling stock and infrastructures are the main determinants of the financial difficulties of ANM (see Box 4 for details).

**Box 4. The main determinants of the financial insolvency of ANM S.p.A.**

This box provides a snapshot of the main causes underlying the financial problems of ANM. Although investigating the issue goes beyond the scope of this report, it helps to understand the project performance and its future scenarios.

Many interviewees indicated the merger process, through which ANM was established, as the main cause of its current insolvency. As mentioned in Section 2.1., ANM S.p.A. was established in 2013 when the Municipality of Naples merged three previous separate companies Metronapoli S.p.A. (the service provider of the metro lines and funiculars), Napolipark (the parking operator) and the ANM S.p.A. itself, which, before 2013, was only in charge of the bus network (Figure A). The result of this process was a large company whose mission was to provide the city with an integrated and efficient transport service. Today, the company comprises three business units: urban railway, buses and parking. Figure B shows that while the railway business unit yields a positive EBIT,[98] the parking and buses business units produce a negative EBIT. Specifically, the bus network yields an average annual loss of EUR 25 million, which is financially unsustainable for the company and negatively influences the quality of the transport service.


Figure A. The ANM merger process


Figure B. EBIT dynamics in the ANM business units

The second issue, closely linked to the merger process, is personnel redundancy, which, according to some people, is the legacy of cronyism and opportunistic behaviour from the past.[99] Between 2011 and 2016 ANM decreased personnel costs by about EUR 25 million. Although cuts at company level were carried out, the analysis at business unit level reveals something slightly different. Costs were reduced in the buses business unit, where the number of employees was cut by 35% (882 people) through early retirement policies and reallocation of employees on the other business units. 87 people were reallocated to the railway business unit and 63 to the parking unit, resulting in cost increases for those units. For instance, the personnel and administrative costs increased by EUR 3.5 million in the railway business unit, to

97 Press article, Corriere del Mezzogiorno, 17.01.18. Available at http://corrieredelmezzogiorno.corriere.it/napoli/cronaca/18_gennaio_17/anm-perde-25-milioni-ogni-anno-pensiamo-aumentare-costo-biglietti-f1eb7158-fb5f-11e7-b1f6-dbd2d5a7f7a1.shtml

98 Earnings Before Interest & Taxes (EBIT) is an indicator of a company's profitability, calculated as revenue minus operating expenses, excluding tax and interest.

99http://www.occhiodinapoli.it/anm-responsabilita-lavoratori-marco-sansone-non-ci-sta/. http://www.lettera43.it/it/articoli/politica/2017/11/12/napoli-le-stazioni-della-metro-sono-opere-darte-senza-treni/214676/. Interviewed people talked about this issue as well.

some extent penalising its performance in terms of EBIT. According to ANM, personnel costs are still the main cost component on the company balance sheet. Further cuts and the hiring of highly-skilled labour (especially train drivers) are necessary to solve this problem.[100]

The reduction in public funding for public transport is the third main determinant of ANM's financial insolvency. Partly due to the crisis and partly for the reasons already discussed in Section 4.5, the compensation payments made to ANM decreased by 20% (EUR 32 million) between 2011 and 2016 (Figure 18a, Section 4.5.), despite the extension of the metro service. ANM claims that if it had received the same amount of compensation payments as in 2011 (EUR 150 million), the company would have recovered its structural deficit (Figure B) achieving break-even point in 2016 (Figure C). On top of that, ANM also reports a lack of funds for the ordinary and extraordinary maintenance of the rolling stock and infrastructures (i.e. Art Stations) owned by the Municipality of Naples.

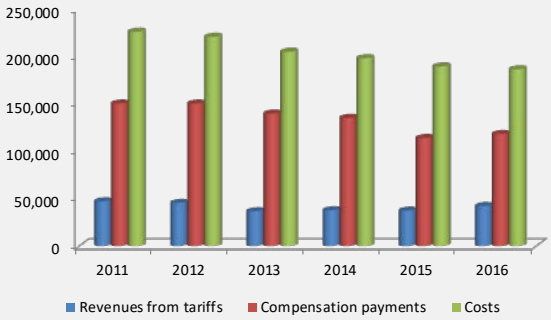



Figure C. Relationship between revenues from tickets, compensation payments and operating costs as in ANM balance sheet. Data are in Million EUR.

*Source: Authors on data and documents provided by ANM. Financial analysis of ANM 2011 – 2016; General considerations.*

### *4.7 PROJECT'S BEHAVIOURAL PATTERN*

This section takes a step forward in understanding the role played by the identified determinants on the observed performance of the project. They have not operated separately from each other, rather, they have acted simultaneously contributing, either positively or negatively to the generation of the project's long-term effects and shaping its actual performance. Moreover, they acted in different phases of the project's life cycle, reinforcing the results already achieved or diluting them.

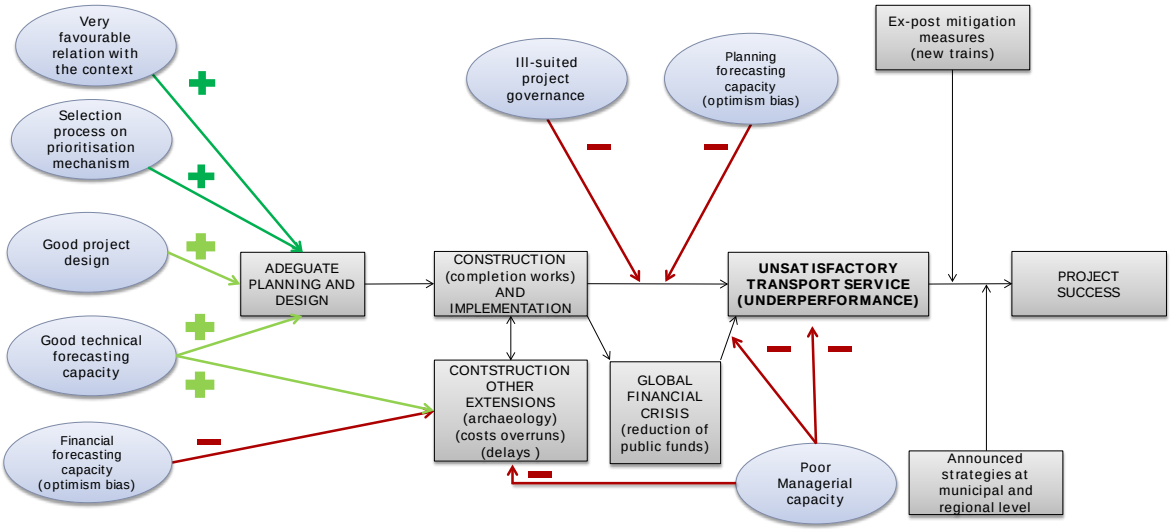
**The project's behavioural pattern** (illustrated in Figure 20) **shows how causes and effects have interacted with each other in a dynamic perspective, i.e. from the project's planning and design to the operating phase.** Circles in light blue indicate the projects' determinants, while the rectangular boxes in light grey denote the observed events. The '+' signs next to the green arrows indicate that the factor has positively influenced the project performance; in contrast, the sign '-' next to red arrows highlights the negative role played by the identified determinant. Arrows in dark green indicate factors with a strong influence on the project, while arrows in light grey indicate factors with a positive, but less strong influence.

**The behavioural pattern of the Vanvitelli-Dante section of metro Line 1 is unique** and shows a project that lies midway between an underperforming project (near to failure) because of its poor managerial capacity and governance structure and a project with large scope for further improvement (a successful project) should ex

100 Press article, Corriere del Mezzogiorno, 17.01.18. Available at http://corrieredelmezzogiorno.corriere.it/napoli/cronaca/18_gennaio_17/anm-perde-25-milioni-ogni-anno-pensiamo-aumentare-costo-biglietti-f1eb7158-fb5f-11e7-b1f6-dbd2d5a7f7a1.shtml e Financial analysis of ANM 2011 – 2016; General considerations. Document provided by ANM.

post announced corrective actions materialise in the short to mid-term (3-5 years) (see Section 2.3).

**Figure 20. Behavioural pattern of the Vanvitelli-Dante section of metro Line 1 in Naples: Shooting Supernova.**[101]




*Source: Authors*

The extremely favourable context (mobility, institutional, cultural and socio-economic) and the supply of a basic service that reflected the urgent needs of the people were pre-conditions offered by the context, which are key determinants of the still positive, although unsatisfactory, project performance.

The way the project was selected and the project design fitted well into the context where the project was implemented and proved to be the right choices that led to an adequate planning phase and a construction phase on schedule.[102] Both the design (including engineering and architectural capabilities) and the selection process (based on a double prioritisation mechanism) were discussed and gained wider consensus among the stakeholders of the project, including citizens and local associations.

**A propitious context and good ex ante preconditions prevented the total failure of the project due to the negative effect of a forecasting capacity** affected by optimism bias, **an inadequate governance structure and the low quality of the managerial capacity**. This makes the project a *Shooting Supernova.*[103]

**Despite these factors leading to underperformance, there is scope for the project to turn itself round into a successful project.** Ex post mitigation

[101] See below for an explanation.

[102] As explained several times in this report, the construction phase here is understood as the one related to the completion work of the Vanvitelli–Dante section, which started with the Naples Urban Plan in 1997.

[103] As stated in the First intermediate Report, *the Supernova status* identifies a project 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. In addition *A Shooting Star* is a project 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 (promptly) implemented, thus leading to project failure. The situation is exacerbated if unexpected negative events materialise during project implementation.

measures and corrective actions (e.g. the purchase of new rolling stock) have already been implemented, in part. The progressive introduction of new ones (as was announced) may improve the current state-of-play.

# 5 FINAL ASSESSMENT

The final assessment of project is based on five evaluation criteria that will be discussed below. It is based on the insights from the ex post CBA, the qualitative scoring system in Section 3 and the behavioural pattern of the project.

## *5.1 PROJECT RELEVANCE AND COHERENCE*

At the time of design and implementation, the Vanvitelli-Dante section of Line 1 pursued a set of objectives that mirrored the real needs of citizens and local institutions. Congestion and air pollution from circulating cars, traffic noise, limited accessibility to downtown Naples, the need for a more effective land-use programme, and the demand for a more efficient transport service were all problems that made **the project highly relevant for Naples**. The project was one of a set of priorities for the city to be completed in five years. Afterwards, the project became part of the a wider transportation programme at regional level that shared the same objectives: increasing the territory served by the public railway network, improving the architectural and urban quality of the station buildings and the areas where the stations were located, offering citizens an attractive public transport service contrasting the massive use of cars. This was also in line with the EU transport strategy adopted in 2001[104] according to which the Commission proposed some 60 measures aimed also at developing a European transport system capable of shifting the balance between modes of transport and revitalising the railways. **Therefore, the project's objectives were in compliance with existing development needs at local level.**

The project was not only characterized by a high degree of relevance in terms of objectives, but **the transport investment projects implemented under the Naples Transport Plan in 1997 (including the Vanvitelli-Dante section of Line 1)**, the Plan of the 100 Stations and the Regional OP in the 2000-2006 programming period **were all coherent with each other**. In order to improve the interconnectivity and efficiency of the public transport, several interventions at local and regional level were implemented in the railway sector, road and bus networks, parking systems and maritime transport network. These investments also embraced interventions in compliance with transport investment priorities at national level such as the realisation of high-speed railways, which connect the major cities in Italy, including Naples.

## *5.2 PROJECT EFFECTIVENESS*

The judgment about the capacity of the Vanvitelli-Dante section to achieve the stated objectives needs to consider the project as part of the whole of Line 1. Between 2004 and 2017, each year, an average of 13 million passengers used the Vanvitelli-Dante section[105] of metro Line 1 and all of them were diverted from the road network (buses and cars). Thus, appreciable results were achieved in terms of time savings, VOC reduction, accident cost, air pollution, GHG emissions and noise. **Social costs fell compared to the past, when the urban mobility situation was unsustainable**. The project also delivered relevant learning benefits in the planning, design and construction phases, which today are 'exported' all over the world and improved the image of the city conveying infrastructures that fully integrate with the surrounding environment and represent an extra attraction for tourists going to Naples. The

104 Commission White paper – 'European transport policy for 2010: time to decide' [COM(2001)370]. It set the framework for investment in transport over the 2000-2006 programming period.
105 33 million users on the whole of Line 1.

aesthetic quality is not only a unique attribute characterizing the new stations. They are green, smart, safe and eye-friendly; that is, attributes that people judged positively with a feeling of having improved their quality of life. **Accordingly, such an investment positively contributed to the economic growth of the city** removing, to some extent, bottlenecks and probably fostering productivity related economic effects, **to the general well-being in the city and to environmental sustainability** thanks to the progresses made in reducing traffic and the construction of energy-saving infrastructures. **The project also had a positive impact on distributional matters**. Social cohesion increased because of the improved accessibility to the city transport network; while a better territorial cohesion was ensured by removing missing links between different areas of the city.

**The other side of the coin reveals an inadequate service quality.** Metro Line 1 is continuously targeted by the press and public opinion for the insufficient frequency of trains, frequent interruptions of the service, reduced working time and malfunctions of trains. This in turn negatively impacts on journey comfort, its reliability and waiting times. Inconveniences related to the malfunction of displays reporting travelling information is another reason for people's outrage. The unsatisfactory delivery of a service that is unable to meet demand has two side effects: the first is the low attractiveness of the metro to potential new users; the second is linked to the incentive to actual users to return to individual private means of transport at the expense of collective transport modes. In the case of Naples this would mean losing all the advancements that have been made compared to the past.

**The balance of the positive and negative aspects suggests that in the end the project yields net positive benefits.** It has generated positive effects towards the stated objectives, although more could have been achieved had certain conditions occurred (see below). In this sense the effects have not stabilised yet and it is reasonable to consider that there is still large scope for further improvement. **This will depend on the successful implementation of ongoing investments (new trains and new extensions of the line), and on the commitment of local institutions to implementing the announced strategies.** In an otherwise scenario, the risk analysis suggests a positive probability that the project's ENPV will fall under its baseline value and the ERR will turn out to be lower than the reference SDR with the consequent worsening of the project performance. On top of that, there is the uncertainly related to the current financial situation of ANM, which paves the way for additional scenarios ranging from the broad failure of the public transport in the city to a new course and a better performance of the transport system.

As far as mechanisms are concerned, **a favourable** institutional, cultural and social **context, positively contributed to the planning and construction phase of the project and, most of all, to its operating performance.** Before the project, the mobility situation was so problematic that the investment yields a positive result despite the many circumstances that have negatively influenced it, causing the project itself to underperform.

**An appropriate selection process was essential in the planning and construction phase in order for the project to be delivered in time.** The prioritisation mechanism, along with the involvement of the major stakeholders, was a well-chosen strategy for the definition of the project and to avoid delays in the completion work of this segment of metro Line 1. Similarly, **the project design well mirrored the needs of the city at the time of planning.** The high quality and

aesthetic standards of the stations greatly impacted on the city's image, its urban quality and on the real estate market in Naples. Moreover, the design has undoubtedly influenced the well-being, the behaviour and the quality of life of the people who judge the new stations in a positive way. Having been designed during a favourable economic cycle and because of the subsequent crisis and lack of funds, today, these infrastructures are criticised for their high maintenance costs.

Experts from the Commission pointed to an overestimation of benefits in the ex ante CBA stemming from two problems. The first is related to the correct identification of the project. It is likely that the estimated benefits were computed by looking at the entire RMS, while costs only referred to the segment of the metro under assessment. The second is that the analysis relied too much on the future availability of rolling stock. This supports the idea that **the forecasting capacity was probably affected by an optimism bias.**

**The main causes of the project's underperformance (both the Vanvitelli-Dante segment and the whole of Line 1) are without a doubt an ill-suited project governance and poor managerial capacity.** The analysis, in fact, shows that a key determinant of the past, present and even future performance of the project is the governance structure, which has always been characterised by fragmented actions and lack of strategic coordination. In addition, the weakness of the managerial capacity came to light on at least three occasions, related to the inaccuracy of the programming phase, to the chronic problem of lack of funds and changed circumstances due to unpredictable events (e.g. the crisis and archaeology) causing delays in the completion of work related to the further extensions of the metro. These, in turn, are also the main causes of traffic bottlenecks in proximity of the construction sites and a source of annoyance for Neapolitans.

### *5.3 PROJECT EFFICIENCY*

**The project delivers value for money from the socio-economic perspective, in the sense of appreciable benefits compared to costs.** In the face of an investment cost of EUR 753 million, the Vanvitelli-Dante section yields to society an amount of monetised discounted benefits equal to EUR 1,173 million. The ex post CBA suggests a baseline economic net present value of EUR 389 million and an economic rate of return for society of 3.24%. The cost benefit ratio is 1.35 indicating that cost savings and positive externalities slightly outweigh investment and operating costs, although estimations were carried out under conservative hypotheses. This result mainly comes from two factors. First, the time savings by the metro users in this section of Line 1. As a matter of fact, the metro attracts a sufficient number of passengers that make the metro worthwhile, despite all its problems. Second, the impact on property values in the catchment areas of the stations positively contributes to this results. The urban renewal interventions yielded a return of EUR 118 million, representing the second most important benefit, after time savings.

As far as financial sustainability is concerned, ANM receives compensation payments from the Municipality of Naples and the Region Campania. By drawing from these funds, **ANM allocates the necessary amount of money to guarantee the financial sustainability of the project.** Although the financial sustainability of the project is somewhat ensured and the annual financial needs of this segment are by now stabilised, and the project is efficiently implemented in the operating phase, there is a serious and wider threat to the financial sustainability of the whole urban

transport system in Naples. The reduction in funds allocated to ANM, its internal managerial inefficiency, and probably external interventions (e.g. the merger between the public transport service providers in the city) are the main drivers of the current state of play.

### *5.4 EU ADDED VALUE*

The EU added value for the whole metro Line 1 perspective is that **through the action of the European Commission, the EU has supported Naples in achieving the objective of sustainable mobility since the seventies, and EU support** remains crucial for future developments.

From the outset, the European Commission has been involved several times as co-financer of metro Line 1 in Naples. In 1978 the European Commission co-funded 33% of costs planned at that time. In addition to this initial grant, in different programming periods the ERDF also co-financed:

- the purchase of rolling stock;
- excavation and construction work on the new segments of Line 1;
- completion work (i.e. catenary systems, the necessary technological equipment for the train rides, etc.) on the new segments;
- metro Line 6, which connects to Line 1 at Municipio station.

**DG-REGIO also exerted pressure to stimulate and accelerate some of the interventions deemed necessary to complete the metro network in the city**. For instance, in June 2017 the Commission threatened the suspension of EU funds if the construction work at Duomo station in the city centre of Naples was not completed by the end of March 2018 at the latest.[106] According to the Municipality of Naples, the 2005 original schedule foresaw the completion work by the end of 2010.[107] While the EU services have a key responsibility during the programming phase and until the co-financing decision was taken, it has more limited capacity to influence the downstream phase, which is more in the hands of national and regional actors according to the shared management system. A possible tool to influence the process is by introducing conditions for the use of funds in terms of timing, providing disincentives to delaying the process and deviating from the planned objectives. Although this has recently been done, it is likely to have limited scope in substantially influencing the project performance for two reasons: the first is that EU intervention only focussed on a single station in a segment already operating; in contrast, project performance is strongly linked to the opening of new routes; secondly the metro service is today jeopardised by the financial problems of ANM (and the Municipality of Naples).

From the local institutions' viewpoint, **the EU added value has materialised, over the years, as a more efficient and effective way of using public resources.** According to interviewees, the regulatory framework underlying the European Structural Funds, which makes them *results-oriented,* has helped them improve the management of public funds. However, the more strategic aspect of EU added value is less documented than the role of fund provider.

***We have capitalised on previous experience of EU projects regarding how to allocate public money more efficiently than***

106 http://www.lavocedellevoci.it/2017/06/25/metronapoli-ultimatum-ue-persi-i-fondi-se-lavori-non-finiti-per-marzo-2018/

107 Municipality of Naples, DG- Infrastructures, Public Works, and Mobility. Chronology of Metro Line 1 Development (March, 2017).

***we did in the past*** *(Source: interviewee from the Municipality of Naples)**.***

### *5.5 FINAL ASSESSMENT*

**The Vanvitelli-Dante section of metro Line 1 in Naples was a vital project for the city, but it is currently underperforming**. The actual number of users and the strong need for a metro service in a city where traffic-related problems still represent a major concern, make the project valuable from the socio-economic viewpoint, and to some extent, efficient as regards the balance between costs and generated benefits. This supports the fact that the project was highly relevant for the context in which it was implemented and coherent with other (complementary) transport investments in the region.

Although moderately positive effects were generated, all the interviewed stakeholders agree that both this segment and the whole of Line 1 failed to meet initial expectations. Local authorities were not able to guarantee a satisfactory and comfortable transport service to the citizens, who complain about low frequency, frequent delays of trains, and even recurring interruptions to the service. **Therefore, while some results materialised, the performance of the project needs to be improved.**

Several reasons ranging from a weak forecasting capacity to an inappropriate project governance, and to poor managerial capacity underlie the unsatisfactory project performance.

**Table 18. Evaluation matrix**

| CRITERION | EQ | ASSESSMENT | SCORE (*) |
|---|---|---|---|
| **Relevance** | To what extent did the original objectives of the examined major project match:<br>• the existing development needs,<br>• the priorities established at the programme, national, and/or EU level. | The project was and over the years remained fully in line with the development needs and the priorities established at various levels | 5 |
| **Coherence** | • Are the project components in line with the stated project objectives?<br>• To what extent was the examined the project consistent with other national and/or EU interventions carried out in the same field and in the same area? | Fully consistent | 5 |
| **Effectiveness** | • Has the examined major project achieved the objectives stated in the application for Cohesion policy support?<br>• Was the actual implementation in line with the foreseen time schedule?<br>• Which factors, including the availability and the form of finance, influenced the implementation time and the achievement observed, and to what extent?<br>• What has changed in the long-run as a result of the project (e.g. is there evidence showing the contribution of the project to private sector investments)?<br>• 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)?<br>• How have these changes matched the objectives set and addressed the existing development needs and the priorities established at the programme, national and/or EU level?<br>• Did the selected project turn out to be the best option among all feasible alternatives? | Given existing physical constraints, the project was the best option among all feasible alternatives.<br>The project has achieved some of expected objectives, particularly those related to urban renewal. In contrast, the project underperforms from the transport service viewpoint. This is due to both exogenous and endogenous factors. | 3 |
| **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?<br>• To what extent have the interventions been cost effective? | It was not possible to compare costs and benefits between the original cost-benefit analysis (CBA) and the ex post CBA for project identification related reasons.<br>That said, the ex ante CBA slightly overestimated the benefit cost-ratio compared to the ex post CBA (1.9 vs. 1.6).<br>The ex post CBA returned a positive ENPV, but it was characterised by high uncertainty. The probability that the ENPV will fall under the baseline value is 80% and there is a good probability that it | 3 |

| CRITERION | EQ | ASSESSMENT | SCORE (*) |
|---|---|---|---|
| | | turns out to be negative. | |
| **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 their risk profile, complexity or scope, have not been carried out without EU support)?<br>• Did the examined major projects achieve EU-wide effects (e.g. for preserving the environment, building trans-European transport networks, broadband coverage etc.)?<br>• 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 hard to implement without EU support, however, its effects are still uncertain. | 3 |

*Note: scores range from 1 to 5. Source: Authors*

# 6 CONCLUSIONS AND LESSONS LEARNT

The Vanvitelli-Dante section of metro Line 1 in Naples was conceived to give a clear sign of a change in perspective compared to previous urban transport policies and interventions, which were judged inadequate to meet the needs of sustainable mobility in the city. The project was planned from the outset as an integrated transport and land-use programme at city level and was meant to represent the basis for the mobility plan at regional level. The project design was based on two levels of integration. The first one was from the transport perspective, i.e. an efficient interaction between infrastructures, service and pricing. The second level of integration was related to land-use interactions, i.e. the contribution of the stations to the urban quality and land values of the surrounding areas. Although giant steps have been taken compared to the past, the project has not yet been able to reconcile these two levels of integration. The ambitious plan of changing the image of the city by endowing it with aesthetic infrastructures of high architectural standards was not followed hand-in-hand by an accurate programming phase for the local transport service.

> ***The arrival of the metro to downtown Naples has been a godsend, but the transport service that the metro delivers is, to date, inadequate for the mobility needs of our city. No city ever screamed more loudly for an improved subway system.***
> *(Source: interviewee from the Region of Campania)*

The misalignment of the results achieved regarding these two faces of the project offers interesting insights from the policy perspective.

**The project (including Line 1) is recognised as a best practice for having improved the quality of the urban environment** by designing eye-friendly transport infrastructures, which have strongly and positively impacted on the behaviour of people and their every-day life. Today, the Art Stations represent a case study for architects and designers from all over the world, a valuable asset for the city, and an-extra attraction for tourists. However, **developing such goal-oriented and costly infrastructures also requires ensuring an optimum use of them**, and specifically, guaranteeing that the primary goal for which they were built (i.e. the metro transport service) is fully achieved. Clearly, **this has proved to be too ambitious a goal for the weak governance structure underlying the project that lacks the basic mechanisms to move in this direction**. The current governance configuration is not an effective deterrent for avoiding poor strategic direction, the absence of coordination and overlapping of responsibilities among the actors involved. Moreover, there is no effective risk transfer mechanism that links the remuneration for the project developer to charges paid by the users or the quality of the transport service delivered (such as, for example, those of some PPP schemes).

**This ex post assessment also suggests that in order to ensure the success of a project, good planning and design are not enough. The integration of construction with operation, in a perspective of the quality of the service for end-users, is also needed.** The analysis shows that the major players involved in the project were not able to react promptly to suitably accommodate changes in the context and needs (e.g. the progressive lack of funds) as well as to unpredictable events (e.g. the crisis and, at least in part, archaeological issues) and ensuring the

expected level of service in the operating phase of the project. More accurate and forward-looking planning related to the transport service and more appropriate ex ante mitigation measures would definitely have led to a better public transport service.

**Finally, this case study also proves that the ability to interpret the needs of the context in which the projects are to be implemented is a skill that pays off.** According to the interviewees, great efforts were made in the process of identifying and incorporating stakeholder concerns, needs and values into the project decision-making process. In the same vein, a massive communication campaign to inform citizens about what the project would look like was carried out. This also included the use of documents and posters as a way of presenting information to the general public conveying the main idea of the project progressing over time and the related events, including the opening of new stations. **The effective exploitation of the context prevented delays from happening at least for the completion work of this segment of Line 1**, **and prevented the whole of metro line 1 from turning into a failure.**

# ANNEX I. METHODOLOGY OF EVALUATION

This Annex summarises the methodological approach undertaken 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.[108]

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.

[108] 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 19. 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 | It 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. |

| | | |
|---|---|---|
| **EFFECTS RELATED TO QUALITY OF LIFE AND WELL-BEING** | **DIRECT EFFECT** | **DESCRIPTION** |
| | 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)[109]. 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)[110]. 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.

### 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,

[109] 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

[110] 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.

the third building block of the methodological approach 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.

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 have been 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 determinants 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 20. 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:<br>**1.** 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;<br>**2.** 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:<br>**3.** professional ability to react to changes in the context/needs as well as to unforeseen;<br>**4.** 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 21. Behavioural patterns archetypes**

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

| TYPE | DESCRIPTION |
|---|---|
| **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 Syntesis 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 (i.e. the section Vanvitelli – Dante of the metro line 1 in Naples), 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 CBA Guide[111]. This annex aims to present in more detail the assumptions, results of the CBA and the risk analysis for the project under assessment.

## A II.1 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 ex-post CBA is the section Vanvitelli (excluded) – Dante of the metro Line 1 in Naples. As explained in Section 1 of the main report, the project was co-funded by the ERDF in the programming period 2000 – 2006 and concerned the realisation of completion works related to an existing tunnel connecting five stations. In order to have a self-sufficient unit of analysis, the costs of civil works sustained before the completion works were included in this ex-post assessment. The inclusion of these costs is due to the fact that both excavations and tunnel construction were conceived for the realisation of the metro and could not have been otherwise used. Therefore, even if the costs were split into two different projects, they were two complementary components of an unique plan and only their combination has permitted to have a functioning infrastructure able to produce benefits.[112]

The investment costs, as to be understood in this analysis, also included the costs for the purchase of the new trains (expected in the period 2019-2020). The entry into service of the new trains is expected to increase the quality of the transport service both in terms frequency and reliability and, therefore, the number of passengers. Likewise, the new trains are also likely to increase the operating costs necessary to provide the public transport service (e.g. additional trains means additional train drivers) which were also taken into account (see below for details).

The project was implemented from 1991 to 2003 while the new trains are scheduled to be supplied between 2019 and 2020, as shown in Table 22.

**Table 22. Synthesis of the interventions**

| ACTIVITY | IMPLEMENTATION PERIOD |
|---|---|
| **Civil works** | 1991 – 1998 |
| **Completion works** | 1998 – 2003 |
| **Supply of new rolling stock** | 2019 – 2020 |

*Source: Authors*

- *Time horizon*

The time horizon for the CBA of the project was set at 25 years (excluding 13 years of construction). Accordingly, the timeframe for the project's evaluation runs from 1991, when the first capital expenditure occurred, to 2028 (for a total of 38 years). This approach differs from the one recommended in the First Intermediate Report, which

[111] European Commission (2014).
[112] See Section 1.3 in the main report for details.

suggests a 25 years' time horizon including both the investment and the operation phase. The rationale behind the choice of having a longer operating phase with respect to that suggested by the First Intermediate Report was to capture the full benefits generated by project. Indeed, including 13 years of construction would have meant to reduce the operation phase of the project to only 12 years; i.e. a period of time which is insufficient for the project to fully generate the expected benefits.

- *Constant prices and discount rates*

In line with the guidelines of the First Interim Report, the CBA was performed at 2017 constant prices. Historical data were expressed into EUR 2017 prices by using the yearly average percentage variation of the consumer price index provided by the International Monetary Fund. As for data from 2017 onwards, they were estimated in real terms (no inflation is considered). Over the entire period of analysis, inflows and outflows were considered net of VAT.

Consistent with the choice of using constant prices, the financial and social discount rates were expressed in real terms as well. Specifically, in the financial analysis, both inflows and outflows – for both the backward and forward periods of analysis – were discounted and capitalised by using a real financial discount rate of 4%, as suggested by the EC CBA Guide (2014). With regard to the economic analysis, a real backward social discount rate of 1.37% and a real forward social discount rate of 2.14% were applied.[113]

- *Without the project scenario*

Before the project implementation, buses, funiculars, and private cars were the transport modes connecting the residential hilly part of Naples with its historic centre and the intermediate stations. In that basis, the reference scenario for the CBA (without the project) is a "Business as usual" scenario, meaning that no action would have been implemented to significantly improve nor modernise the quality of the existing buses and funiculars network service.

- *Data sources*

The CBA analysis relied on historical data provided by different institutions that are responsible at different level of the local public transport system in Naples as described in Table 23.

**Table 23. Data Sources**

| DATA | INSTITUTION |
|---|---|
| **Investment costs (civil works, completion works, rolling stocks)** | Region of Campania |
| **Inflows (revenues from tariff, compensation payments, commercial revenues, advertising)** | ANM S.p.A. - the service provider (henceforth ANM) |
| **Operation and maintenance costs** | ANM – the service provider |
| **Passengers** | ANM – the service provider<br>UNICO CAMPANIA – company in charge of the management of the tariff system |

*Source: Authors*

Forecasts were based on experts' opinions, discussions with stakeholders, and evidence collected during the interviews. Additional information and data were gathered from official documents available online and open databases.

[113] They were specifically calculated for Italy (see the First Interim Report for details).

- *Technical features*

The project concerns the section Vanvitelli – Dante of the metro Line 1 connecting the hilly part of Naples with its historic centre. The total length of the section is 5.03 km (over a 18 km line) with 5 stops: Quattro Giornate, Salvator Rosa, Materdei, Museo, and Dante. The average slope of this segment is 5.5%, the average depth is 24 meters (maximum depth of 44 meters at Salvator Rosa station), and 68 escalators and lifts ensure the full accessibility to the trains platforms. All the five stations are Art Stations while three of them are high turnout stations (Quattro Giornate, Museo, and Dante).

### A II.2 Future scenario

#### Demand

For conservative reasons, future developments of the regional metropolitan system were not taken into account in the estimation of the future demand. This also avoids include further uncertainty in the project's performance assessment. Actually, in order to assess the future performance of the project, future costs and benefits were estimated by taking into account only future developments of the entire Line 1 with respect to both the infrastructures and the purchase of new rolling stocks. Infrastructural developments will link the section under assessment directly with important hubs of the city (e.g. the airport and the administrative city centre); while additional trains are expected to increase the frequency and the service reliability. Therefore, such developments are likely to affect the performance of the segment under assessment.

Specifically, in the ex-post assessment the demand analysis is based on the following assumptions:

1. For the with-project scenario:
    - From 2004 to 2016, the number of passengers on the section under assessment corresponds to the observed values provided by ANM and UNICO Campania;
    - From 2017 to 2019, the number of passengers stems from projections provided by ANM;
    - From 2019 onwards, the growth rate of the number of passengers was estimated according to discussions with the stakeholders and experts' opinions. In particular, from 2020 to 2022, the number of passengers is expected to increase because of the entry into service of the new trains. The impact of the additional rolling stock was estimated to be 2% per train. From 2023 to 2024, the completion[114] of the metro line 1 is expected to increase the demand mobility by 16.6% per year.
2. For the without-project scenario, for which no data can be directly observed after 2001 (i.e. the opening of the first stop in the section Vanvitelli-Dante):
    - The number of passengers on the section under assessment equals zero because the project consisted of the realisation of a new infrastructure;
    - The number of buses' users was assumed to equal the observed values plus 68% of the passengers on the section under assessment. Therefore, historical and the future growth rates of the number of buses'

[114] The interviewees have claimed that the construction works on the metro Line 1 will be completed by 2022.

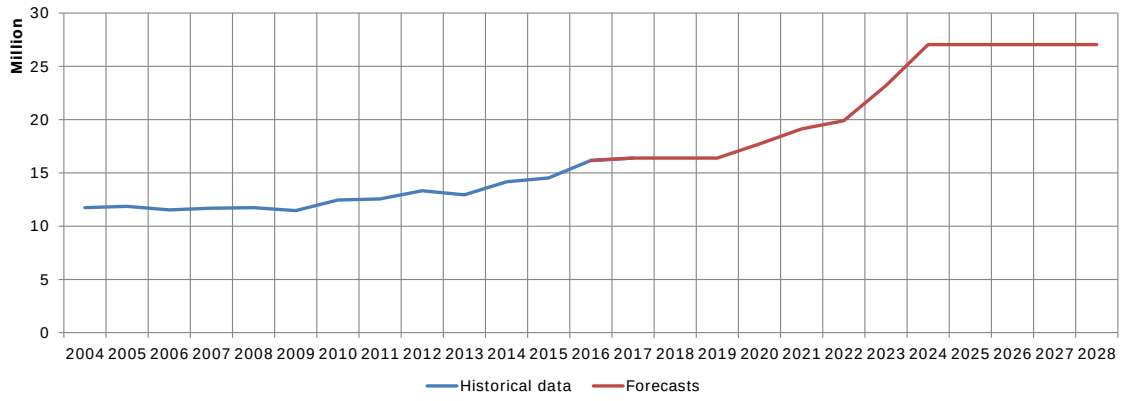
users were assumed to coincide with those, respectively, observed and forecasted for the passengers on the metro section under analysis;

- The number of funiculars' users was assumed to be constant at 2001 levels.

As far as the trip purpose was concerned, the analysis took into account the breakdown between commuting and others trip reasons (e.g. leisure). The split into these two trip purpose categories was built on yearly survey data collected by UnicoCampania.

For both with-project and without-project[115], historical data and future estimation of the number of passengers in the section Vanvitelli (excluded) - Dante resulting from the above assumptions are shown in Figure 21.

**Figure 21. Demand – historical data (2004-2016) and forecasts (2016-2028). Number of passengers on the section Vanvitelli - Dante.**




*Source: Authors*

Moreover, for the sake of prudence, the traffic forecast did not consider any generated demand, but only demand diverted from alternative transport modes (car and buses). Table 24 shows the total number of passengers in the segment Vanvitelli (excluded) – Dante broken down by diverted passengers from buses and cars[116]. Given the flat trend of passengers using the funicular before and after the project realisation, the conclusion is that no passengers have been diverted from this kind of public transport mode.

[115] Notice that only the line showing total number of passengers on the section under assessment in the with-project scenario is displayed because in the without-project scenario it would be a line constant at 0.

[116] Note that, following the assumptions made for the with-project and without-project scenarios, the total number of passengers in the section section Vanvitelli – Dante coincides with the incremental number of passengers.

**Table 24. Total demand in the section Vanvitelli (excluded) – Dante split by previous mode of travel (Million)**

| YEAR | TOTAL NUMBER OF PASSENGER | PASSENGER DIVERTED FROM BUS | PASSENGER DIVERTED FROM CAR |
|---|---|---|---|
| **2004** | 11.7 | 8.0 | 3.8 |
| **2005** | 11.9 | 8.0 | 3.8 |
| **2006** | 11.5 | 7.8 | 3.7 |
| **2007** | 11.7 | 7.9 | 3.8 |
| **2008** | 11.7 | 8.0 | 3.8 |
| **2009** | 11.5 | 7.8 | 3.7 |
| **2010** | 12.5 | 8.5 | 4.0 |
| **2011** | 12.6 | 8.5 | 4.0 |
| **2012** | 13.3 | 9.0 | 4.3 |
| **2013** | 12.9 | 8.8 | 4.2 |
| **2014** | 14.2 | 9.6 | 4.6 |
| **2015** | 14.5 | 9.9 | 4.7 |
| **2016** | 16.2 | 11.0 | 5.2 |
| **2017** | 16.4 | 11.1 | 5.3 |
| **2018** | 16.4 | 11.1 | 5.3 |
| **2019** | 16.4 | 11.1 | 5.3 |
| **2020** | 17.7 | 12.0 | 5.7 |
| **2021** | 19.1 | 13.0 | 6.2 |
| **2022** | 19.9 | 13.5 | 6.4 |
| **2023** | 23.2 | 15.7 | 7.5 |
| **2024** | 27.0 | 18.3 | 8.7 |

*Note: The total number of passengers and the split by previous mode of travel is assumed to be constant at 2024 levels up to 2028.*

*Source: Authors' calculations based on data from ANM, UNICO CAMPANIA, and Piano Urbano Mobilità Sostenibile (2016)*

#### Supply

On the supply side, the information on new trains to be purchased was included in the ex-post analysis and considered as part of the project under assessment. As explained below, due to the fact that the trains will run the entire metro line, only an apportionment of the future related costs was ascribed to the project.

### A II.3 Financial Analysis

#### Investment costs

Table 25 reports the investment costs of the project broken down by the main items (the following analysis focuses on investment costs expressed in present value).[117] Civil works cover the largest share (85%) of the total investment costs. They include excavation works, the construction of tunnels and stations. The completion works represent 20% of total investment costs. The supply of rolling stock accounts for 5% of the total investment costs. The share of the rolling stock' investment was

[117] The discrepancy between nominal and present values of the investment costs stems from the fact of having expressed all the financial values in 2017 constant prices. Specifically, it was done in two steps. Firstly, the nominal value of the investment costs sustained from 1991 to 2003 was transformed in present value (EUR 2017) by adjusting it for the inflation index. Secondly, the resulting value was discounted at a financial discount rate of 4%. Likewise, future investment costs related to the supply of rolling stocks were first adjusted by applying the inflation rate and then capitalized at the same rate of 4%.

apportioned to the project by equalling it to the ratio between the length of the section and the total length of metro Line 1 (about 20%).

**Table 25. Investment costs broken down by project component (EUR, VAT excluded)**

| PROJECT ITEM | NOMINAL VALUE | PRESENT VALUE (€ 2017) |
|---|---|---|
| **Civil works** | 375,335,446 | 1,443,726,781 |
| **Completion works** | 98,526,387 | 249,786,315 |
| **Supply of rolling stocks** | 17,745,840 | 15,839,091 |
| **Total** | **491,607,673** | **1,709,352,187** |

*Source: Authors*

### Residual value

The residual value calculations were based on the following assumptions:

- Civil works (mainly tunnels) were assumed to have a lifetime of 100 years, which is a common assumption used in this kind of studies[118]. Therefore, their residual value equals 75% of their total investment costs (EUR 404 million);
- Technologies made available through completion works will be obsolete by the end of the project horizon (as hypothesised also in the ex-ante CBA). Therefore, their residual value equals zero;
- The rolling stock was assumed to have, on average, a 15-years lifetime as explained by experts during the interviews. Therefore, their residual value equals 40% of their total investment costs (EUR 7 million).

Accordingly, the residual value of the project as a whole amounts to EUR 411 million (expressed in EUR 2107 not discounted).

### Operating & Maintenance costs

The O&M costs data were provided by the local public transport operator ANM and they were assumed to be constant to the 2016 level up to 2028, with the exception of the operating railway costs[119]. In 2021, the operating railway costs were assumed to increase by 33%[120] due to the entry into service of new 10 trains. From 2021 onwards, they were assumed to remain constant until the end of the time horizon. The remaining operating and maintenance cost items (i.e. station management and maintenance, administrative personnel) were assumed to be stable because the extent to which they are influenced by the incremental generated demand is negligible.

In the counterfactual scenario, the incremental operating and maintenance costs were assumed to equal to zero for two main reasons. Firstly, in the without-project scenario, it was supposed that no actions would had been taken. Secondly, ANM claimed that only negligible changes in the buses supply network were carried out after the opening of the route Vanvitelli – Dante[121]. Therefore, the incremental O&M costs coincided with the total O&M costs sustained for the section Vanvitelli – Dante.

[118] Mackie, P., Nellthorp, J., & Laird, J. (2003); Davidson, G., Howard, A., Jacobs, L., Pintabona, R., & Viggiani (2013); Zernich, B. (2014).

[119] The operating railway costs include all the costs related to trains that ANM sustains to provide the service. This includes, for example, the costs for train drivers, train cleaning, train maintenance, and so on so forth.

[120] This percentage was estimated looking at the average railway operating costs of a single train on the section Vanvitelli – Dante, and multiplying the resulting unitary cost for the 10 new trains. This calculation enabled to detect the percentage increase in railway operating costs due to the additional rolling stock.

[121] Moreover, such buses did not run only in the areas affected by the project implementation, but also in other parts of the city.

**Operating revenues**

Operating revenues generated by the segment Vancitelli (excluded) – Dante included:

- The revenues from tickets by passengers on this section of metro Line 1;
- The revenues from commercial property rental and advertising in this section.

Historical data and projections up to 2019 were provided by ANM. From 2020 to 2028 revenues from commercial property rental and advertising were assumed to be constant while the estimation of revenues from tickets was based on passengers forecasts and the average ticket price.

**Project's Financial Performance**

From the financial viewpoint, the profitability of the project is negative. The Financial Net Present Value of the investment (FNPV/C) is equal to EUR -1,389 million (real discount rate of 4%), with an internal rate of return (FRR/C) of -2.6%. 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 Financial Net Present Value on the national capital (FNPV/K) is negative as well (EUR -1,055 million) with an internal rate of return for capital (FRR/K) of -1.8%. These negative values reveal that the project does not provide an adequate financial return on national capital employed, based on the benchmark applied (4% in real terms). The results of the project financial performance are presented in Tables overleaf.

**Table 26. Financial performance indicators of the project**

| INDICATOR | EUR |
|---|---|
| **FNPV/C** | -1,608,333,970 |
| **FRR/C** | -2.6% |
| **FNPV/K** | -1,181,022,218 |
| **FRR/K** | -1.8% |

*Source: Authors*

**Table 27. Financial return on investment (EUR)**

| It. | *Project financial effectiveness* | Present value | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | **Operational income** | **206,733,338** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **3,629,303** | **5,891,254** | **6,805,187** |
| 1.1 | Revenues from tariff - tickets | **189,827,237** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3,182,706 | 5,361,743 | 6,000,222 |
| 1.2 | Advertising | **6,788,732** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 247,367 | 173,048 | 282,204 |
| 1.3 | Rent of commercial property | **10,117,369** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 199,230 | 356,464 | 522,761 |
| 2 | **CAPEX** | **1,709,352,187** | **21,816,278** | **34,237,725** | **78,257,657** | **118,572,207** | **131,760,206** | **133,533,071** | **60,100,809** | **24,151,959** | **24,862,521** | **31,237,736** | **27,798,646** | **31,055,602** | **17,656,694** | **0** | **0** | **0** |
| 2.1 | Civil works | **1,443,726,781** | 21,816,278 | 34,237,725 | 78,257,657 | 118,572,207 | 131,760,206 | 133,533,071 | 60,100,809 | 24,151,959 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2.2 | Completion works | **249,786,315** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 24,862,521 | 31,237,736 | 27,798,646 | 31,055,602 | 17,656,694 | 0 | 0 | 0 |
| 2.3 | Rolling stock | **15,839,091** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | **OPEX** | **372,938,125** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **13,268,835** | **15,328,828** | **16,577,863** |
| 3.1 | Station management | **44,207,015** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1,581,357 | 1,714,925 | 1,818,815 |
| 3.2 | Labour | **92,133,390** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2,629,163 | 3,630,273 | 5,048,085 |
| 3.3 | Operating railway | **143,539,325** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5,645,692 | 6,282,762 | 5,785,898 |
| 3.4 | Maintenance | **24,787,314** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 889,128 | 964,228 | 1,070,717 |
| 3.5 | Indirect costs | **68,271,081** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2,523,495 | 2,736,640 | 2,854,348 |
| 4 | **Residual value** | **267,223,004** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** |
| 5 | **Total (1-2-3+4)** | **-1,608,333,970** | **-21,816,278** | **-34,237,725** | **-78,257,657** | **-118,572,207** | **-131,760,206** | **-133,533,071** | **-60,100,809** | **-24,151,959** | **-24,862,521** | **-31,237,736** | **-27,798,646** | **-31,055,602** | **-17,656,694** | **-9,639,532** | **-9,437,573** | **-9,772,676** |

| It. | *Project financial effectiveness* | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | **Operational income** | **6,490,750** | **6,361,691** | **6,578,629** | **5,898,247** | **5,707,601** | **5,260,850** | **5,629,815** | **5,478,086** | **6,134,252** | **6,660,889** | **6,938,762** | **7,434,524** | **7,587,119** | **9,346,146** |
| 1.1 | Revenues from tariff - tickets | 5,464,350 | 5,313,790 | 4,925,466 | 4,867,758 | 5,309,552 | 4,930,515 | 5,283,060 | 5,197,369 | 5,741,994 | 6,161,832 | 6,439,206 | 6,934,967 | 7,087,562 | 8,846,589 |
| 1.2 | Advertising | 309,707 | 353,012 | 355,722 | 308,890 | 254,693 | 181,722 | 179,442 | 187,885 | 137,258 | 249,585 | 249,834 | 249,834 | 249,834 | 249,834 |
| 1.3 | Rent of commercial property | 716,693 | 694,888 | 1,297,441 | 721,598 | 143,356 | 148,612 | 167,314 | 92,832 | 255,000 | 249,473 | 249,722 | 249,722 | 249,722 | 249,722 |
| 2 | **CAPEX** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** |
| 2.1 | Civil works | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2.2 | Completion works | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2.3 | Rolling stock | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1,774,584 | 15,971,256 |
| 3 | **OPEX** | **15,354,963** | **15,301,178** | **14,897,082** | **15,356,055** | **12,809,273** | **12,442,473** | **11,726,486** | **11,892,840** | **10,587,799** | **12,656,002** | **12,668,670** | **12,668,670** | **12,668,670** | **12,668,670** |
| 3.1 | Station management | 1,631,677 | 1,669,988 | 1,661,075 | 1,662,235 | 1,520,178 | 1,438,321 | 1,348,004 | 1,437,458 | 1,476,581 | 1,693,855 | 1,695,551 | 1,695,551 | 1,695,551 | 1,695,551 |
| 3.2 | Labour | 4,139,297 | 4,190,109 | 4,100,040 | 4,208,736 | 3,541,326 | 3,278,761 | 3,136,515 | 3,276,819 | 2,674,365 | 2,979,922 | 2,982,905 | 2,982,905 | 2,982,905 | 2,982,905 |
| 3.3 | Operating railway | 6,062,772 | 5,837,190 | 5,551,310 | 5,897,923 | 4,479,333 | 4,635,314 | 4,345,924 | 4,105,769 | 3,238,945 | 4,537,162 | 4,541,704 | 4,541,704 | 4,541,704 | 4,541,704 |
| 3.4 | Maintenance | 1,107,093 | 1,037,870 | 976,603 | 1,015,705 | 884,717 | 870,569 | 768,380 | 800,889 | 813,538 | 875,771 | 876,648 | 876,648 | 876,648 | 876,648 |
| 3.5 | Indirect costs | 2,414,123 | 2,566,021 | 2,608,053 | 2,571,456 | 2,383,719 | 2,219,509 | 2,127,662 | 2,271,904 | 2,384,370 | 2,569,291 | 2,571,863 | 2,571,863 | 2,571,863 | 2,571,863 |
| 4 | **Residual value** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** |
| 5 | **Total (1-2-3+4)** | **-8,864,213** | **-8,939,488** | **-8,318,453** | **-9,457,809** | **-7,101,671** | **-7,181,623** | **-6,096,671** | **-6,414,755** | **-4,453,547** | **-5,995,113** | **-5,729,908** | **-5,234,147** | **-6,856,135** | **-19,293,781** |

| It. | *Project financial effectiveness* | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 |
|---|---|---|---|---|---|---|---|---|---|
| 1 | **Operational income** | **10,053,873** | **10,436,046** | **12,085,503** | **14,008,770** | **14,008,770** | **14,008,770** | **14,008,770** | **14,008,770** |
| 1.1 | Revenues from tariff - tickets | 9,554,316 | 9,936,489 | 11,585,946 | 13,509,213 | 13,509,213 | 13,509,213 | 13,509,213 | 13,509,213 |
| 1.2 | Advertising | 249,834 | 249,834 | 249,834 | 249,834 | 249,834 | 249,834 | 249,834 | 249,834 |
| 1.3 | Rent of commercial property | 249,722 | 249,722 | 249,722 | 249,722 | 249,722 | 249,722 | 249,722 | 249,722 |
| 2 | **CAPEX** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** |
| 2.1 | Civil works | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2.2 | Completion works | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2.3 | Rolling stock | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | **OPEX** | **14,167,433** | **14,167,433** | **14,167,433** | **14,167,433** | **14,167,433** | **14,167,433** | **14,167,433** | **14,167,433** |
| 3.1 | Station management | 1,695,551 | 1,695,551 | 1,695,551 | 1,695,551 | 1,695,551 | 1,695,551 | 1,695,551 | 1,695,551 |
| 3.2 | Labour | 2,982,905 | 2,982,905 | 2,982,905 | 2,982,905 | 2,982,905 | 2,982,905 | 2,982,905 | 2,982,905 |
| 3.3 | Operating railway | 6,040,466 | 6,040,466 | 6,040,466 | 6,040,466 | 6,040,466 | 6,040,466 | 6,040,466 | 6,040,466 |
| 3.4 | Maintenance | 876,648 | 876,648 | 876,648 | 876,648 | 876,648 | 876,648 | 876,648 | 876,648 |
| 3.5 | Indirect costs | 2,571,863 | 2,571,863 | 2,571,863 | 2,571,863 | 2,571,863 | 2,571,863 | 2,571,863 | 2,571,863 |
| 4 | **Residual value** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **411,377,537** |
| 5 | **Total (1-2-3+4)** | **-4,113,560** | **-3,731,387** | **-2,081,930** | **-158,663** | **-158,663** | **-158,663** | **-158,663** | **411,218,874** |

*Source: Authors*

**Table 28. Financial return on national capital (EUR)**

| lt. | *Project financial effectiveness* | Present value | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | **Inflow** | **473,956,342** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **3,629,303** | **5,891,254** | **6,805,187** |
| **1.1** | Revenues from tariff - tickets | **189,827,237** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3,182,706 | 5,361,743 | 6,000,222 |
| **1.2** | Advertising | **6,788,732** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 247,367 | 173,048 | 282,204 |
| **1.3** | Rent of commercial property | **10,117,369** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 199,230 | 356,464 | 522,761 |
| **1.4** | Residual value | **267,223,004** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **2** | **Outflow** | **1,654,978,560** | **3,754,372** | **17,230,280** | **62,060,090** | **103,072,144** | **116,884,905** | **119,419,882** | **46,530,435** | **10,821,533** | **24,862,521** | **19,037,251** | **11,057,577** | **10,136,767** | **4,798,306** | **13,268,835** | **15,328,828** | **16,577,863** |
| **2.1** | National contribution | **1,282,040,435** | **3,754,372** | **17,230,280** | **62,060,090** | **103,072,144** | **116,884,905** | **119,419,882** | **46,530,435** | **10,821,533** | **24,862,521** | **19,037,251** | **11,057,577** | **10,136,767** | **4,798,306** | **0** | **0** | **0** |
| **2.2** | Station management | **44,207,015** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1,581,357 | 1,714,925 | 1,818,815 |
| **2.3** | Labour | **92,133,390** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2,629,163 | 3,630,273 | 5,048,085 |
| **2.4** | Operating railway | **143,539,325** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5,645,692 | 6,282,762 | 5,785,898 |
| **2.5** | Maintenance | **24,787,314** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 889,128 | 964,228 | 1,070,717 |
| **2.6** | Indirect costs | **68,271,081** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2,523,495 | 2,736,640 | 2,854,348 |
| **3** | **Total (1-2)** | **-1,181,022,218** | **-3,754,372** | **-17,230,280** | **-62,060,090** | **-103,072,144** | **-116,884,905** | **-119,419,882** | **-46,530,435** | **-10,821,533** | **-24,862,521** | **-19,037,251** | **-11,057,577** | **-10,136,767** | **-4,798,306** | **-9,639,532** | **-9,437,573** | **-9,772,676** |

| lt. | *Project financial effectiveness* | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | **Inflow** | **6,490,750** | **6,361,691** | **6,578,629** | **5,898,247** | **5,707,601** | **5,260,850** | **5,629,815** | **5,478,086** | **6,134,252** | **6,660,889** | **6,938,762** | **7,434,524** | **7,587,119** | **9,346,146** |
| **1.1** | Revenues from tariff - tickets | 5,464,350 | 5,313,790 | 4,925,466 | 4,867,758 | 5,309,552 | 4,930,515 | 5,283,060 | 5,197,369 | 5,741,994 | 6,161,832 | 6,439,206 | 6,934,967 | 7,087,562 | 8,846,589 |
| **1.2** | Advertising | 309,707 | 353,012 | 355,722 | 308,890 | 254,693 | 181,722 | 179,442 | 187,885 | 137,258 | 249,585 | 249,834 | 249,834 | 249,834 | 249,834 |
| **1.3** | Rent of commercial property | 716,693 | 694,888 | 1,297,441 | 721,598 | 143,356 | 148,612 | 167,314 | 92,832 | 255,000 | 249,473 | 249,722 | 249,722 | 249,722 | 249,722 |
| **1.4** | Residual value | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **2** | **Outflow** | **15,354,963** | **15,301,178** | **14,897,082** | **15,356,055** | **12,809,273** | **12,442,473** | **11,726,486** | **11,892,840** | **10,587,799** | **12,656,002** | **12,668,670** | **12,668,670** | **13,112,316** | **16,661,484** |
| **2.1** | National contribution | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 443,646 | 3,992,814 |
| **2.2** | Station management | 1,631,677 | 1,669,988 | 1,661,075 | 1,662,235 | 1,520,178 | 1,438,321 | 1,348,004 | 1,437,458 | 1,476,581 | 1,693,855 | 1,695,551 | 1,695,551 | 1,695,551 | 1,695,551 |
| **2.3** | Labour | 4,139,297 | 4,190,109 | 4,100,040 | 4,208,736 | 3,541,326 | 3,278,761 | 3,136,515 | 3,276,819 | 2,674,365 | 2,979,922 | 2,982,905 | 2,982,905 | 2,982,905 | 2,982,905 |
| **2.4** | Operating railway | 6,062,772 | 5,837,190 | 5,551,310 | 5,897,923 | 4,479,333 | 4,635,314 | 4,345,924 | 4,105,769 | 3,238,945 | 4,537,162 | 4,541,704 | 4,541,704 | 4,541,704 | 4,541,704 |
| **2.5** | Maintenance | 1,107,093 | 1,037,870 | 976,603 | 1,015,705 | 884,717 | 870,569 | 768,380 | 800,889 | 813,538 | 875,771 | 876,648 | 876,648 | 876,648 | 876,648 |
| **2.6** | Indirect costs | 2,414,123 | 2,566,021 | 2,608,053 | 2,571,456 | 2,383,719 | 2,219,509 | 2,127,662 | 2,271,904 | 2,384,370 | 2,569,291 | 2,571,863 | 2,571,863 | 2,571,863 | 2,571,863 |
| **3** | **Total (1-2)** | **-8,864,213** | **-8,939,488** | **-8,318,453** | **-9,457,809** | **-7,101,671** | **-7,181,623** | **-6,096,671** | **-6,414,755** | **-4,453,547** | **-5,995,113** | **-5,729,908** | **-5,234,147** | **-5,525,197** | **-7,315,339** |

| It. | *Project financial effectiveness* | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 |
|---|---|---|---|---|---|---|---|---|---|
| **1** | **Inflow** | **10,053,873** | **10,436,046** | **12,085,503** | **14,008,770** | **14,008,770** | **14,008,770** | **14,008,770** | **425,386,307** |
| **1.1** | Revenues from tariff - tickets | 9,554,316 | 9,936,489 | 11,585,946 | 13,509,213 | 13,509,213 | 13,509,213 | 13,509,213 | 13,509,213 |
| **1.2** | Advertising | 249,834 | 249,834 | 249,834 | 249,834 | 249,834 | 249,834 | 249,834 | 249,834 |
| **1.3** | Rent of commercial property | 249,722 | 249,722 | 249,722 | 249,722 | 249,722 | 249,722 | 249,722 | 249,722 |
| **1.4** | Residual value | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 411,377,537 |
| **2** | **Outflow** | **14,167,433** | **14,167,433** | **14,167,433** | **14,167,433** | **14,167,433** | **14,167,433** | **14,167,433** | **14,167,433** |
| **2.1** | National contribution | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **2.2** | Station management | 1,695,551 | 1,695,551 | 1,695,551 | 1,695,551 | 1,695,551 | 1,695,551 | 1,695,551 | 1,695,551 |
| **2.3** | Labour | 2,982,905 | 2,982,905 | 2,982,905 | 2,982,905 | 2,982,905 | 2,982,905 | 2,982,905 | 2,982,905 |
| **2.4** | Operating railway | 6,040,466 | 6,040,466 | 6,040,466 | 6,040,466 | 6,040,466 | 6,040,466 | 6,040,466 | 6,040,466 |
| **2.5** | Maintenance | 876,648 | 876,648 | 876,648 | 876,648 | 876,648 | 876,648 | 876,648 | 876,648 |
| **2.6** | Indirect costs | 2,571,863 | 2,571,863 | 2,571,863 | 2,571,863 | 2,571,863 | 2,571,863 | 2,571,863 | 2,571,863 |
| **3** | **Total (1-2)** | **-4,113,560** | **-3,731,387** | **-2,081,930** | **-158,663** | **-158,663** | **-158,663** | **-158,663** | **411,218,874** |

*Source: Authors*

**Financial Sustainability**

The investment costs were co-financed by the ERDF and the national contributions. Specifically, for the completion works the EU assistance was 50% (EUR 44 Million) of the eligible expenditures (EUR 88 million). The EC also granted ERDF assistance (EUR 123 million)[122] for the construction and excavation works carried out between 1991 and 1998. On top of that, the project received additional EUR 13.3 million for the purchase of new rolling stock according to a co-financing rate of 75%.

The project financial sustainability is presented in the table overleaf. Cash inflows include the project revenues (revenues from tariff – tickets; advertising; rent of commercial property) and the compensation payments. The latter include the compensation payments received by ANM to cover both the operating costs (from the Region of Campania and the Municipality of Naples) and the extraordinary maintenance costs received by ANM from the Municipality of Naples. Cash outflows include operating, and ordinary and extraordinary maintenance costs for the section under assessment as well as its investment costs.

The analysis of the financial sustainability suggests that the project would not be financial self-sustainable without the service compensation payments that ANM receives from the Municipality of Naples and from the Region of Campania according to the public service utilisation contract in force.

[122] The civil works were split into three sub-projects and each of them was granted a different co-funding rate. Thus, it is not possible to assess a unique co-funding rate for civil works.

**Table 29. Financial sustainability of the project (EUR)**

| Project sustainability in EURO | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sources of financing | 21,816,278 | 34,237,725 | 78,257,657 | 118,572,207 | 131,760,206 | 133,533,071 | 60,100,809 | 24,151,959 | 24,862,521 | 31,237,736 | 27,798,646 | 31,055,602 |
| Total revenues | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Compensation payments | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Total inflows** | **21,816,278** | **34,237,725** | **78,257,657** | **118,572,207** | **131,760,206** | **133,533,071** | **60,100,809** | **24,151,959** | **24,862,521** | **31,237,736** | **27,798,646** | **31,055,602** |
| CAPEX | 21,816,278 | 34,237,725 | 78,257,657 | 118,572,207 | 131,760,206 | 133,533,071 | 60,100,809 | 24,151,959 | 24,862,521 | 31,237,736 | 27,798,646 | 31,055,602 |
| OPEX | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Total outflows** | **21,816,278** | **34,237,725** | **78,257,657** | **118,572,207** | **131,760,206** | **133,533,071** | **60,100,809** | **24,151,959** | **24,862,521** | **31,237,736** | **27,798,646** | **31,055,602** |
| **Net cash flow** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** |
| **Cumulated net cash flow** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** |

| Project sustainability in EURO | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sources of financing | 17,656,694 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total revenues | 0 | 3,629,303 | 5,891,254 | 6,805,187 | 6,490,750 | 6,361,691 | 6,578,629 | 5,898,247 | 5,707,601 | 5,260,850 | 5,629,815 | 5,478,086 |
| Compensation payments | 0 | 9,639,532 | 9,437,573 | 9,772,676 | 8,864,213 | 8,939,488 | 8,318,453 | 9,457,809 | 7,101,671 | 7,181,623 | 6,096,671 | 6,414,755 |
| **Total inflows** | **17,656,694** | **13,268,835** | **15,328,828** | **16,577,863** | **15,354,963** | **15,301,178** | **14,897,082** | **15,356,055** | **12,809,273** | **12,442,473** | **11,726,486** | **11,892,840** |
| CAPEX | 17,656,694 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| OPEX | 0 | 13,268,835 | 15,328,828 | 16,577,863 | 15,354,963 | 15,301,178 | 14,897,082 | 15,356,055 | 12,809,273 | 12,442,473 | 11,726,486 | 11,892,840 |
| **Total outflows** | **17,656,694** | **13,268,835** | **15,328,828** | **16,577,863** | **15,354,963** | **15,301,178** | **14,897,082** | **15,356,055** | **12,809,273** | **12,442,473** | **11,726,486** | **11,892,840** |
| **Net cash flow** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** |
| **Cumulated net cash flow** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** |

| Project sustainability in EURO | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | … | 2027 | 2028 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sources of financing | 0 | 0 | 0 | 0 | 1,774,584 | 15,971,256 | 0 | 0 | 0 | | 0 | 0 |
| Total revenues | 6,134,252 | 6,660,889 | 6,938,762 | 7,434,524 | 7,587,119 | 9,346,146 | 10,053,873 | 10,436,046 | 12,085,503 | | 14,008,770 | 14,008,770 |
| Compensation payments | 4,453,547 | 5,995,113 | 5,729,908 | 5,234,147 | 5,081,551 | 3,322,525 | 4,113,560 | 3,731,387 | 2,081,930 | | 158,663 | 158,663 |
| **Total inflows** | **10,587,799** | **12,656,002** | **12,668,670** | **12,668,670** | **14,443,254** | **28,639,926** | **14,167,433** | **14,167,433** | **14,167,433** | | **14,167,433** | **14,167,433** |
| CAPEX | 0 | 0 | 0 | 0 | 1,774,584 | 15,971,256 | 0 | 0 | 0 | | 0 | 0 |
| OPEX | 10,587,799 | 12,656,002 | 12,668,670 | 12,668,670 | 12,668,670 | 12,668,670 | 14,167,433 | 14,167,433 | 14,167,433 | | 14,167,433 | 14,167,433 |
| **Total outflows** | **10,587,799** | **12,656,002** | **12,668,670** | **12,668,670** | **14,443,254** | **28,639,926** | **14,167,433** | **14,167,433** | **14,167,433** | | **14,167,433** | **14,167,433** |
| **Net cash flow** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | | **0** | **0** |
| **Cumulated net cash flow** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | | **0** | **0** |

*Source: authors*

### A II.4 Economic Analysis

#### From market to accounting prices

In line with the EU CBA Guide (2014), the social opportunity cost of the project's inputs and outputs were considered in the economic analysis. For this purpose, market prices were converted into accounting prices by using appropriate conversion factors. Some of them were drawn by the ex-ante CBA, other ones (e.g. for labour) were calculated *ex-novo* (Table 30). As for labour, it is worth noting that the shadow wage provided in the First Interim Report for the region of Campania (0.85) was adopted to correct past values, instead 0.63 was used to correct future values. The Table below summarises the applied conversion factors for each cost item.

**Table 30. Conversion factors for input**

| ITEM | CONVERSION FACTOR | SOURCE |
|---|---|---|
| Labour cost under investment costs | 0.85 backwards<br>0.63 forwards | Conversion factors for labour as reported in the First Interim Report, Volume I |
| Material cost under investment costs | 0.95 | Ex-ante CBA |
| Rent costs under investment costs | 0.70 | Ex-ante CBA |
| Station management costs under operating costs | 0.52 | Ex-ante CBA |
| Labour costs under operating costs | 0.85 backwards<br>0.63 forwards | Conversion factors for labour as reported in the First Interim Report, Volume I |
| Operating railway costs under operating costs | 0.75 | Ex-ante CBA |
| Maintenance costs under operating costs | 0.69 | Ex-ante CBA |
| Other costs under operating costs | 1 | Experts' opinion |

*Source: Authors based on cited sources*

#### Project's effects

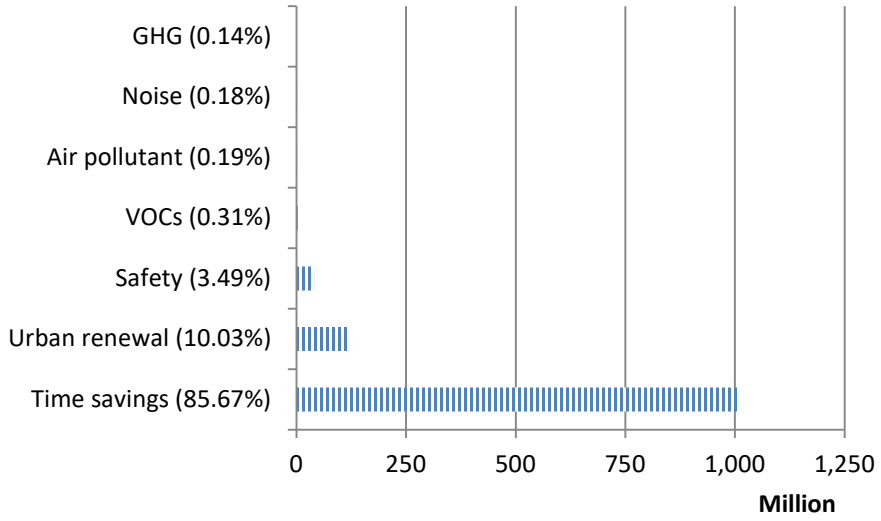
The benefits generated by the implementation of the project can be distinguished into:

- Change in consumer surplus, represented by time savings and vehicle operating costs;
- Reductions in negative externalities as a result of the traffic diverted the road network, including air pollution savings, GHG savings, reduction of collisions and accidents, reduction of traffic noise, and time savings for those who keep moving by car or bus;
- Increases in positive externalities due, among others things, to urban renewal in proximity of the new metro stations proxied by an increase in housing property value;

- Increases of negative externalities as a result of the inconveniences caused by the works during the construction phase, i.e. increased road congestion, air pollution emissions, GHG emissions, and the potential decrease in commercial activities' business.

While a broader range of benefits and negative externalities generated by the project were discussed in the main report, in the ex-post CBA only measurable benefits were quantified. As reported in Figure 22, they are time savings, urban renewal, safety gains, trip cost savings (VOC savings), air pollutant, noise, and GHG reductions[123]. Time savings represents the main benefit among the total monetised benefits (85.7%), followed by the increase in property values (10%) and safety gains (3.5%). The remaining benefits account only for a negligible share. In what follows, the assumptions and the methodology underlying their calculations are discussed in detail.

**Figure 22. Main socioeconomic benefits (Present Value, EUR)**




*Source: Authors*

### Time savings

The realisation of the project has allowed passengers to save time: in a congested city such Naples, the metro is a faster transport mean as compared to cars and buses. The ex-post time savings were calculated in terms of person-hours saved thanks to the project implementation multiplied by the cost of a unit of time in Italy (see the First Interim Report - Volume I). The amount of person-hours saved was computed as the difference between the hours needed for an average travel, either by car or bus, along the section Vanvitelli – Dante before the project implementation, and the respective actual travel time by metro. Based on evidence collected during the interviews, the time savings for people diverted from car and buses were estimated to be, respectively, 20 minutes, and 30 minutes. As shown above, the time savings are the most dominant benefit, covering 86% (about EUR 1,000 million) of the total amount of benefits. 67% of the time savings come from people diverted from buses and the

[123] The project implementation led to benefits in terms of trip cost savings, air pollution reduction, noise reduction, and GHG reduction only through the reduction in the number of circulating cars. These benefits could have been generated also by a reduction in the number of circulating buses. However, this did not occur because only negligible changes in the supply of buses was carried out by ANM as result of the opening of the section Vanvitelli- Dante.

remaining 33% from people diverted from car (54% commuters and 46% for other scopes).

**Trip cost savings**

The passengers of the metro diverted from cars have experienced trip cost savings because the cost of the metro (ticket) is on average cheaper than the cost they would have sustained by taking the car[124]. The trip cost savings for passengers diverted from cars were calculated as the difference between car operating costs and the cost of the metro. The car operating costs were calculated multiplying the cost per km of the most used car in Naples[125] by the number of km avoided. The cost of the metro in the section Vanvitelli – Dante was estimated as a share of the average ticket cost based on the share of passengers in the section Vanvitelli-Dante as compared to the overall Line 1. Specifically, since the tariff system includes different types of tickets (one way, 90 minutes validity, annual, etc.), the average price was estimated as the average of each tariff weighted by the number of users using that kind of ticket[126]. The trip cost savings generated by the project amounts to EUR 3.6 million (0.31% of the total benefits).

**Air pollution savings**

The reduction of the traffic generated by people diverted from cars leads to a reduction of cars' emission and, in turn, to a decrease in local air pollution. The amount of air pollution emissions avoided was estimated by multiplying the average emission factors in urban areas in Italy broken down by fuel category[127] and the avoided km by car in the route Vanvitelli – Dante. This benefit represents a share of 0.19% (EUR 2.2 million) of the total economic benefits coming out from the project coming out of the project ex-post analysis.

**GHG emission savings**

The reduction in the number of circulating cars also causes a decrease in GHG emissions. The GHG emissions' savings were calculated on the basis of cars' vehicle-km avoided by type of fuel used, multiplied by the corresponding unit parameters reported in the First Interim Report. This benefit accounts for 0.14% (EUR 1.6 million) of the total economic benefits coming out of the project ex-post analysis.

**Reduction of collisions and accidents**

During the operation phase of the project, the reduction of cars on the road has translated into a decrease in the number of accidents, including slight and severe injuries, and fatalities. The figure of avoided collisions and accidents was calculated following the ex-ante assumptions on the number of accidents that occurs per 1,000,000 vehicle-km[128]. The reduction in accident costs was estimated using the social accident cost for fatalities, severe injuries and slight injuries as reported in the

[124] The cost of the car is comprehensive of the costs related to fuel consumption, tire deterioration, capital share, and maintenance.

[125] Data on the vehicle fleet in Naples are available on the ACI database (Automobile Club d'Italia – Automobile Club of Italy). Moreover, on the ACI website it is possible to know the cost per km of a car by specifying the automobile manufacturer and the car model.

[126] The information regarding the distribution of passengers by type of ticket and the related price was provided by UNICOCampania.

[127] Emission factors are from The Italian National Institute for Environmental Protection and Research (ISPRA). These factors were multiplied by the unit cost of emissions as reported in First Intermediate Report.

[128] According to the ex-ante analysis, each 1,000,000 vkm occur 0.02 fatalities, 0.42 severe injuries, 1.72 slight injuries.

First Interim Report. This safety gain is worth 3.49% (EUR 41.0 million) of the total economic benefits.

#### Reduction of traffic noise

The reduction of traffic noise stemming from the reduction in congestion was valued under the assumption that the project implementation reduces the daily dense traffic. This occurs because the project implementation induce people to move with the public transport service rather than with the private car. Thus, the values reported in the First Interim Report were used to monetise this benefit, that accounts for 0.18% (EUR 2.1 million) of the total economic benefits.

#### Urban renewal

The benefits from urban renewal was not calculated in the ex-ante CBA analysis. However, as also stated by the interviewees, the project caused an increase in the value of properties in the proximity of the new stations. In the ex-post CBA, this benefit was calculated by employing three sources of data:

- The total amount of buildings (in square meters) in the catchment area of the new stations (i.e. in a 500 radius from the new stations). These data were provided by the Municipality of Naples;
- The housing property value per square meter in 2001 and 2008 in each catchment area as reported in the OMI database (Italian real estate market observatory);
- The percentage change from 2001 to 2008 in the housing property values caused by the arrival of the metro. These percentages were calculated for each station catchment area in the section Vanvitelli – Dante by Pagliara and Papa (2011).

The external benefit on property values represents 10.03% (EUR 117.7 million) of the total economic benefits generated by the project.

#### Project's Economic Performance

The socio-economic ex-post indicators provide a (moderate) positive result, meaning that the project is desirable for society and it has increased welfare. The results of the economic analysis are presented in the table below.

**Table 31. Economic performance indicators of the project**

| INDICATOR | EUR |
|---|---|
| **ENPV** | 389,363,622 |
| **B/C** | 1.35 |
| **EIRR** | 3.24% |

*Source:* Authors

**Table 32. Economic return of the project (ENPV and ERR) (EUR)**

| It. | | Present value | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | **CAPEX** | **845,702,870** | **18,462,931** | **28,975,096** | **66,228,791** | **100,346,653** | **111,507,545** | **113,007,905** | **50,862,805** | **20,439,598** | **21,040,941** | **26,436,231** | **23,525,758** | **26,282,093** | **14,942,710** | **0** | **0** |
| **1.1** | Civil works | 690,091,695 | 18,462,931 | 28,975,096 | 66,228,791 | 100,346,653 | 111,507,545 | 113,007,905 | 50,862,805 | 20,439,598 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **1.2** | Completion works | 139,756,366 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 21,040,941 | 26,436,231 | 23,525,758 | 26,282,093 | 14,942,710 | 0 | 0 |
| **1.3** | Rolling stock | 15,854,809 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **2** | **OPEX** | 264,340,321 | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **10,428,357** | **12,091,522** |
| **2.1** | Station management | 21,298,641 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 822,306 | 891,761 |
| **2.2** | Labour | 64,798,796 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2,234,788 | 3,085,732 |
| **2.3** | Operating railway | 99,429,255 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4,234,269 | 4,712,072 |
| **2.4** | Maintenance | 15,688,694 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 613,498 | 665,317 |
| **2.5** | Indirect costs | 63,124,936 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2,523,495 | 2,736,640 |
| **3** | **Residual value** | **325,901,369** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** |
| **4** | **Socio-economic benefits** | **1,173,505,444** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **13,442,840** | **13,140,606** | **12,807,608** | **42,258,518** | **42,328,685** |
| **4.1** | Time savings | 1,005,338,359 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 28,487,369 | 28,779,832 |
| **4.2** | VOCs | 3,606,628 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 29,886 | 51,532 |
| **4.3** | Noise | 2,121,025 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 58,420 | 60,068 |
| **4.4** | GHG | 1,589,452 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 34,287 | 35,254 |
| **4.5** | Air pollutant | 2,231,999 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 61,477 | 63,210 |
| **4.6** | Safety | 40,965,149 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1,128,317 | 1,160,136 |
| **4.7** | Urban renewal | 117,652,834 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 13,442,840 | 13,140,606 | 12,807,608 | 12,458,763 | 12,178,654 |
| **5** | **Total** | **389,363,622** | **-18,462,931** | **-28,975,096** | **-66,228,791** | **-100,346,653** | **-111,507,545** | **-113,007,905** | **-50,862,805** | **-20,439,598** | **-21,040,941** | **-26,436,231** | **-10,082,918** | **-13,141,487** | **-2,135,102** | **31,830,162** | **30,237,163** |

| It. | | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | **CAPEX** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **1,685,855** | **15,172,693** |
| **1.1** | Civil works | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **1.2** | Completion works | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **1.3** | Rolling stock | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1,685,855 | 15,172,693 |
| **2** | **OPEX** | **13,169,222** | **12,091,971** | **12,090,030** | **11,794,185** | **12,137,523** | **10,154,293** | **9,831,560** | **9,284,288** | **9,436,619** | **8,415,953** | **9,990,183** | **9,343,944** | **10,000,183** | **9,343,944** | **9,343,944** |
| **2.1** | Station management | 945,784 | 848,472 | 868,394 | 863,759 | 864,362 | 790,493 | 747,927 | 700,962 | 747,478 | 767,822 | 880,805 | 881,686 | 881,686 | 881,686 | 881,686 |
| **2.2** | Labour | 4,290,872 | 3,518,403 | 3,561,593 | 3,485,034 | 3,577,426 | 3,010,127 | 2,786,947 | 2,666,038 | 2,785,296 | 2,273,210 | 2,532,934 | 1,879,230 | 2,535,469 | 1,879,230 | 1,879,230 |
| **2.3** | Operating railway | 4,339,424 | 4,547,079 | 4,377,893 | 4,163,483 | 4,423,442 | 3,359,500 | 3,476,485 | 3,259,443 | 3,079,327 | 2,429,209 | 3,402,872 | 3,406,278 | 3,406,278 | 3,406,278 | 3,406,278 |
| **2.4** | Maintenance | 738,795 | 763,894 | 716,130 | 673,856 | 700,836 | 610,455 | 600,692 | 530,182 | 552,614 | 561,341 | 604,282 | 604,887 | 604,887 | 604,887 | 604,887 |
| **2.5** | Indirect costs | 2,854,348 | 2,414,123 | 2,566,021 | 2,608,053 | 2,571,456 | 2,383,719 | 2,219,509 | 2,127,662 | 2,271,904 | 2,384,370 | 2,569,291 | 2,571,863 | 2,571,863 | 2,571,863 | 2,571,863 |
| **3** | **Residual value** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** |
| **4** | **Socio-economic benefits** | **41,249,686** | **41,494,975** | **41,344,412** | **29,228,267** | **32,019,879** | **32,168,411** | **34,258,847** | **33,077,805** | **36,296,918** | **37,022,317** | **40,989,028** | **41,674,788** | **41,676,488** | **41,678,189** | **45,014,280** |
| **4.1** | Time savings | 27,987,037 | 28,455,580 | 28,528,538 | 27,853,368 | 30,367,594 | 30,523,011 | 32,417,790 | 31,380,913 | 34,365,793 | 35,347,256 | 39,124,435 | 39,702,629 | 39,702,629 | 39,702,629 | 42,878,839 |
| **4.2** | VOCs | 56,184 | 65,025 | 64,045 | 85,677 | 250,750 | 232,188 | 338,984 | 237,229 | 332,504 | 32,930 | 37,077 | 115,935 | 115,935 | 115,935 | 125,210 |
| **4.3** | Noise | 58,761 | 59,873 | 60,150 | 58,726 | 63,842 | 64,315 | 68,296 | 66,307 | 72,552 | 74,459 | 82,789 | 84,012 | 84,012 | 84,012 | 90,733 |
| **4.4** | GHG | 34,487 | 35,139 | 35,302 | 34,466 | 37,469 | 39,048 | 42,847 | 42,941 | 48,454 | 51,234 | 58,641 | 61,208 | 62,908 | 64,609 | 71,614 |
| **4.5** | Air pollutant | 61,835 | 63,006 | 63,297 | 61,799 | 67,183 | 67,680 | 71,869 | 69,776 | 76,348 | 78,354 | 87,120 | 88,408 | 88,408 | 88,408 | 95,480 |
| **4.6** | Safety | 1,134,893 | 1,156,380 | 1,161,734 | 1,134,230 | 1,233,041 | 1,242,168 | 1,319,060 | 1,280,640 | 1,401,266 | 1,438,085 | 1,598,966 | 1,622,596 | 1,622,596 | 1,622,596 | 1,752,404 |
| **4.7** | Urban renewal | 11,916,491 | 11,659,972 | 11,431,345 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **5** | **Total** | **28,080,464** | **29,403,004** | **29,254,381** | **17,434,081** | **19,882,357** | **22,014,118** | **24,427,286** | **23,793,517** | **26,860,298** | **28,606,365** | **30,998,845** | **32,330,844** | **31,676,305** | **30,648,390** | **20,497,642** |

| It. | | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 |
|---|---|---|---|---|---|---|---|---|---|
| **1** | **CAPEX** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** |
| **1.1** | Civil works | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **1.2** | Completion works | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **1.3** | Rolling stock | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **2** | **OPEX** | **10,468,016** | **10,468,016** | **10,468,016** | **10,468,016** | **10,468,016** | **10,468,016** | **10,468,016** | **10,468,016** |
| **2.1** | Station management | 881,686 | 881,686 | 881,686 | 881,686 | 881,686 | 881,686 | 881,686 | 881,686 |
| **2.2** | Labour | 1,879,230 | 1,879,230 | 1,879,230 | 1,879,230 | 1,879,230 | 1,879,230 | 1,879,230 | 1,879,230 |
| **2.3** | Operating railway | 4,530,350 | 4,530,350 | 4,530,350 | 4,530,350 | 4,530,350 | 4,530,350 | 4,530,350 | 4,530,350 |
| **2.4** | Maintenance | 604,887 | 604,887 | 604,887 | 604,887 | 604,887 | 604,887 | 604,887 | 604,887 |
| **2.5** | Indirect costs | 2,571,863 | 2,571,863 | 2,571,863 | 2,571,863 | 2,571,863 | 2,571,863 | 2,571,863 | 2,571,863 |
| **3** | **Residual value** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **411,377,5370** |
| **4** | **Socio-economic benefits** | **48,617,406** | **50,564,164** | **58,960,220** | **68,750,421** | **68,753,225** | **68,756,029** | **68,758,833** | **68,761,637** |
| **4.1** | Time savings | 46,309,147 | 48,161,512 | 56,156,323 | 65,478,273 | 65,478,273 | 65,478,273 | 65,478,273 | 65,478,273 |
| **4.2** | VOCs | 135,227 | 140,636 | 163,982 | 191,202 | 191,202 | 191,202 | 191,202 | 191,202 |
| **4.3** | Noise | 97,992 | 101,911 | 118,829 | 138,554 | 138,554 | 138,554 | 138,554 | 138,554 |
| **4.4** | GHG | 79,326 | 84,561 | 101,003 | 120,574 | 123,378 | 126,182 | 128,986 | 131,790 |
| **4.5** | Air pollutant | 103,119 | 107,243 | 125,046 | 145,803 | 145,803 | 145,803 | 145,803 | 145,803 |
| **4.6** | Safety | 1,892,596 | 1,968,300 | 2,295,038 | 2,676,014 | 2,676,014 | 2,676,014 | 2,676,014 | 2,676,014 |
| **4.7** | Urban renewal | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **5** | **Total** | **38,149,389** | **40,096,148** | **48,492,204** | **58,282,405** | **58,285,209** | **58,288,013** | **58,290,817** | **469,671,158** |

*Source: Authors*

### A II.5 Sensitivity analysis

A sensitivity analysis was carried out on the key variables in order to determine whether they are critical or are 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. 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 a long list of different variables. As a result of the sensitivity test (see table below), the following critical variables have been identified as critical: passengers annual growth rate and the saved travel time by diverted from buses.

Results of the sensitivity analysis

| INDEPENDENT VARIABLE | VARIATION (in %) of the economic NPV due to a ± 1% variation | CRITICALITY JUDGEMENT * |
|---|---|---|
| Passengers annual growth rate | 6.0% | Very critical |
| Travel time saved for diverted from bus | 1.7% | Critical |
| Travel time saved for diverted from car | 0.8% | Not critical |
| Residual value of civil works | 0.8% | Not critical |
| OPEX | 0.7% | Not critical |
| Urban renewal | 0.3% | Not critical |
| Occupancy rate | 0.2% | Not critical |
| Cost of the car | 0.1% | Not critical |
| Cost of the metro | 0.1% | Not critical |
| Number of severe injuries | 0.1% | Not critical |
| Number of fatalities | 0.0% | Not critical |
| Number of slight injuries | 0.0% | Not critical |
| Residual value of rolling stock | 0.0% | Not critical |

*Very critical: ΔNPV > +5%; Critical: ΔNPV > +1%; Not critical: ΔNPV < +1%.*

The above standard sensitivity analysis was enriched with a sensitivity analysis carried out on the social discount rate (SDR). As shown in the First Intermediate Report129 the forward SDR adopted for Italy is lower than the forward SDRs adopted for the other countries, reflecting the Italy lower GDP growth rate expected in the next future. Therefore, one may ask about the impact of a higher SDR on the project. The Table below shows the ENPV values of the project (right hand-side column) associated with three values of the forward SDR (left hand-side column). The forward SDR ranges from 1% (the minimum threshold) to 3.5%, i.e. the value suggested by the EC (2014) to be adopted for the European countries should national values be missing.

The analysis suggests that the increase of the forward SDR from 2.14% (the baseline scenario considered in the analysis) to 3.5% reduces the ENPV by about 20%, but it never turns on negative values. This limits any concern related to a potential bias stemming from the adoption of a too low forward SDR for Italy.

129 Annex III, Social Discount Rate, Table 15, page 76.

The impact on the forward SDR on the project ENPV

| Forward Social Discount Rate | Economic Net Present Value (EUR) |
|---|---|
| 1% | 466'053'708 |
| 2.14% (baseline) | 389'363'622 |
| 3.5% | 309'049'184 |

### AII.6 Risk assessment

The risk assessment was conducted on the above critical variables: '*passengers annual growth rate*' and '*travel time saved for diverted from bus*'. 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 analysis was elaborated using the Monte Carlo simulation technique with 10,000 random repetitions. In brief, at each iteration the algorithm 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.

The risk assessment shows that the expected value of the ENPV is equal to EUR 362.5 (lower than the reference case), and that the expected value of the ERR is 3.12% (against a reference case of 3.24%). The probability that the ENPV will fall below the baseline value is 58% and there is positive probability (0.1%) that it turns on negative values. Moreover, The ERR has a probability of 4.2% of falling below the reference social discount rate. Taking together, these results point to high uncertainty associated with this project.

**Figure 23. Results of the risk analysis for ENPV (left-hand side) and ERR (right-hand side)**

**CBA Reference value**

| 389,363,622 |
|---|

**Estimated parameters of the distribution**

| | |
|---|---|
| Mean | 362,540,951 |
| Median | 359,710,172 |
| Standard deviation | 142,782,496 |
| Minimum | -16,526,310 |
| Maximum | 790,720,359 |

**Estimated probabilities**

| | |
|---|---|
| Pr. ENPV ≤ base value | 0.577 |
| Pr. ENPV ≤ 0 | 0.001 |

**CBA Reference value**

| 3.2363% |
|---|

**Estimated parameters of the distribution**

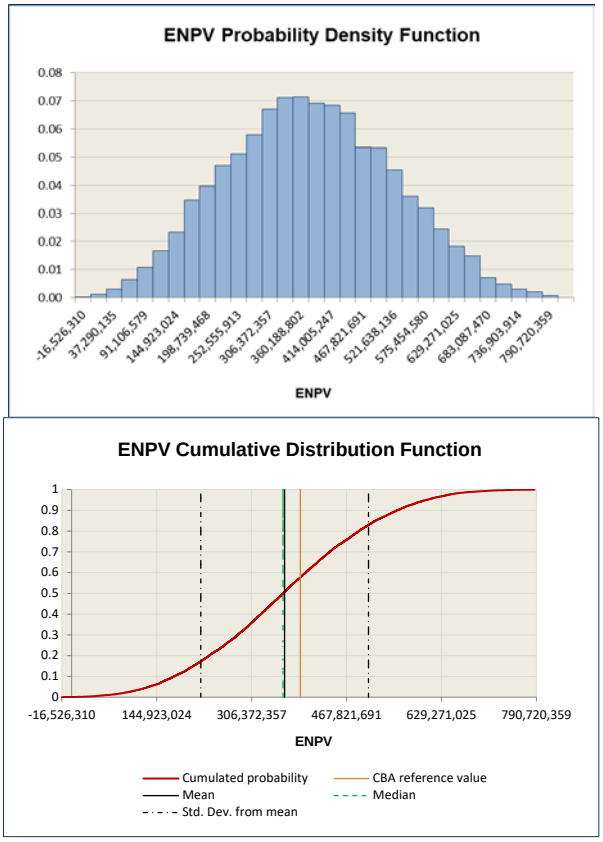
| | |
|---|---|
| Mean | 3.1189% |
| Median | 3.1339% |
| Standard deviation | 0.55% |
| Minimum | 1.473% |
| Maximum | 4.556% |

**Estimated probabilities**

| | |
|---|---|
| Pr. ERR ≤ base value | 0.572 |
| Pr. ERR ≤ Social discount rate | 0.042 |

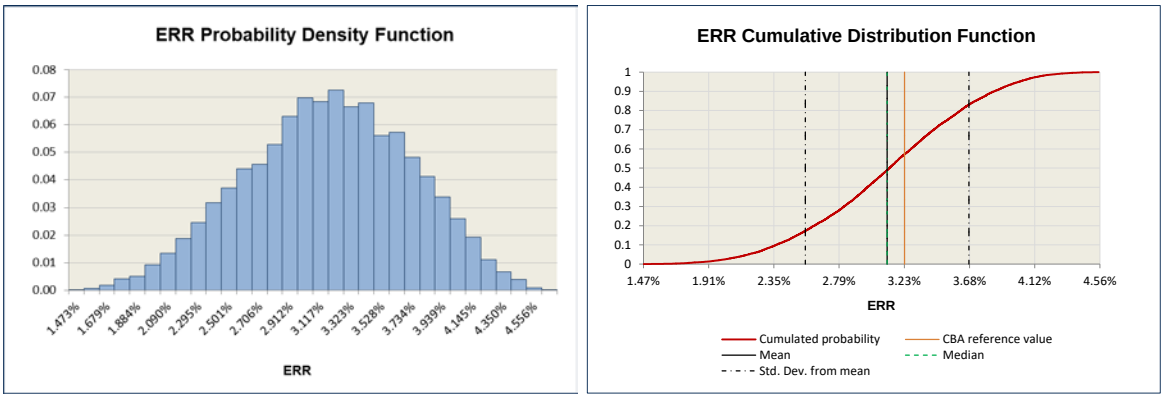
*Source: Authors*

**Figure 24. Probabilistic distribution of the Economic Net Present Value (EUR)**




*Source: Authors*

**Figure 25. Probabilistic distribution of the Economic Internal Rate of Return (ERR)**




*Source: Authors*

## ANNEX III. LIST OF INTERVIEWEES

The following table provides the list of interviewed people for the ex-post assessment. They were identified on the basis based on the authors referenced in the documents included in the application dossier provided by the European Commission. The institutions approached through these referenced contacts have been consulted in order to confirm the most appropriate and relevant persons to be involved in this ex-post analysis. Additional stakeholders have been identified on the basis of the review of articles and Web Sites, which have been consulted as part of this evaluation.

In addition to the interviews, authors participated to the conference "To Santa Barbara - Tunnels in Naples between past and future" held in Naples on 1 December 2017 and organised by the Italian Tunnelling Society. Several issues related to the metro tunnel construction in Naples were discussed. Several stakeholders of the project, local institutions and experts in the field participated at the meeting.

| NAME | POSITION | AFFILIATION | DATE |
|---|---|---|---|
| Francesco Maria Angelini | Project Economist | JASPERS | 9/11/2017 |
| Francesca Pagliara | Professor | University Of Naples Federico II - Department Of Civil, Architectural And Environmental Engineering | 13/11/2017 |
| Giulio Villani | Researcher | University Of Naples Federico II - Department Of Civil, Architectural And Environmental Engineering | 13/11/2017 |
| Armando Cartenì | Professor | University Of Campania "Luigi Vanvitelli" Naples Federico II - Department of Engineering | 13/11/2017 |
| Anna Savarese | Vice President | NGO "LEGAMBIENTE" (League for the Environment) Campania | 13/11/2017 |
| Giancarlo Chiavazzo | Scientific Director | NGO "LEGAMBIENTE" (League for the Environment) Campania | 13/11/2017 |
| Vincenzo De Luca | President | Region of Campania | 14/11/2017 |
| Franco Picarone | President | Region of Campania<br>Budget Committee | 14/11/2017 |
| Maria Teresa Di Mattia | Director | Region of Campania<br>DG ERDF Managing Authority | 14/11/2017 |
| Ornella Carbone | Senior Consultant Technical Assistance to the ERDF Managing Authority of the Region of Campania | Region of Campania<br>Agency for Sustainable Mobility (ACAMIR) | 14/11/2017 |
| Maria Gilda Donadio | Press Office Manager | Azienda Napoletana Mobilità (A.N.M.) S.p.a. | 14/11/2017 |
| Kordula Felicitas Gross | Head of Controlling Department | Azienda Napoletana Mobilità (A.N.M.) S.p.a. | 14/11/2017 |
| Guido Rodia | Technical Manager | Consorzio UNICOCAMPANIA | 15/11/2017 |
| Vincenzo Orazzo | Metro Line Operating Director | Azienda Napoletana Mobilità (A.N.M.) S.p.a. | 15/11/2017 |
| Ottavio Ragone | Journalist – deputy editor<br>(Vice caporedattore) | La Repubblica, Napoli | 15/11/2017 |
| Antonio De Risi | Technical Director | Metropolitana di Napoli (M.N.) S.p.a. | 16/11/2017 |
| Mauro Iorio | Manager | Metropolitana di Napoli (M.N.) S.p.a. | 16/11/2017 |

| | | | |
|---|---|---|---|
| Dario Gentile | Director | Region of Campania<br>Agenzia Campana per la Mobilità Sostenibile (ACAMIR)<br>Public Transport Services Planning, Adjustment and Control Unit | 16/11/2017 |
| Mario Calabrese | Chief of the DG – Infrastructures, Public Works and Mobility | Municipality of Naples<br>DG – Infrastructures, Public Works and Mobility | 16/11/2017 |
| Raffaele Mucciariello | Director | Municipality of Naples<br>DG – Infrastructures, Public Works and Mobility | 16/11/2017 |
| Nicola Pascale | Head of the staff | Municipality of Naples<br>DG – Infrastructures, Public Works and Mobility | 16/11/2017 |
| Serena Riccio | Director of Metro Line 1 and 6 Unit. | Municipality of Naples<br>DG – Infrastructures, Public Works and Mobility | 16/11/2017 |
| Carlo De Grandis | Policy Officer | European Commission<br>DG MOVE Unit C.4 – Rail Safety and Interoperability | 23/11/2017 |
| Luca Cascone | President | Region of Campania<br>Planning, Public Works, Transportation Committee | 01/12/2017 |
| Marcello Martinez | Professor | University of Campania<br>Department of Economics | 12/12/2017 |

# ADMINISTRATIVE MILESTONES OF THE METRO LINE 1 IN NAPLES

Milestones the project Vanvitelli-Dante as part of the Metro Line 1.

| Date | MILESTONES by Metro Line 1 segment |
|---|---|
| | ***Piscinola/Scampia – Vanvitelli*** |
| 29.04.1976 | By a public tender, MN Metropolitana di Napoli SpA is entrusted by the Municipality of Naples for the design and construction of Metro Line 1 in Naples (Garibaldi Square – Bovio Square – Vomero area – Colli Aminei). City Council Resolution n. 13/1976. The Convention is signed on 22.07.1976 repository n. 25821 |
| 15.02.1982 | The City Conuncil of Naples approves the project Metro Line 1 (Garibaldi Square – Bovio Square – Vomero area – Colli Aminei). City Council Resolution n. 11/1982. MN Metropolitana di Napoli SpA submits the executive project to the municipality on 03.06.1982 |
| 22.07.1983 | The City Conuncil approves the *Capitolato di Concessione* of the project (technical specifications, costs and timing). City Council Resolution n. 21/1983 |
| 1984 | The extension of Line 1 from Colli Aminei to Piscinola/Scampia is approved by *Commissariali* resolutions 162/1984 and 163/1984; Region of Campania resolution n.3481/1984 and city council resolution n. 344/1984 |
| 08.02.1985 | The construction works of the extension Colli Aminei - Piscinola/Scampia start. Document n. 149471/1985 and 149472/1985 |
| 21.07.1988 | The project for the realisation of Piscinola depot/maintenace infrastructures is approved by the City Council Regulation n. 2/1988 |
| 1992/93 | The segment Vanvitelli – Colli Aminei is opened |
| 1995 | The segment Colli Aminei – Piscinola/Scampia is opened. The works for connecting the Piscinola/Scampia Station to depot starts. Approval of costs adjustemts for works related to the segments *Bernini/Cimarosa* in the Vanitelli area (document n. 64185/1995) |
| | ***Vanvitelli - Dante*** |
| 1988 | By Decision C (88) 0166/038 of 16 February 1988 ('the decision of 16 February 1988'), the Commission granted assistance from the ERDF for the completion of part of that project, namely the construction of the Museo-Cilea section and the Materdei station ('Project No 850503067'). That assistance amounted to 50% of the eligible public expenditure in respect of Project No 850503067, (set at ITL 156 963 000 000), and therefore to a maximum of ITL 78 481 500 000 ('Grant of Assistance No 850503067'). The total investment cost of that project was estimated at ITL 156 963 000 000. |
| 1989 | By Decision C (89) 2178/021 of 21 December 1989 ('the decision of 21 December 1989'), the Commission awarded, pursuant to the same provisions of Regulation No 1787/84, a second grant of ERDF assistance for the completion of another part of the Line 1 construction project, namely the construction of the Dante-Museo section and the Museo and Dante stations ('Project No 850503066'). That assistance amounted to 35.22% of the eligible public expenditure for Project 850503066 (set at ITL 227 153 000 000), and therefore to a maximum of ITL 80 000 000 000 ('Grant of Assistance No 850503066').The total investment cost of that project was estimated at ITL 227 153 000 000. |
| 1991/98 | Excavation works of the segment Vanvitelli – Dante as approved in 1982. |
| 1997 | The Naples' Transport Plan is approved the City Council with resolutions n. 90/1997 and 91/1997 on 18 March. The planned works are brokendown by functional lots. See also related documents n. 201687 issued on 05.02.1997 and n. 202906 issued on 0.2.10.1997 |
| 2000 | The 100 Station Plan is approved. The Plan contains the project of the *Art Stations.* EU co-financing decision was issued in 2005. EC C(2005) n. 5241. |
| 2001 | The segment Vanvitelli – Salvator Rosa is opened |
| 2002/03 | The segment Salvator Rosa – Dante is opened |
| 2003 | Piscinola depot and maintenace infrastructuresis completed. EU co-financing decision. |
| | ***Dante – Garibaldi (and extention to Centro Direzionale)*** |
| 1997 | The Interministerial Committee for Economic Planning (CIPE) approves the Dante – Garibaldi final project with Resolution n.185/1997 |
| 1998 | Archaeological investigations prescribed by the Superintendency related to the above project start |
| 1999 | The works for the construcion of the route Dante – Garibaldi start (Documents n. 206199 issued on 29.06.1999 and n. 206200 issued on 29.06.1999) |
| 2002 | The CIPE approves the modification (*variante*) of the final project approved in 1997 with regulation n.141/2002. The modification includes the extention to Centro Direzionale (excluded the station). The total cost of the project is EUR 689 million. The CIPE co-founds the project. The Municipality complies with CIPE's regulation by the City Concil regulation n. 2497/2003. |
| 2005 | The City Council (resolution n. 4464) approves further modifications to the original project for freezing engineering interventions related to works in presence of groudwater resources.<br>EC approves the co-financing of the Major Project 'Realisation of Construction Works in the Dante – Garibaldi – Centro Direzionale of Metro Line 1 in Naples. POR Campania FESR 2000 – 2006. Asse IV – Reti e Nodi di Servizi - Misure 5.1 (promuovere recupero e miglioramento qualità urbana) and 6.1 (Sistema Regionale Integrato dei trasporti). EC resolutions n. 5235 07/12/2005 and n. 5252 22/10/2007 |
| 2007/08 | The Ministry of Transport and Infrastructures approves the above modfications with resolution n. 379/2007. Also the CIPE approves the above modifications with resolution n. 12/2008. The costs is now EUR 1,375 million. In 2007, EC approves the co-financing of the Major Project 'Realisation of Technological Works in the segment Dante – Garibaldi' of Metro Line 1 in Naples. POR Campania FESR 2007-2013 Asse IV "Accessibilità e Trasporti" Obiettivo Operativo 4.6 "Sistema della metropolitana regionale" |
| 2011/12 | Completion and inauguration of the segment Dante – Università |

| | |
|---|---|
| 2013 | The extension up to Garibaldi is opened. The Duomo station remains closed for archaelogical related issues. |
| 2014 | The municipality of Naples sends to Ministry of Transport and Infrastructures the preliminary document *(istruttoria*) and modifications for the completion of the segment Dante-Garibaldi/Centro Direzionale for a total of EUR 1,757 million. The municipality asks for a financial contribution of EUR 219 million. |
| 2015 | The Municipio station is partially opened to the public. Archaelogical works are on-going. |
| ***Garibaldi – Centro Direzionale - Airport*** | |
| 2004/05 | The Region of Campania entrusts the municipality of Naples for the realisation of this section of Metro Line 1 (City Council regulation n. 4065/2004. The CIPE approves the preliminary project by the municipality with resolution n. 90/2005. |
| 2006 | MN Metropolitana di Napoli SpA is entrusted for the design and construction on 18th January. |
| 2012/13 | The final project is approved by the City Council with resolution n. 840/2012 for a total amount of EUR 700 million. The CIPE approves the final project with resolution n. 88/2013. |
| 2014 | The excavation works starts. |
| 2015/16 | Modifications to the final projects are approved by the City Council (resolution n. 561/2015 and 724/2016). There are no increases in costs. |

*Source: Municipaity of Naples, DG- Infrastructures, Public Works, and Mobility. Chronology of Metro Line 1 Development (March, 2017).*

# REFERENCES

## ACADEMIC PAPERS

Anguera (2006), The Channel Tunnel—an ex post economic evaluation, *Transportation Research Part A: Policy and Practice*, Elsevier

Cascetta, E. (2013). The Naples Metro Project in the Italian and European context. PPT Presentation by Prof. Cascetta (February 19th 2013, Faculty of engineering, University of Naples Federico II, Naples)

Cascetta, E., & Cartenì, A. (2014). The hedonic value of railways terminals. A quantitative analysis of the impact of stations quality on travellers behaviour. *Transportation Research Part A: Policy and Practice*, *61*, 41-52.

Cascetta, E., & Pagliara, F. (2008). Integrated railways-based policies: the Regional Metro System (RMS) project of Naples and Campania. *Transport Policy*, *15*(2), 81-93.

Cascetta, E., & Pagliara, F. (2013). Public engagement for planning and designing transportation systems. *Procedia-Social and Behavioral Sciences*, *87*, 103-116.

Cascetta, E., Cartenì, A., & Henke, I. (2014). Stations quality, aesthetics and attractiveness of rail transport: empirical evidence and mathematical models [Qualità delle stazioni, estetica e attrattività del trasporto ferroviario: evidenze empiriche e modelli matematici]. *Ingegneria Ferroviaria*, *69*(4), 307-32.

Cascetta, E., Carteni, A., Pagliara, F., & Montanino, M. (2015). A new look at planning and designing transportation systems: A decision-making model based on cognitive rationality, stakeholder engagement and quantitative methods. *Transport policy*, *38*, 27-39.

Cascetta, E., Pagliara, F., & Papola, A. (2007). Governance of urban mobility: complex systems and integrated policies. *Advances in complex systems*, *10*(supp02), 339-354.

*D'Acierno, L., Gallo, M., Montella, B., & Placido, A. (2013, October). The definition of a model framework for managing rail systems in the case of breakdowns. In Intelligent Transportation Systems-(ITSC), 2013 16th International IEEE Conference on (pp. 1059-1064). IEEE.*

Davidson, G., Howard, A., Jacobs, L., Pintabona, R., & Zernich, B. (2014). NORTH AMERICAN TUNNELING CONFERENCE, *North American Tunneling: 2014 proceedings.*

*De Risi (2016), La Metropolitana delle tre "A". A Napoli la trasformazione delle stazioni da luoghi di degrado a simboli d'arte, Logistica e Mobilita – Il giornale dell'Ingegnere, n. 1-2 Gennaio/Febbraio 2016*

*Florio, M. (2014). Applied welfare economics: Cost-benefit analysis of projects and policies (Vol. 22). Routledge.*

Flyvbjerg, B., Bruzelius, N., & van Wee, B. (2008). Comparison of Capital Costs per Route-Kilometre in Urban Rail. European Journal of Transport and Infrastructure Research, 8(1), 17-30.

Gargiulo, C., & De Ciutiis, F. (2010). Urban Transformation and Property Value Variation. The Role of HS Stations. Tema. *Journal of Land Use, Mobility and Environment*, 2.

Hirschman, A. O. (2014). *Development projects observed*. Brookings Institution Press.

Imperiali, E. (2014). Centro Einaudi, SRM, Unione Industriali di Napoli, Ci vuole una terra per vedere il mare. Primo Rapporto «Giorgio Rota» su Napoli. *Rivista economica del Mezzogiorno*, *28*(4), 1102-1104.

Mackie, P., Nellthorp, J., & Laird, J. (2003). Toolkit for the economic evaluation of world bank transport projects. Institute for Transport Studies, University of Leeds.

*Mandolini, A., & Viggiani, G. M. (2017). Experiences gathered from the construction of Napoli underground. Procedia Engineering, 172, 31-41.*

Mohammad, S. I., Graham, D. J., Melo, P. C., & Anderson, R. J. (2013). A meta-analysis of the impact of rail projects on land and property values. *Transportation Research Part A: Policy and Practice,* 50, 158-170.

Morone, A., & Nunziante, P.(2012). Naples, a case study. Rise and Fall of contemporary art as a factor in urban design regeneration.

*Nesticò, A., & Bencardino, M. (2016). Urban real estate values on vast area and macroeconomic parameters. Procedia-Social and Behavioral Sciences, 223, 410-415.*

*Pagliara, F., & Papa, E. (2011). Urban rail systems investments: an analysis of the impacts on property values and residents' location. Journal of Transport Geography, 19(2), 200-211.*

Russo, G., Corbo, A., Cavuoto, F., Manassero, V., De Risi, A., & Pigorini, A. (2016, December). Underground culture: Toledo station in Naples, Italy. In *Proceedings of the Institution of Civil Engineers-Civil Engineering* (Vol. 170, No. 4, pp. 161-168). Thomas Telford Ltd.

Secondo, 2016 Secondo Rapporto Giorgio Rota su Napoli (2016). Crescita, vento a favore? http://www.rapporto-rota.it/rapporti-su-napoli/2016-crescita,-vento-a-favore.html

TO, H. R., & Barker, M. M. (2001). White paper European Transport Policy for 2010: time to decide.

Viggiani, G. (Ed.). (2013). Geotechnical Aspects of Underground Construction in Soft Ground. London: CRC Press.

**REPORTS**

EC (2014). Guide to Cost-Benefit Analysis on Investment Projects, Economic appraisal tool for Cohesion Policy 2014-2020. *European Commission*

EC (2015). Action Plan. Making the best use of new financial schemes for European transport infrastructure projects*. European Commission*

European Parliament (2017). Research for REGI Committee – Public Private Partnerships and Cohesion Policy.

**UFFICIAL DOCUMENTS**

ACAM (2010). Infrastrutture Industria E Servizi Di Trasporto E Logistica In Campania, 2009 Terzo rapporto. *Centro Studi ACaM*

Document prepared by Ing. Cascone, President of the 4th Regional Committee on Transport, Public Works and Urban Planning of the Region of Campania.

Ex-ante cost-benefit analysis "*Completamento delle opere civili e realizzazione delle opere tecnologiche della linea 1 Tratta Dante (esclusa)-Municipio (inclusa)-Garibaldi (inclusa)-Centro Direzionale (esclusa)*" POR 2000-2006 Region of Campania.

Legambiente. (2016). Rapporto Pendolaria 2016.

Municipality of Naples (1997). Urban Transport Plan.

Municipality of Naples (2000). The 100 Station Plan.

Municipality of Naples (2016). Urban Plan of Sustainable Mobility (PUMS) Observatory.

Municipality of Naples, DG- Infrastructures, Public Works, and Mobility. Chronology of Metro Line 1 Development (March, 2017).

**SLIDES**

“Da Vitruvio alla Metropolitana di Napoli”. PPT by Prof. Cascetta at the conference “In Onore di Santa Barbara”, held in Naples on December 1st 2017

PPT (dated 8 Sept. 2017) by Prof. Calabrese, Head of the Department of Mobility, Infrastructures and Public Works of the Municipality of Naples.

**PRESS ARTICLES**

http://napoli.repubblica.it/cronaca/2017/07/18/news/metropolitana_di_napoli_via_libera_all_acquisto_di_10_nuovi_treni_per_la_linea_1-171020076/

https://napoli.fanpage.it/comune-di-napoli-maxi-mutuo-da-150-milioni-per-comprare-i-treni-della-metro/.

http://napoli.repubblica.it/cronaca/2017/05/11/news/metro_linea_1_costi_esorbitanti-165161959/

http://corrieredelmezzogiorno.corriere.it/napoli/cronaca/17_dicembre_07/metro-nuovi-blocchi-polemiche-sindaco-mette-l-anm-mirino-14a55e52-db%E2%80%A6

http://corrieredelmezzogiorno.corriere.it/napoli/cronaca/18_gennaio_17/anm-perde-25-milioni-ogni-anno-pensiamo-aumentare-costo-biglietti-f1eb7158-fb5f-11e7-b1f6-dbd2d5a7f7a1.shtml

http://corrieredelmezzogiorno.corriere.it/napoli/cronaca/18_gennaio_17/anm-perde-25-milioni-ogni-anno-pensiamo-aumentare-costo-biglietti-f1eb7158-fb5f-11e7-b1f6-dbd2d5a7f7a1.shtml

http://www.lavocedellevoci.it/2017/06/25/metronapoli-ultimatum-ue-persi-i-fondi-se-lavori-non-finiti-per-marzo-2018/

**Getting in touch with the EU**

**In person**

All over the European Union there are hundreds of Europe Direct information centres. You can find the address of the centre nearest you at: https://europa.eu/european-union/contact_en

**On the phone or by email**

Europe Direct is a service that answers your questions about the European Union. You can contact this service:

– by freephone: 00 800 6 7 8 9 10 11 (certain operators may charge for these calls),

– at the following standard number: +32 22999696 or

– by email via: https://europa.eu/european-union/contact_en

**Finding information about the EU**

**Online**

Information about the European Union in all the official languages of the EU is available on the Europa website at: https://europa.eu/european-union/index_en

**EU publications**

You can download or order free and priced EU publications at: https://publications.europa.eu/en/publications. Multiple copies of free publications may be obtained by contacting Europe Direct or your local information centre (see https://europa.eu/european-union/contact_en).

**EU law and related documents**

For access to legal information from the EU, including all EU law since 1952 in all the official language versions, go to EUR-Lex at: http://eur-lex.europa.eu

**Open data from the EU**

The EU Open Data Portal (http://data.europa.eu/euodp/en) provides access to datasets from the EU. Data can be downloaded and reused for free, for both commercial and non-commercial purposes.

KN-04-20-152-EN-N

Publications Office
of the European Union

ISBN: 978-92-76-17420-2