Spatial effects in the ex-ante evaluation of urban underground transportation infrastructure projects

A study of the gap between the perceived spatial effects of Het Souterrain and the spatial effects incorporated in already conducted CBAs

Abstract: Underground transportation infrastructure projects are a possible solution in the Netherlands to the increasing demand of transportation, limited space and congestion in urban areas and this type of projects is in line with the need for an improvement of the quality of the public urban space. During the ex-ante evaluation of these projects a Cost-Benefit analysis (CBA) must be conducted. The perception is that spatial effects of such projects are not always (properly) included in CBAs, and therefore the CBAs are incomplete. A possibility exists that decisions are taken by decision-makers concerning the construction of such projects on base of incomplete policy information. In this paper the spatial effects of these projects are examined on base of an in-depth case study of Het Souterrain. Furthermore, this paper examines whether the perceived spatial effects of Het Souterrain are incorporated in already conducted CBAs on base of a desk research of 18 CBAs of underground transportation projects (tunnels), infrastructural projects and urban area development projects. Multiple perceived spatial effects are outlined in this paper. The (merged) spatial effect ‘The spatial development of real estate, resulting from private investments in this real estate’ is not (yet properly) incorporated in existing CBAs. Two possible explanations, hereof, are: the unpredictability of private investments in specific real estate, and the difficulty of attributing private investments in specific real estate to an individual urban underground transportation infrastructure project. It is difficult to generalize this spatial effect to other cases. Chances are greater that private investments will be made in adjacent real estate as the result of an urban underground transportation infrastructure project if certain conditions are met.

Keywords: Spatial Effects, Cost-Benefit Analysis, Underground Transportation Infrastructure, Urban Areas, In-depth Single Case Study

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Introduction
Underground transportation infrastructure projects are a possible solution for municipalities to the increasing demand on transportation\(^1\), limited space\(^2\) and congestion\(^3\) in urban areas. In addition, this type of projects is in line with the need for improvement of the quality of the public urban space. During the decision-making process of transportation infrastructure projects the costs and benefits need to be balanced (Pearce & Özdemiroglu, 2002). Nowadays, when a municipality applies for funding\(^4\) with the national government for the

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1 Passenger transport and freight transport have grown enormously the past 30 years in the Netherlands: growth passenger transport ± 30% and growth freight transport 70%-90% (Bogaerts, et al., 2004).
2 Urban areas become more dense, which results in less available space for transport infrastructure (COB, 2016).
3 In 2013, The Hague: travel times are on average + 22% (in comparison with the predicted travel times) due to congestion (TomTom, 2014).
4 A CBA is mandatory in the decision-making process of projects in the Netherlands when the funding by the Dutch government is above 225
construction of a transportation project a Cost-Benefit analysis (CBA) has to be conducted by an independent party (Ministry of Infrastructure and the Environment, 2012). A CBA is a tool which provides insight into the distribution of costs and benefits (of a particular project) to the relevant actors (Eijgenraam, Koopmans, Tang, & Verster, 2000). The CBA provides the decision-makers of transportation infrastructure projects with important policy information (Mouter, Annema, & van Wee, 2013), since it shows whether the benefits outweigh the costs of the project compared to the state of affairs in which no project is built- also called the reference case (van Wee & Rietveld, 2014). The use of the CBA tool in the decision-making process leads to a better (informed) decision-making process (Mouter, Annema, & van Wee, 2013). However, the exact role of a CBA in the decision-making process is not easy to establish, because other factors also play a role when decision-makers have to make a go/no-go decision of a specific project (Rienstra, 2008; Eijgenraam, Koopmans, Tang, & Verster, 2000; Annema, 2014; Mackie, 2010). Key-actors in the Dutch CBA practice were of the opinion that a CBA ought to play a role in the appraisal of spatial-infrastructure projects and that this CBA should be used to support a go/no-go decision in the ex-ante evaluation of spatial-infrastructure projects (Mouter, Annema, & van Wee, 2013). A limitation of CBAs is that not all the (welfare) effects can be (properly) taken into account in a CBA (Mouter, Annema, & van Wee, 2015). CBAs are often incomplete, because project effects are uncertain, unknown and/or difficult to monetize (Mouter, Annema, & van Wee, 2013). Under these conditions, political decisions based on results of a CBA study are based on incomplete information. It is possible that due to this incomplete policy information, transportation infrastructure projects have been implemented which are economic less efficient than alternative transportation infrastructure projects would have been. This could result in cost overruns and disappointing achievements (Flyvbjerg, Bruzelius, & Rothengatter, 2003; Priemus, 2010).

This paper focuses on spatial effects of urban underground transportation infrastructure projects. A potential danger of a CBA for urban transportation infrastructure projects is that spatial effects are not taken into account (properly) and therefore those CBAs are incomplete. In those cases a possibility exists that decisions are made by decision-makers based on incomplete policy information. The goal of this paper is to gain insight into the spatial effects of urban underground transportation projects and the possible incorporation of these spatial effects in the ex-ante evaluation of these projects, so that the policy information during the decision-making process will become more complete enabling politicians to make more information based decisions about such projects.

To determine the spatial effects of urban underground transportation infrastructure projects a case study of Het Souterrain has been conducted. Het Souterrain is a tram tunnel located in The Hague under the Grote Marktstraat/Kalvermarkt (on -2), with a length of 1,250 meters connecting the central railway station of The Hague with the Prinsegracht. Above the tram tunnel (on -1) a parking of 500 places has been built. Het Souterrain is chosen as a case study, because it is a prototype urban underground transportation infrastructure project, ensuring an improvement of the public transport system and an improvement of the quality of the public space (Leijten, 2015). A second reason for choosing Het Souterrain is that the project has been finished several years ago, which increases the feasibility of identifying the spatial effects which resulted from this project. The main research question is:

million euro (for projects in The Hague, Amsterdam and Rotterdam), and is above 112,5 million euro (for projects in the rest of the Netherlands) (Ministry of Infrastructure and the Environment, 2012).
What are the perceived spatial effects of Het Souterrain, are these spatial effects incorporated in already conducted CBAs and why can particular spatial effects not (yet properly) be incorporated in CBAs?

In the next section the research methods and data collection tools, used to answer the research question will be presented and explained.

Methodology

This study is based on multiple research methods: an in-depth single case study and a desk research. The in-depth single case study is conducted using also desk research, expert interviews and an actor analysis.

The perceptions of spatial effects are researched using interviews with experts. Chosen is to study perceptions of spatial effects because a broad exploration of the possible spatial effects of an urban underground transportation infrastructure project is given in this study. There is not much known about spatial effects of urban underground transportation infrastructure projects in the Netherlands. Therefore, a quantitative research is not conducted using surveys, in which in-depth research is done into the realised spatial effects. A selection of eighteen people have been interviewed anonymously in the framework of this study. The respondents were closely involved in the decision-making process of Het Souterrain. One can see in Table 1 an (anonymous) list of respondents.

Table 1: (anonymous) List of respondents

<table>
<thead>
<tr>
<th>Respondent</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respondent 1</td>
<td>Department Traffic at the municipality of The Hague</td>
</tr>
<tr>
<td>Respondent 2</td>
<td>Department Traffic at the municipality of The Hague</td>
</tr>
</tbody>
</table>

The interviews were conducted anonymously, so that all the information from them could be used in this paper. All the respondents gave me permission for that. There is always a chance that a respondent does not want to be quoted if anonymity has not been assured. Moreover, people are more inclined to withhold information when the interviews are not conducted anonymously. Anonymity invites to tell the real story. Some quotes or information provided are put in this paper with name. In those cases, written permission is given by the respondents. All interviews were recorded on tape to ensure that no information would go lost. A disadvantage of recording interviews is that a respondent might be cautious in telling everything he or she knows. Guarantee of anonymity helps to build trust.

Next, in already conducted (existing) CBAs is searched to spatial effects and the way in which these spatial effects are incorporated. A selection of 18 projects have been analysed. A selection of different kinds of projects is made to get the validity of the results of this study as high as possible. CBAs are analysed of underground transportation projects (tunnels), infrastructural projects and urban
Table 2: Analyzed CBAs

<table>
<thead>
<tr>
<th>Names of the projects</th>
<th>Reference to the CBAs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boulevard Scheveningen</td>
<td>(De Nooij, Hof, &amp; Poort, 2007)</td>
</tr>
<tr>
<td>Dublin port tunnel</td>
<td>(Rattigan)</td>
</tr>
<tr>
<td>Tunnel under the N65 at Helvoirt</td>
<td>(The Committee N65 Ondergronds bij Helvoirt)</td>
</tr>
<tr>
<td>Boul Mountain tunnel</td>
<td>(Kocabay &amp; Kopurlu, 2010)</td>
</tr>
<tr>
<td>New West River crossing</td>
<td>(Ecorys, 2012)</td>
</tr>
<tr>
<td>Tunnel investment and tolling alternatives in Antwerp</td>
<td>(Proost, Van der Loo, de Palma, &amp; Lindsey, 2005)</td>
</tr>
<tr>
<td>Road network in the region Arnhem-Nijmegen</td>
<td>(DHV, 2011)</td>
</tr>
<tr>
<td>Western access of Amersfoort</td>
<td>(Wageningen UR; MUConsult, 2012)</td>
</tr>
<tr>
<td>Urbanization variants and public transport projects in Almere</td>
<td>(Zwaneveld, Romijn, Renes, &amp; Geurs, 2009)</td>
</tr>
<tr>
<td>Zuidas in Amsterdam</td>
<td>(Eigenraam, Ossokina, Blodijk, &amp; Groot, 2006)</td>
</tr>
<tr>
<td>Option for Schiphol and the region</td>
<td>(Decisio; bureau Louter; SEO/AAE, 2008)</td>
</tr>
<tr>
<td>Sportcampus in Rotterdam</td>
<td>(Decisio, 2013)</td>
</tr>
<tr>
<td>Provincial arrangements within urban development in the province Utrecht</td>
<td>(Rosenberg, Buys, Buitendijk, &amp; Wever, 2012)</td>
</tr>
<tr>
<td>Inner urban or outside?</td>
<td>(Lubbe, de Boer, Marlet, Koopmans, &amp; Willebrands, 2011)</td>
</tr>
<tr>
<td>Urban renovation</td>
<td>(den Breejen, et al., 2006)</td>
</tr>
<tr>
<td>Building successfully in the city</td>
<td>(van Hoek, Koning, &amp; Mulder, 2011)</td>
</tr>
<tr>
<td>Area development Atalanta</td>
<td>(Briene, Hamdi, &amp; Verheijen, 2011)</td>
</tr>
<tr>
<td>Benefits of rerouting railways to tunnels in urban areas: a case study of the Yongsan line in Seoul</td>
<td>(Chang, Han, Jung, &amp; Kim, 2014)</td>
</tr>
</tbody>
</table>

In the next section the results of the research are described.

Results

This section deals with the results of the study and consists of: Theoretical framework spatial effects, Role of knowledge and professional analysis, Role of spatial arguments, Perceived spatial effects of Het Souterrain, Spatial effects in already conducted CBAs, Gap between the perceived spatial effects of Het Souterrain and the spatial effects of the existing CBAs, Explanation why particular spatial effects are not (yet properly) incorporated in CBAs, and Generalization to other cases.

Theoretical framework spatial effects

In this study spatial effects are defined\(^7\) as: Effects on the representation/embodiment/manifestation of the social functions (living, working, recreation and nature) in an urban area (residential areas, working places, areas reserved for leisure) as a result of underground transportation infrastructure. Examples of spatial effects are: an improvement of the public space, no horizontal pollution, and an improved living environment.

Five types of spatial effects can be categorized\(^8\):

- **Use of space (during construction)**\(^9\): Underground transportation infrastructure projects can be constructed by the wall-roof method and can be constructed by the drilling method. With the wall-roof method the use of space during construction is only temporally at the start of the construction. With this method first the walls are built and later the roof is built on the walls. After this has been done the ground will be restored and the construction on the ground starts. Space still will be used on the ground (during the construction), but only at the beginning and the end of the tunnel and possible intermediate stations. With the drilling method the total construction is underground. Space still will be used on the ground (during the construction) at the beginning and the end of the tunnel and possible intermediate stations.

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\(^{6}\) This paper is not a conducted CBA, but it is an analysis of the benefits of the case the Yongsan line in Seoul.

\(^{7}\) The definition of a spatial effect is based on the definition Oude Ophuis et al. (1999) gives.

\(^{8}\) The categories are based on the types of spatial effects of Oude Ophuis et al. (1999).

\(^{9}\) Note that space on the ground will be used for underground projects at the beginning and the end of the tunnel and possible intermediate stations.
• Construction nuisance: In the area where infrastructure is constructed negative external effects will occur, like noise and vibrations, visual pollution, degradation of amenities and barrier effects. These nuisance aspects will deteriorate the functionality of the space. When underground transportation infrastructure is constructed by the wall-roof method, construction nuisance will occur at the beginning of the construction. When the roof has been placed on the walls the construction on the ground is ready. This ensures that the construction nuisance disappears.

• (Re)development of area: In the phase when the infrastructure is in use, the space that will be available after the construction of the infrastructure can be (re)designed and (re)developed. The (re)development of an area will be determined by two factors: the construction method and the typology of the urban area. When underground transportation infrastructure is constructed by the wall-roof method the total space above ground can be (re)developed after the roof is placed. When underground transportation infrastructure is constructed by the drilling method no construction takes place on the ground and therefore during the total construction time the space on the ground can be (re)developed. The typology of the urban area provides information about the potential of the urban area.

• Elimination of nuisance by the use of infrastructure: When above ground infrastructure is brought underground (like Het Souterrain), the nuisance as a result of the presence and use of the infrastructure (visual and noise pollution) are eliminated. The quality of the area will be improved and the value of the area will be increased.

• Removal of intersections: When above ground infrastructure is brought underground (like Het Souterrain), intersections on the ground disappear. The quality of the area will be improved and the value of the area will be increased.

In the next section the role of knowledge and professional analysis during the decision-making process of Het Souterrain is explained.

Role of knowledge and professional analysis
Respondent 10 mentioned that a quick scan CBA was made of Het Souterrain. For this quick scan CBA, costs and benefits were entered in a software programme. According to multiple respondents (2, 9, 10, 13) the role of knowledge and professional analysis in the decision-making process of Het Souterrain was that information that was in favour of the tram tunnel has been used as ammunition by the municipality of The Hague for the support of the tram tunnel and information that was not in favour of the tram tunnel has been ignored by the municipality of The Hague. Knowledge thus was not used fully independently.

In the next section the role of spatial arguments in the decision-making process of Het Souterrain is treated.

Role of spatial arguments
According to multiple respondents (2, 3, 4, 5, 6, 7, 8, 11, 12, 14) multiple spatial arguments have been used during the decision-making process of Het Souterrain by the municipality of The Hague to support the go-decision of Het Souterrain. According to respondent 10 the expected spatial effects, which were used as spatial arguments, had not been calculated in the quick scan CBA or via other policy analysis tools, but they played a qualitative role.

10 Unfortunately, the quick scan CBA is not available anymore.
role in the decision making process of Het Souterrain. According to respondent 10, the transportation arguments were not sufficient enough for the go-decision. Spatial arguments were needed to support the realization of Het Souterrain.

According to respondent 7 and 8 spatial arguments were especially important in the beginning of the decision-making process to get Het Souterrain on the political agenda of the municipality of The Hague. According to respondent 8 and 10 later in the decision-making process transportation arguments became more important. This was because obtaining the funds from the Ministry of Transport, Public Works and Water Management was mainly based on transportation arguments supported with calculations. According to multiple respondents (2, 8, 10 and 13) and policy documents (municipality of The Hague, 1991; municipality of The Hague, 1993) the main argument was a transportation argument: the traffic problem on the crossing Grote Marktstraat/Spui should be solved and there should be a faster flow of trams in the Centre of The Hague. Though, spatial arguments have played some role in the obtainment of the funding and according to respondent 10 without these spatial arguments the funds would not have been allocated.

In the next section follow the perceived spatial effects of Het Souterrain.

Perceived spatial effects of Het Souterrain

According to the respondents of this study the perceived spatial effects of Het Souterrain are:

- An improved quality of the public space has been realized in the centre of The Hague.
- Private investments have been made possible, improving the adjacent real estate of shops, offices and residential houses.
- Het Souterrain has given an impulse for the chain stores located in the Grote Marktstraat for improvement and (re)development of their real estate.
- The shop and residential climate have got an impulse. An increased attractiveness of housing, offices and cultural facilities has been realized.
- The nightlife of the centre of The Hague has been boosted.
- Many small businesses have moved or have gone bankrupt due to the prolonged construction and poor accessibility.

The perceived spatial effects of Het Souterrain can be classified in the types of spatial effects determined earlier. The perceived spatial effect ‘Many small businesses have moved or have gone bankrupt due to the prolonged construction and poor accessibility’ belong to the category ‘Construction nuisance’. The perceived spatial effect ‘A tram-free environment in the Grote Marktstraat has been realized, which is good for cyclists and pedestrians.’ belong to the category ‘Elimination of nuisance by the use of infrastructure. The other perceived spatial effects belong to the category ‘(Re)development of area’. The perceived spatial effects ‘An enhanced, more attractive and safer living environment have been realized’ and ‘An improved quality of the public space has been realized in the centre of The Hague’ could also belong to the category ‘Removal of intersections’.

In the next section follow the spatial effects in already conducted CBAs.
**Spatial effect in already conducted CBAs**
The following spatial effects can be derived from already conducted CBAs:

- An increase in value of houses/An increase of quality of houses
- An increase in value of offices/An increase of quality of offices
- An increase of amenity value and recreational value
- Effects for the flora and fauna
- Value of lost view
- An increase of spatial/urban quality—An increased attractiveness of the centre
- An improvement of the open (green) public space
- Nuisances during construction
- Land revenues
- Real estate revenues/Positive real estate market effects
- Allocation of land for different functions
- Positive living ability effects

Almost all the spatial effects in already conducted CBAs could be classified as an ‘Elimination of nuisance by the use of infrastructure’, ‘Removal of intersections’ and as ‘(Re)development of area’. The exception is that the spatial effect ‘Value of lost view’ should be categorized as ‘Use of space’.

Many of the spatial effects in already conducted CBAs are monetized as an increase of the price of adjacent houses, offices, shops and other real estate. The increase of the real estate price depends on the distance between the project and the real estate object. A valuation method that also uses increases of real estate (houses) is the hedonic price analysis\(^\text{11}\). Other valuation methods which could be used to determine the value of the effects are: willingness to pay, expenditures of visitors, experience benefits, contingent valuation method, travel costs method, landscape costs, recess of costs in other policy of spatial planning, annual operating costs, annual accident costs, excess travel time, costs of construction and maintenance, annoyance costs, health costs, compensation for losses and the leefbaarometer. These valuation methods are mainly based on the appreciation/valuation/expenditure of people and the fluctuation of certain costs.

An important condition when monetizing a certain effect is that double counting should be avoided. With double counting is meant that the effects may not be counted more than once in the CBA. To prevent double counting the project effects should be categorized in three categories: direct effects, indirect effects and external effects. Certain indirect effects are already included in the direct effect. These indirect effects should not be included in a CBA to prevent double counting (Faber & Mulders, 2012).

In the next section the gap between the perceived spatial effects of Het Souterrain and spatial effects in already conducted CBAs is determined.

**Gap between the perceived spatial effects of Het Souterrain and the spatial effects of the existing CBAs**
The specific perceived spatial effects of Het Souterrain are difficult to unravel in a CBA. Four spatial effects fall (in full) under a spatial effect incorporated in already conducted CBAs. Many of the perceived spatial effects of Het Souterrain are aggregated effects. These effects may therefore fall (fragmentary) under multiple spatial effects as incorporated in already conducted CBAs. The majority of the perceived spatial effects of Het Souterrain are incorporated in already conducted CBAs, often with a different name or in (an)other spatial effect(s). Two perceived spatial effects do not (yet properly) match with the spatial effects incorporated in already conducted CBAs:

\(^{11}\) Hedonic price analysis is used to monetize ecosystems/environmental services on base of housing prices that reflect the value of local environmental attributes (King & Mazotta, 2017).
• Private investments have been made possible, improving the quality of the shops, offices and residential houses.
• Het Souterrain has given an impulse for the chain stores located in the Grote Marktstraat for improvement and (re)development of their real estate.

These two effects are quite similar to each other, and can therefore be taken together. The (merged) spatial effect becomes: 'The spatial development of real estate, resulting from private investments in this real estate'.

Note that the real estate should be in the vicinity of the urban underground transportation infrastructure project. In addition, a condition for this spatial effect is that the urban underground transportation infrastructure project has led to an improved urban public space. This spatial effect is not (yet properly) incorporated in existing CBAs, but according to multiple respondents (3, 4, 5, 6, 7, 8, 11, 12, 14, 15, 16, 17 and 18) it is an important perceived spatial effect of Het Souterrain.

The question can be asked whether this spatial effect actually is a welfare effect for the Netherlands and therefore should be included in the CBA. Effects which do not have an impact on the total economy of a country are called redistributive effects, because these effects ensure an improvement of the economy on the one place and a decline of the economy on the other place. This is the reason that redistributive effects are not taken into account in CBAs (Faber & Mulders, 2012). The (merged) spatial effect might by a redistributive effect, if private investors will invest elsewhere in the Netherlands when they do not invest in real estate on the Grote Marktstraat. Property developers (15, 17 and 18) mentioned that if a Property developer does not invest in the (re)development of a particular real estate, this does not (per se) mean that this Property developer will always invest in other real estate. For each real estate, separately trade-offs are made. So, this

In the next section the problems are determined, which may explain why the (merged) spatial effect is not (yet properly) incorporated in CBAs.

Explanation why particular spatial effects are not (yet properly) incorporated in CBAs
The CBA is a well-known and well-developed policy analysis tool in the Netherlands. If some spatial effects are not (yet properly) incorporated in existing CBAs it is highly likely that this is the result of issues that are difficult to overcome. Two possible problems, which may explain why the (merged) spatial effect is not (yet properly) incorporated in CBAs, are:

• The unpredictability of private investments in specific real estate.
• The difficulty of attributing private investments in specific real estate to an individual urban underground transportation infrastructure project.

The unpredictability of private investments in certain real estate
According to many respondents (3, 4, 5, 9, 12, 14, 16, 17 and 18) it is difficult to predict in advance with close certainty if and in what extent private investments in real estate will happen as a result of an urban underground transportation infrastructure project. There are multiple unforeseen circumstances (external effects and social developments) that may lead to different outcomes. However, when a few conditions are met by a municipality, the chance is higher according to multiple Property developers (15, 17 and 18) that private investors will invest in high degree in real estate. These conditions are:

• A high quality urban public space should be created, which results in the belief and the securing of trust in a certain location among Property developers.
• There should be a good co-operation relation between the municipality and the Property developers.
• There should be a long-term vision of the municipality which result in a secure investing climate for Property developers.
• The vision of a municipality should be carried out.

The difficulty of attributing private investments in certain real estate to an individual project

According to multiple respondents (9, 12, 16 and 18) it is difficult to attribute private investment in real estate entirely to an individual urban underground transportation infrastructure project. Other projects and spatial interventions may have an influence on the spatial development of an urban area. In addition, also unforeseen circumstances (external effects and social developments) can have an influence on the (spatial) outcome of an urban underground transportation infrastructure project. The (extent of) private investments in adjacent real estate are one of the possible (spatial) outcomes of such projects.

It is difficult to include the spatial effect ‘The spatial development of real estate, resulting from private investments in this real estate’ in CBAs, due to the two problems mentioned above.

It is important to know in what extent the results of this research can be generalized to other cases and which lessons we can learned from this study. Therefore, in the next section the generalization of the results of this research to other cases is discussed.

Generalization to other cases

Flyvbjerg (2006) states that one can often generalize results from a single case and that a case study can contribute to scientific developments. A carefully and strategically chosen case may add substantially to its generalizability. As has been described before, Het Souterrain is a typical and general underground transportation project because it has improved the public transportation and the quality of the public space; that is why some important lessons can be of use for other urban underground transportation infrastructure projects. Yin (2000) states that one can generalize from case study to theory when the method of generalization is analytic generalization. Analytic generalization includes that a previously developed theory should be used as a template for comparison of the empirical results of the case study. The theory to use when analyzing urban underground infrastructure projects is that the effects that are the result of such a project should be included in an ex-ante CBA of a similar project. When the finding of a case study is that a particular effect is the result of a certain project, the conditions have to be established under which this effect also is the result of another project. Kennedy (1979) states that someone who conducts a single case study should produce and share the findings of the case and that the receivers of these findings have to determine whether these are applicable to their own situation. Someone who conducts a single case study has to be very specific about the description of the attributes of the case.

What can be concluded from Flyvbjerg, Yin and Kennedy is that it is possible to generalize from a single case study and generate from that some important lessons. For each new case it has to be assessed whether these lessons are applicable in other cases. If a new case has the same characteristics as the single case study and the same conditions are present here, it is a fair chance that the lessons of the case study are applicable to this case.

It is difficult to generalize the spatial effect ‘The spatial development of real estate, resulting from private investments in this real estate’ to other urban underground transportation infrastructure projects. Multiple factors influence whether a Property
developer will invest in real estate as a result of an urban underground transportation infrastructure project. It can be ruled out that private investments always will occur as a result of urban underground transportation infrastructure projects. It is more plausible to state that chances are greater that private investments will be made in adjacent real estate as the result of an urban underground transportation infrastructure project if certain conditions are met. These conditions are:

- Real estate has to be present in the vicinity of the underground transportation infrastructure project. If real estate is not present in the vicinity of an underground transportation infrastructure project, it will not be possible at all for the Property developers to invest in this real estate.
- The underground transportation infrastructure project is built in a densely built-up area with economic potential. There has to be potential to build real estate in the area. This potential for example increases if an urban area is crowded with shopping public, if it is nice to live in this area, if the business climate is good, and when crime rates are low.
- The economy of a city/country should be healthy. The Property developers must have enough financial potential, making private investments possible from an economic point of view. In addition, Property developers have to make a return on the investments. When the economy is not thriving, it is more difficult for the Property developers to collect sufficient revenues from the real estate.
- The underground transportation infrastructure project has to lead to a spatial development of the area.
- There should be a good cooperative relation between the Property developers and the municipality.
- The municipality should have a clear persistent long-term vision/ambition based on the consistency of policies. The vision of the municipality should have a connection with the vision of the Property developers. It is important that this vision will be carried out by the municipality and the does not stay a plan. This leads to a secure environment to invest for Property developers.

In the next sections follow the conclusion of the study.

**Conclusion**

The following research question was key for this paper: *What are the perceived spatial effects of Het Souterrain, are these spatial effect incorporated in already conducted CBAs and why can particular spatial effects not (yet properly) be incorporated in CBAs?*

The perceived spatial effects of Het Souterrain are:

- A tram-free environment in the Grote Marktstraat has been realized, which is good for cyclists and pedestrians.
- The centre of The Hague has received an impulse and has got new, lively and vibrant.
- An enhanced, more attractive and safer (living) environment have been realized.
- Het Souterrain has given an impulse for the chain stores located in the Grote Marktstraat for improvement and (re)development of their real estate.
- An increased attractiveness of housing, offices and cultural facilities has been realized.
• The nightlife of the centre of The Hague has been boosted.
• Many small businesses have moved or have gone bankrupt due to the prolonged construction and poor accessibility.

There is a gap between the perceived spatial effects of Het Souterrain and the spatial effects in existing CBAs. Two perceived spatial effects do not (yet properly) match with the spatial effects incorporated in already conducted CBAs:

• Private investments have been made possible, improving the quality of the shops, offices and residential houses.
• Het Souterrain has given an impulse for the chain stores located in the Grote Marktstraat for improvement and (re)development of their real estate.

These two effects are quite similar to each other, and can therefore be taken together. The (merged) spatial effect becomes: 'The spatial development of real estate, resulting from private investments in this real estate'.

It is difficult to generalize this (merged) spatial effect to other urban underground transportation infrastructure projects. It can be concluded that the chance is bigger that private investments will be done in adjacent real estate as the result of a certain urban underground transportation infrastructure projects if certain conditions are met.

In the next sections follow the discussion of the research.

Discussion
The discussion consists of a substantive discussion and of drawbacks of the research methods.

Substantive discussion
A spatial effect can be included in an ex-ante CBA of an urban underground transportation infrastructure project, if this spatial effect has a high degree of certainty, can be predicted, and if there is a causal relation between the spatial effect and the development of an urban underground transportation infrastructure project. Spatial effects are difficult to monetize. According to Mouter et al. (2015) project effects which are difficult to monetize do not get as much attention in CBAs as project effects which are easy to monetize. It is not necessarily a problem that spatial effects cannot be incorporated in CBAs, when these effects are considered by the decision-makers via other ways. In addition, this paper has stated that spatial arguments of the municipality of The Hague had a more qualitative role in the argumentation of the municipality of The Hague. According to respondent 10, Het Souterrain would not have got a go-decision without these qualitative spatial arguments.

In this section a way is discussed to incorporate spatial effects that are not yet included in existing CBAs. In this paper we arrived at the conclusion that the following spatial effect has not (yet properly) been incorporated in already conducted CBAs: 'The spatial development of real estate, resulting from private investments in this real estate'. The focus of the discussion thus will be on this spatial effect.

My recommendation is to make for a particular urban underground transportation infrastructure project an ex-ante evaluation of this spatial effect on basis of a scenario analysis, taking into account the unpredictability of private investments in specific real estate and the difficulty of attributing private investments to an individual urban underground transportation infrastructure project. Several scenarios are made in a scenario analysis. A scenario is a rich and detailed portrait of a plausible future world (Moniz, 2006). It is a plausible description of what might occur. A scenario is a policy analysis tool describing a possible set of future conditions. So, the essence of a scenario analysis is to obtain different future images. A way to incorporate the private investments in particular real estate resulting
from an urban underground transportation infrastructure and to take into account the unpredictability and the complexity of the attribution of this spatial effect to an individual project is to make scenarios for this spatial effect. At least two scenarios should be made: a best-case scenario and a worst-case scenario. In the best-case scenario the spatial effect is maximally included and in the worst-case scenario the spatial effect is not included at all. It is possible to determine the bandwidth of the project results by calculating a best-case scenario and a worst-case scenario.

For each scenario a separate CBA should be made. The spatial effect could be incorporated qualitatively in the CBA. In the best-case scenario the effect should get a ++ or a +, and in the worst-case scenario the effect should get a 0. The worst-case scenario does not need to be monetized because the effect is 0 (euro). From a study of Mouter et al. (2015) follows that effects which are difficult to monetize have a relatively weak position in the CBA compared with effects which are easy to monetize. So, the best-case scenario better should be monetized.

In paper different valuation methods have been mentioned which could be used to monetize spatial effects. Unfortunately, none of the possible valuation methods could be used to monetize the spatial development of real estate, resulting from private investments in this real estate. My preferred method, to get an indication of the economic value of (potential) private investments in real estate, would be to interview existing and potential Property developers. During the interview the following question should be asked: How will the real estate develop when particular spatial developments are done by the municipality and what would be the increase of value of the real estate? It will be difficult to monetize this spatial effect. The possibility exists that Property developers will lie about their future intentions to get a project realized. It is also possible that a Property developer does not know yet if and how much will be invested in real estate when a spatial development is realized by the municipality. The decision-making process of Het Souterrain has shown that spatial arguments have played a qualitative role and that without these spatial arguments Het Souterrain would not have received a go-decision. So, if it is difficult to monetize this spatial effect, this effect should be incorporated qualitatively in the scenario analysis and in the CBA.

Decision-makers are enabled to make a more informed political decision concerning an urban underground transportation infrastructure project when analysts provide them with the two kinds of scenarios and CBAs.

In the next section follow the drawbacks of the research methods.

**Drawbacks of the research methods**

There are a few drawbacks of the research methods discussed in this paper. First, an in-depth single case study is conducted; while with a multiple-case study more possible spatial effects could be identified. Second, it is difficult to determine to what extent the results are generalizable to other projects. Besides that, when a quantitative method had been used for this thesis, realized spatial effects could have been determined and measured: this thesis only gives perceptions of perceived spatial effects. In response to the first two drawbacks I wish to state that the value of this thesis is that it gives an interesting first exploration of the possible spatial effects of Het Souterrain and that important lessons can be learned based on this in-depth case study. It is too much work for a Master thesis to study multiple cases and therefore an in-depth case study is carried out to learn very specific for one case.

Third, the main subject of study is the CBA. It is unfortunate that not an extended CBA was conducted during the decision-making process of Het Souterrain. Should an extended CBA be conducted, we would know the role of the
spatial effects in this policy analysis tool. Note that (this information follows from respondent 10) a quick scan CBA had been made of Het Souterrain and in this CBA the spatial effects were not incorporated. In response to the third drawback it can be said that the respondents have been asked if and how the spatial effects would be incorporated in the CBA if an extended CBA had been made. From the interviews we know what the role of spatial effects would have been in a CBA if an extended CBA had been made.

Fourth, it might be that information provided by the respondents has been biased, subjective, not true or not relevant. Fifth, it is possible that an interview bias exists for some answers to questions that have been posed in order to verify assessments given by someone else. With interview bias is meant that an answer of a respondent can be influenced by the way the interviewer asks the question (Mouter, 2014). In order to keep the fourth and fifth drawback as small as possible, to multiple respondents the same questions were asked and the respondents were asked whether they agreed to certain assessments of another respondent in order to verify the validity of assessments.

In the next section the recommendation for further research are described.

**Recommendations for further research**

This study is based on an in-depth single case study. It is therefore difficult to determine to what extent the results can be generalised to other projects. But some important lessons can be learned from this study. With multiple cases, more spatial effects could be identified and the role of spatial effects could be analysed in different decision-making processes. In addition, multiple cases will give more information about conditions that should be met under which there are bigger chances that particular spatial effects are the result of a particular urban underground transportation infrastructure project. The first recommendation for further research is to study multiple underground transportation projects in urban areas, to find the perceived spatial effects and their role in the decision-making process of the projects and to find the conditions under which the spatial effects are realized. On basis of multiple cases more specific statements could be made.

The second recommendation for further research is to study the perceived spatial effects of the multiple cases with a quantitative method to determine if the perceived spatial effects have been realized.

Multiple valuation methods of spatial effects have been discussed in this thesis. What is fundamentally missing in this study is that the valuation methods were not tested for the spatial effects that arise from underground transportation infrastructure projects. The third recommendation for further research is to monetize the spatial effects of urban underground transportation infrastructure projects on basis of the valuation methods mentioned in this thesis.

In the substantive discussion of this paper a way to incorporate ‘The spatial development of real estate, resulting from private investments in this real estate’ in a CBA has been described. The question remains whether this will work. Testing this method would provide an answer. The fourth recommendation for further research is to make two CBAs based on a best-case scenarios and a worst-case scenario for a particular urban underground transportation infrastructure project. The results of this analysis should be given to political decision-makers. These politicians should answer the following question: Has the result of the analysis led to more complete policy information and can a more informed political decision concerning this case be made?

In the substantive discussion of this paper two problems with the recommended monetization method have been mentioned. The first is: the possibility exists that Property developers will not tell the (whole) truth.
about their intentions to get a particular project realized. The second is: it is possible that a Property developer does not yet know whether and how much will be invested in real estate after the municipality has realized a spatial development of a particular area. The fifth recommendation for further research is to determine ex-post which investments have been made and how much has been invested in real estate as a result of the (re)development of an area. The data given by the Property developers concerning their future investments should be compared with the results of the recommended research. The two problems mentioned in this section could due to the recommended research kept as small as possible.

List of references


The Committee N65 Ondergronds bij Helvoirt. (n.d.). *Maatschappelijke baten aanleg van een tunnel bij de N65 door HELVOIRT.*


