Navigating mega projects through complexity and uncertainty: strategic and adaptive capacity in planning and decision-making

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4. Keeping it Simple? A Case Study into the Advantages and Disadvantages of Reducing Complexity in Mega Project Planning

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Introduction

Sometimes things are not as simple as they seem, but sometimes they are not as complex as they seem, either. The same is true of mega infrastructure projects. Not all of these are necessarily of the same complexity. Especially line infrastructure projects, such as rail and highways, start with a single primary function (connecting several places) but can become very complex over time. They have to deal with a frequently changing context of different interests, purposes, constraints and ambitions. It has been a natural inclination in academic works to have a negative view of large infrastructure projects. They cost too much; they take too long to complete; they do not deliver on promises of patronage. As Flyvbjerg et al. (Flyvbjerg, 2007; Flyvbjerg et al. , 2002, 2004) show, the large majority of large transport projects do indeed show these symptoms. However, not all mega projects are planning disasters and this paper looks at a project that was successful in keeping budget and schedule in order to see what its 'secret' is. Although project success has many potential definitions (e.g. patronage, economic spin-off, public appreciation), most mega project literature focuses on time and cost aspects for project successfulness (Shenhar et al., 2001). As this literature is the basis of the exploration of the case, we will keep success limited to cost and time management aspects. The analysis in this case also does not extend to the time after delivery, thus an analysis on other success factors, such as patronage, is beyond the scope of this article.

The metro project Beneluxlijn in Rotterdam, The Netherlands, was finished nearly on time and with budget to spare. It is one of the most expensive infrastructure projects finished in the Netherlands in the last decades, and therefore can be considered a mega infrastructure project. Patronage was not taken into account during the appraisal period, making it difficult to evaluate the project on that basis. What is interesting is that this is also one of the largest projects, in total cost, which was finished in the first decade of this millennium. At first sight it seems the project success can be found in it being kept simple in process, and project scope and management. However, was this indeed key to its success and did it come at a cost?

Keeping it Simple Stupid, or the KISS principle, (Terano 2008) is a common expression (albeit with slight variations) in project management and ICT. It is a design standard that aims to keep the used techniques, originally in aerospace engineering, as uncomplicated as possible (simple) and as easy as possible to understand and repair (stupid). Keeping it simple is, more formally put, the reduction of complexity. The reason for doing so is that with the reduction of complexity comes a reduction of uncertainty as complexity is often defined in relation to uncertainty (Bosch-Rekveldt et al., 2011; Antoniadis et al., 2011). For instance, after a literature review, Vidal et al. (2011: 719) state: "project complexity is the property of a project which makes it difficult to understand, foresee and keep under control its overall behavior, even when given reasonably complete information about the project system." The reduction of complexity means that there are fewer unknowns and fewer variables to predict, and thus the project and planning of the project arguably becomes more manageable. However, as we know from our own academic writing, simplicity is good but it often comes at the cost of richness. We feel we cannot describe the full richness of our case or data because we are limited by words and structures. The same is true for planning and decision-making processes on mega projects. The more we try to close the process and reduce the scope of the project, the less influences we get from outside and the less feedback about alternatives and uncertainties is brought into the process (Deutsch, 1966; Innes & Booher, 2010). The 'tunneling' of decision-making lessens the strategic potential of cross-pollination between different trajectories and streams of policymaking (Marchau et al., 2010; Priemus, 2007; Swyngedouw et al., 2002). Two questions are thus raised. First, what are the advantages and disadvantages of reducing complexity by simplification? And second, can we say something about the type of projects that are more appropriate for either side of the complexity dimension?

This article starts with an overview of the factors behind the cost and time overruns in mega projects as identified in the literature. It relates them to issues of complexity and uncertainty because overruns are the manifestation of problems associated with these issues in this type of project. In the following section the research design is discussed. The subsequent section presents the case and the analysis of the mechanisms leading to its successful management of time and cost. The concluding section discusses the opportunities and threats of the approach identified, and considers the findings in the light of existing literature.

Mega Projects on a Budget

It is analytically attractive to treat political decision-making and project management as separate fields of analysis, as it enables a researcher to separate the political aspects from the engineering side. In practice however these fields are strongly related. Mega projects remain under political scrutiny well after the official final decision is made. Decisions made early on can have disastrous effects when abstract political ambitions crystalize in specific technical challenges. The literature review will therefore deal with literature from mega project research, decision-making and project management. I will use a backtracking approach moving from effects (cost and time overruns), through identified causes, to finally link them to the strategies for dealing with uncertainty and complexity.

Mega projects take a special position in public policy. They require large amounts of financing and staffing, and are often part of very politically charged processes. As Flyvbjerg et al. (2003) and Altshuler and Luberoff (2003) indicate mega projects have a bad track record in keeping to budget and time schedules. Cost escalations happen in almost nine out of ten projects with a cost increase of 28 per cent on average (Flyvbjerg et al., 2003). In recent decades the cost of mega projects worldwide has increased dramatically despite technological improvements in building and management techniques (Altshuler & Luberoff, 2003). Although there are no articles addressing comparative analysis of time delays in large projects, there is a strong relation between delays and cost overruns. For instance, the delays in the Channel Tunnel increased the construction cost by about $1 million a day (Flyvbjerg et al., 2004). There seem to be several phenomena contributing to the overruns affecting mega projects.

Cost and time overruns are a mismatch between the estimation and the practical result. It therefore makes sense to first look at the accuracy of cost and time estimations. To be sure, there is a great uncertainty in estimations related to mega projects (Bruzelius et al., 2002). However, Flyvbjerg argues that uncertainty cannot be the only reason and that there is often a tendency of 'optimism bias' or 'strategic misrepresentation' (Flyvbjerg, 2008). Optimism bias relates to the fact that people are naturally inclined to estimate things more positively than one could objectively derive from practice. We hope that this time things will go right and thus are pre-disposed to neglect the elements that can go wrong. By contrast, strategic misrepresentation means deliberately under-estimating cost and time for political and strategic reasons. The rationale here is that if you were to show the real cost, the project would never be built; however, once you start building infrastructure it is difficult to stop even if the costs are far higher than previously expected. Thus it can be strategically beneficial to keep the estimates deliberately low. Flyvbjerg (Flyvbjerg, 2008) concludes that these two are the most prominent variables in explaining the inaccuracy of estimations and forecasts. The contested nature of information makes it attractive for different actors to present their information strategically (De Bruijn & Leijten, 2007). However, Osland & Strand disagree with the findings of Flyvbjerg and argue that his empirical data is not sufficient to support his argument of strategic misrepresentation and argue that he is guilty of applying the logic of suspicion. "For Flyvbjerg and other proponents for the hermeneutics of suspicion, the actors actually admitting telling lies can be seen as the "tip of the iceberg". However, it is also a perspective that would not be falsified if no examples of actors admitting lying were found. On the contrary, it could easily be interpreted as a verification that they were lying also for the researchers" (Osland & Strand, 2010: 81). They argue that Flyvbjerg does not use the correct data to support his conclusions and that the projects selected for his research have been based on a whole set of institutional factors, rationalities and political support. However, they do not develop a clear hypothesis about under what circumstances selection leads to the best, lesser or worst project. They also do not convincingly disprove the fact that misrepresentation plays an important role in cost and time overruns.

Somewhat related to the optimism bias is the attraction of the 'technological sublime' – a fixation for the latest technology (Trapenberg-Frick, 2008). Drawn to new technology, aesthetics and other novelties, politicians and engineers favor projects and solutions that bring more uncertainty or more cost. Mega projects are generally great symbols of modern engineering and for politicians an important political legacy. Therefore they would like it to be something special, something that has not been done before: the tallest building, the longest bridge, or the first drilled tunnel in wet soil. For instance, in an analysis of a large European infrastructure project, The Environ Megaproject, Van Marrewijk et al. conclude that the discourse in the decision-making phase was "dominated by stories of the uniqueness of the project, its innovative concept and its creative process management" (Van Marrewijk et al., 2008). The focus on the project's exclusiveness is very attractive in mega project planning.

Another important factor at the decision-making/political side of mega project planning is 'scope creep' or 'scope change'. Mega project development has entered the do-no-harm era (Altshuler et al., 2003) in which mitigation of effects has become very important to decision-making. Mega projects often impact on many interests and many territories and those stakeholders often have particular demands in order for them to accept the plan: lands need to be bought; zoning plans remade; and local politicians co-opted. All these stakeholders will want something in return for their cooperation. The accumulation of changes to the scope is called scope creep. Projects tend to expand as they move from inception through design to development (Shane et al., 2009). Shane et al. take the Holland Tunnel as an example. This tunnel at its inception (1919) was estimated to cost $12 million (US). However, one year later an additional analysis showed that it would actually cost about $28.6 million, and the decision was made to construct the tunnel. Eventually, when finished seven years later, the tunnel had cost $48.4 million of which about $15 million could be attributed to functional and aesthetic factors (Shane et al., 2009). An important factor in scope creep is political volatility. During the process, different politicians in influential positions will have shifting demands. Thus the political and social playing field is very important in this respect.

In the latter phases of mega project planning, project management takes an increasingly prominent place: the mega project is conceived as an engineering task. In engineering-based planning, uncertainty is reduced by cutting things into pieces (Dryzek, 1987; Faludi, 1996). A phase model is often developed with sequential steps that need to be followed in a linear form. Project management theories generally still work in the same tradition. Often developed to reduce complexity, or to keep things manageable, they have the inclination to chop problems up into their parts. Uncertainty from a project management view is strongly related to risk. "In the most general terms, risk is the possibility that events, the resulting impacts, the associated actions, and the dynamic interactions among the three may turn out differently than anticipated" (Miller & Lessard, 2001: 76). The difference between risk and uncertainty is that the potential outcomes are known and thus can be statistically determined (Ward & Chapman, 2003). Uncertainty also includes situations in which the potential outcomes are also unknown. Uncertainty is, in this view, the antonym to planning; it is the possible failure to control the consequences of our actions. Koppenjan et al. call the engineering project management approach a 'predict-and-control' perspective (Koppenjan et al., 2010). Project management of this type was developed in the 1950s and later it was supplemented with risk management. Risks are dealt with by introducing contingency (slack or time-cost) buffers, calculated by probability multiplied with impact. Risks are thus quantifiable, as opposed to uncertainty (Perminova et al., 2008). In many instances uncertainties, are treated in a similar way, effectively ignoring the problem of irreducible uncertainty. Yet, pre-calculated slack or buffers cannot cover some uncertainties. Van der Heijden (Van der Heijden, 1996) identifies three types of uncertainties. The first form is risk, which involves an uncertainty about the outcomes, but where there is sufficient knowledge to make a probability estimate. The second type is a structural uncertainty, where future events are conceivable of happening, but there is not enough knowledge to say something about the likelihood of it happening. The third form is the unknowable. These are the events we cannot even conceive of happening. Project management of mega projects as a predict-and-control only takes into consideration the first type of uncertainty.

An alternative approach in project management is prepare-and-commit (Koppenjan et al., 2010) in which uncertainty is accepted as a given. It takes all types of uncertainty into consideration. Contractors and providers are committed to certain functional outcomes but accept the fact that changes will come and that they could even be very useful. In decision-making and planning, this approach is in line with complexity theory (Byrne, 2005) and evolutionary perspectives (Bertolini, 2007; Boschma & Lambooy, 1999; Nelson & Winter, 2006) as both take into consideration the uncontrollable variables of our society. The decision-making and management of the project needs to remain flexible (Olsson et al., 2006) in order to deal with the uncertainty in project development. One has to be mindful (Sutcliffe, 2006) in redefining ambitions, reworking goals and reorganizing if the situation calls for it. In practice it seems both management types are applied in mixed form as project managers work between limitations and opportunities that are not always theirs to choose. Decisions made earlier by politicians and other stakeholders often have a great influence on the project management range of options (Koppenjan et al., 2010).

A further point made in the literature is that problems that arise during project management are often the result of the preceding decision-making process (e.g. Leijten et al., 2010). In particular, decisions to use a particular technology or time scheme can put great pressure on project management. Opting to use uncertain technologies will effectively negate the benefits of solutions of cost overrun of mega projects such as reference class forecasting (Flyvbjerg, 2006) simply because there are too many unknowns (Sommer & Loch, 2004).

Now that we have indicated the issues associated with mega project, we turn our eye towards the Beneluxlijn, a case different from many other studied cases because it was successful in maintaining its budget and time schedule. The analyses discussed above tended to focus on projects that went wrong, but what about the projects that were successful in managing cost and schedule overruns? The Beneluxlijn case might provide a welcome addition to the buoyant literature on mega project development. The question is whether it is in line with the theory discussed above, or whether it is something special and unique that sets this case apart from others. Table 1 summarizes the concepts discussed in the literature review and which will be used to analyze the Beneluxlijn case. The underlying question will be: in which measure do these concepts also provide explanation of a project being able to keep within cost and time budgets? Or in other words: to what extent does the case adhere to or complement existing concepts?

Table 1: Analytical concepts derived from literature review

Phase	Type	Description
Appraisal and Decision-Making	Optimism Bias (Flyvbjerg, 2008)	Natural inclination to estimate things more positively than one could objectively derive from practice
	Strategic Misrepresentation (Flyvbjerg 2008; De Bruin & Leijten, 2007)	Deliberate positive estimations for strategic reasons
	Technological Sublime (Trapenberg-Frick, 2008; Van Marrewijk et al., 2008)	Politicians and engineers are attracted to technologies or features that have not been done before
	Scope Creep (Altshuler et al., 2003; Shane et al., 2009)	The accumulation of changes in the scope due to political desires and mitigation strategies
Project Management	Predict & Control (Koppenjan et al., 2010)	Uncertainty is calculated as risk and everything is done to control as many aspects as possible, for instance through time and cost buffers
	Prepare & Commit (Koppenjan et al., 2010)	Irreducible uncertainty is accepted and the project management is organized in a manner that it can respond to unexpected developments

The following section will discuss the research methodology applied to the case of the Beneluxlijn. It discusses the different interview types – narrative and reflexive – used in the research. After this brief section, the case and the analysis will be presented, starting with a short case description, followed by the identification of the key enabling mechanisms leading to its successful management of time and cost. The section then continues with a description of the uncertainties in the project and provides a reflection using the concepts developed in the literature review. The article closes with a discussion and conclusion section.

Method

This article uses a deviant case study research design (Gerring, 2007) because it aims to understand why, different from typical mega projects, the Beneluxlijn project has been successful in maintaining time and cost budgets. In line with the literature discussed above, it therefore requires an in-depth understanding of the decision-making and management processes. What were the crucial decisions made in this case that led to such an outcome? What were the mechanisms at work? The deviant case study design is especially well suited for this task. In this article I use a narrative/reflexive interview approach. This means that two types of interviews were done with key stakeholders. The narrative interview focuses on stories that subjects tell as they recollect past events. The interviewees are prompted to reconstruct the process without being pushed into a hypothesis driven direction: "After the initial request for a story, the main role of the narrative interviewer is to remain a listener, abstaining from interruptions, occasionally posing questions for clarification, and assisting the interviewee in continuing to tell his or her story." (Kvale & Brinkmann, 2009: 155). In the case study of the Beneluxlijn, this type of interview was especially useful for reconstructing the decision-making and planning processes, as it prompted respondents to recall the defining moments.

In the reflexive interview, respondents were asked for their responses on particular issues. This type of interview provided insight into the perceptions of actors. A distinction in each question was made for their opinion in general about planning large infrastructure projects and about this project in particular. Especially of use were the questions focusing on the main sources of complexity and uncertainty as they added to the insights derived from the narrative interviews. Thus, the combination of both interview types provides the analysis with insight of the process and the reflexive insights gained from the experience of the main actors of the project. Interviews were done with six stakeholders: 2 project managers, 2 aldermen, 2 transportation company officials. With four of them another reflexive interview was done. Another four reflexive interviews were used from interviewees that were not directly involved with the project, but that were involved in the contextual policy of the project: 2 government officials, a transportation strategist, and an academic expert. Combined with secondary sources such as newspaper articles and policy documents, the interviews give the research and the article its desired depth. The following section reconstructs the decision-making process of the Beneluxlijn based on the narrative interviews, newspaper articles and policy documents. However, the reconstruction in this article is not focused on who did what when from what role, or an actor analysis, but aims to discern broader mechanisms and events and to relate those to theory. The following section discusses the project and its relationship with uncertainty and complexity. This is primarily based on the reflexive interviews combined with relevant sections from the narrative interviews. The article continues with a reflection on the project in relation to the discussed literature.

Beneluxlijn

Beneluxlijn is the name for an extension of the Rotterdam metro network (see figure 1). Designed to join up two pre-existing metro lines, the 11,5km long Beneluxlijn connects Rotterdam city center with the bordering municipalities of Schiedam and Spijkenisse. Built through the related Benelux road tunnel, the project provides an added possibility for crossing the river by public transport (De Nieuwe Maas). After completion, the term Beneluxlijn disappeared and the project became part of the existing Calandlijn. The project was part of the 3M plan (1992) that proposed three possible extensions of the Rotterdam metro network. The projects were the Noordlijn (now operational as RandstadRail), the Beneluxlijn, and the Ridderkerklijn which has never been developed, nor is it forseen in the near future. Figure 1 presents the metro network of Rotterdam. The Beneluxlijn is the dashed section on the left side that goes from Marconiplein station (above the river) to the station of Tussenwater (below the river). Table 2 provides a short timeline of the project.

At 1998 prices, costs for the Beneluxlijn were estimated at 137 million Dutch guilders (€63 million) for preparing the ground; 652 million for civil engineering (€296 million); 191 million for technical rail elements (€87 million); 79 million for making grounds livable again (€36 million) and 586 million for other costs including additional engineering features and a contingency/risk reservation (€266 million). The total amount estimated was 1,645 million guilders (€760 million). The bulk of the costs were to be paid for by a grant from the ministry of transport of 1.4 billion guilders (€670 million). The remaining funds needed to be acquired through a 5 per cent contribution of Rotterdam's public transport operator RET, and additional road contributions from municipal or national road funds. The actual costs for the completed project turned out to be 1.25 billion guilders (1998 prices) or about €560 million euro. The project was finished just a few months after the original schedule.

Table 2: Timeline Beneluxlijn

Date	Event
1992	Presentation of the project 3M, in which the feasibility of three metro extensions is discussed. The 3M report proposes a South Eastern line in the direction of Ridderkerk; a line to the north which has now been completed as the project RandstadRail and a third line, the Beneluxlijn, extending the metro to the west.
1993	The decision is made by government to build the second Benelux road tunnel. (The first tunnel dated from 1967 and was no longer sufficient for all the traffic.) After negotiation the tunnel includes a tube for cars, and also one for bicycles and a metro tunnel.
1993	The decision is made to start preparations for the construction of the Beneluxlijn.
1996	The decision-making procedure is finished and a start is made with the preparation of the building grounds
February 1997	The Ministry of Transport gives out a decree of 1.4 billion guilders for the construction of the metro line. This does not include the construction of the tunnel which is done under the responsibility the ministry itself.
End 1997	Construction is started of civil structures and stations.
1999	A start is made with making areas affected by the project construction habitable again.
2nd quarter 1999	The electrical wiring and rails are put in place
November 2, 2002	Opening of Beneluxtunnel and Beneluxlijn
End 2002	There are many complications with the trains and the security system malfunctioning. No accidents happen but there are many delays. The solution is found by reducing the frequency of the trains

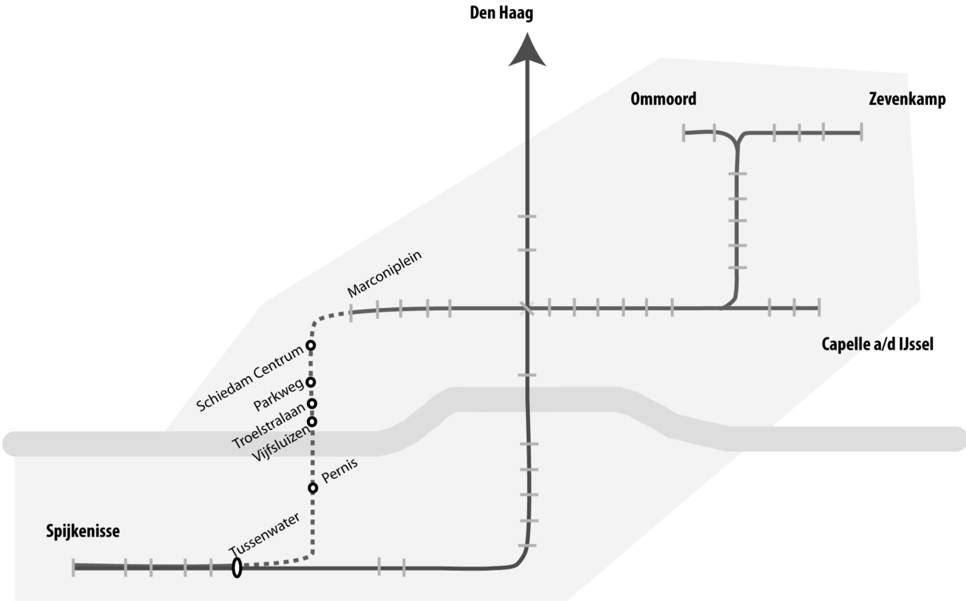

Figure 1: Dashed line is route Beneluxlijn

Beneluxlijn and Risk, Uncertainty and Complexity

Soon after the opening of the Calandlijn, the east-west connection that opened in 1982, plans were made for extending the metro network. At the end of the 1980s a feasibility study was made for the possibility of three extensions. This 3M report proposed, in order of priority: a south eastern line in the direction of Ridderkerk; a line to the north that has now been completed as the project RandstadRail; and the Beneluxlijn that would extend the metro to the east. Perhaps surprisingly, the number one priority Ridderkerk line has never been completed, while the Beneluxlijn, the least important, was realized first. Several crucial enabling mechanisms led to this remarkable outcome.

Firstly, and most importantly, is the political importance of a second Benelux road tunnel (highway connection) under the Maas river. This is the tunnel that connects the section above the river with the harbor south of the river. At the start of the nineties, the first tunnel was so congested that the national government decided that a second tunnel was needed. The municipality of Rotterdam supported this ambition; however, the municipalities of Schiedam and Vlaardingen were strongly opposed. They feared this additional tunnel would attract (unwanted) extra traffic through their cities. This created an 'enormous deadlock' in the decision-making process that was not broken until a 'monster design session' was organized, where none of the participants could leave before a solution was found (Interview local alderman). In the end it turned out that the inclusion of a metro tunnel and a bicycle tunnel was an acceptable option for all parties. This compromise boosted the rational case for the metro; if there was space for a tunnel for a metro as part of the construction of the highway tunnel, then surely it deserved to have a metro connection.

A second enabling mechanism was the so-called 'Tour de Force' program of the municipality of Rotterdam at the end of the 1980's. It was a program that aimed to maximize Rotterdam's influence in and benefit from central government's annual budgeting for major infrastructure projects. Generally, at the end of the year there would be money left over from the central government budget that could fund a new project. However, because municipalities did not invest in making plans for projects for which they were very uncertain about getting funding, they often did not have any 'ready-to-go' projects to offer to the ministry. The Tour de Force program was a break with this situation as Rotterdam decided to make plans for several projects without being sure of funding from the Ministry's budget. Because the planning process for the Benelux tunnel had already been finished, the construction could begin almost immediately. This Tour de Force proved to be a very successful approach. However, there are two drawbacks to this approach. The first is that the program was not embedded in the comprehensive spatial planning of the area. The program was only seen from a transport network perspective. The second is that by this form of preemptive planning, the ability to accommodate feedback and diverse interests, and thus remain adaptive, was effectively closed. During the early planning there was little visibility and sense of urgency because it was unclear when or whether the project would be financed. And therefore little interest could be expected from citizens. The other aspect is that what seemed like a good or even the best idea at that time might have been surpassed by reality. New political regimes might have had different plans or other spatial developments might have moved ahead. Thus the speed of the Tour de Force program put strong restrictions on the adaptability of the decision-making process.

Most respondents argue that the key to managing time and cost in de Beneluxlijn was that there were no surprises. The decision-making process followed a predictable path; opposition to the project was limited and could at the outset be expected to be limited because a large part of the trajectory did not cross densely built-up urban areas; the applied techniques were known.

Risk and uncertainty seem to be the greatest enemy to successful mega project planning and these are easiest prevented by keeping a mega project less complex; by keeping it simple. But how were which risks and uncertainties managed in this project? According to the interviewees the greatest risks and uncertainties when building infrastructure projects is when you go underground. This is because it is always difficult to know exactly what is underneath the ground. Historical and geological research can reduce a certain amount of uncertainty. But issues such as water levels – and the risk of leakages into the tunnel – are dependent on many external factors. The Beneluxlijn protected itself against such risks by aiming to build above ground as much as possible. The lump sum agreement, meaning that overruns will not be paid for by the national government, also forced the project team to keep the project above ground as much as possible because underground is a lot more expensive. Any added cost would come out of the budget of the municipality, not the state, so the financial risk was placed at the level of the municipality, adding an incentive not to underestimate cost or give in to mitigation demands too often. As a result, limited tunneling was done in the center of Schiedam and in other areas noise was mitigated with above the ground noise-reduction measures.

There was one moment in which the project encountered some trouble. In a certain section of the viaduct there was an irregularity in the NOx (Nitrogen oxides) values in the iron used which caused the iron to be more fragile than normal. The project had to be saved by a reevaluation of the safety norms. Even though the iron might not have been in accordance with the norms specific for that material, the construction was still safe overall. As a respondent stated: "[Despite the issue with the NOx values in the iron] we knew we could still manage to have a safe construction. That was more realistic than stacking safety norm upon safety norm" (Interview director Gemeentewerken). Thus even though a project element might not have fallen within its norms, the construction was still within the overall norm. In this case, even though the iron used might not have been up to the norm, the strength of the viaduct as a whole was adequate for its function.

In general, another prominent source of uncertainty and risk according to the interviewees was the changing of actors. Political actors are not always the same as they commonly rotate after elections. This means that you are not always sure of political support. In addition, the rotation of actors in general brings risk. There has to be continuity in, for instance, the staff of the project organization and contractors. Changes can lead to a lot of uncertainty and the risk that things that were first clear to everyone are now lost because of the rotation of actors. Because of the relatively short decision-making process in the Beneluxlijn, the rotation of actors was very limited. The window of opportunity through the construction of the Benelux road tunnel, in combination with the relatively low profile of the project initially, ensured commitment with institutional actors and made it less dependent on political champions.

External actors, such as the affected inhabitants of an area, are also a source of risk. If they are not managed correctly or treated correctly, they could mobilize against the project. They might try and block the project by legal means or even by preventing construction workers from doing their work. In addition, strong resistance from the public leads to bad publicity and a poor image that could affect the project long after it had been built. To prevent this, the Beneluxlijn had an extensive social environment management strategy. This aimed to respond quickly and openly to worries that people might have, and to involve them with the project by, for instance, inviting them to the construction site. "Some people complain that the social environment management adds several per cent to the budget, but I always argue that it is worth it…. It prevents a lot of frustration with both parties" (Interview Project Management). Even though the inhabitants of this region historically accept some nuisance of construction if they understand the benefits for the region, small frustrations can easily lead to big conflicts. And a responsive project management team, as in the case of the Beneluxlijn, can prevent small frustrations adding up.

A further important source of risk and uncertainty cited is the technological aspect of the project. The decisions made about the techniques to use can greatly increase or decrease the risk of the project. New experimental techniques will always bear greater risks than proven and well known technologies. Furthermore, these risks cannot be easily limited to single system components. This relates, for example, to the decision for a safety system: not only the type of system but also the interaction between the system on the train and the system on the tracks is generally surrounded with uncertainties. These risks were dealt with by adopting known technologies, as used in the existing Rotterdam metro lines. "The Beneluxlijn follows the Rotterdam tradition in building metro lines. So in that sense it was not very technologically innovative, it was actually just a continuation of the methods we had used in the past" (Interview director RET). The only moment when it did go wrong was with the safety system problems. This was because a different magnetic spools than before was used as a different company was given the tender for the system than the company that did the other Rotterdam metro sections. Thus ironically proving the point, the introduction of an unknown technological element, in this case a company unknown to the Rotterdam safety system, was the cause of the problem.

Procedures are the last of the sources of uncertainty and risk that are identified by the respondents. The amount of procedures that a project has to go through can be very large.

"the procedures, environmental permits, and building permits all represent a threat as there could be consequences for not following procedures correctly." (Interview project leader). This makes a project even more complex for the project organization. If a procedure is not correctly followed this could have severe consequences for the entire project because a public objection against the project could then cause the whole project to be delayed. So knowledge of procedures is crucial in order to be able to understand where the law allows simplification, for instance through one comprehensive permit request, and especially where complete precision and accuracy is needed. While procedures are complex, the risk can be almost completely controlled with adequate knowledge and understanding of the required procedures. In the Beneluxlijn project, these were kept under tight control of an experienced project management team.

With the construction of the Beneluxlijn the risks and uncertainties were primarily minimized by using only techniques that had been used before in the construction of the Rotterdam metro. This meant that everyone had a good understanding of what these techniques meant and what the risks were. Historical research had been accurate and historical sites were found at the expected locations. The decision-making process of the Beneluxlijn had been reasonably quick, thus there were only a limited amount of changes in the constellation of actors. Furthermore, much attention was given to manage the interaction with external actors. All in all the uncertainties were limited, and the project proved to be on time and within budget

If the uncertainties from this project are placed against the three types of uncertainty identified by Van der Heijden (1996) – risk, structural uncertainty, and unknowable uncertainty – it is clear that the project tackled mainly the first type of uncertainty. The risk estimates seem to have been accurate. Additionally, the project group and decision-makers have, as shown above, put a lot of effort in preventing structural uncertainties by using known techniques in which the project group a lot of experience. In some ways it is lucky that the project ran into so little unknowns; on the other hand, the effort to build primarily above ground greatly reduced the chance of an unknown happening. All told, it seems the project was very successful in keeping the uncertainty manageable, or keeping uncertainties within the acceptable risk level, and that this might be key to its successful managing cost and time.

In the next section, the findings based on the interviews of stakeholders will be set against the explanations identified by the literature.

Reflections from literature on the Beneluxlijn

Within the literature review in the first part of the paper, six elements were identified: optimism bias, strategic misrepresentation, technological sublime, and scope creep are factors during the appraisal and decision-making phase. Predict-and-control and prepare-and-commit are two types of project management that that have different consequences for the management of time and cost during construction. Table 3 provides an overview of the Beneluxlijn and the different elements.

Table 3: Achievement Beneluxlijn on factors identified in the literature

Phase	Type	Beneluxlijn
Phase	Type	Beneluxlijn
Appraisal and Decision-Making	Optimism Bias (Flyvbjerg, 2008)	Rotterdam was very experienced with the techniques used and was able to forecast accurately.
	Strategic Misrepresentation (Flyvbjerg 2008; De Bruin & Leijten, 2007)	The lump sum agreement put the financial risk with the municipality of Rotterdam. This negated any potential motivation for misrepresentation
	Technological Sublime (Trapenberg-Frick, 2008; Van Marrewijk et al., 2008)	Rather than experiment with different technologies, the Beneluxlijn showed the opposite of the technological sublime. The project made use of existing techniques as much as possible
	Scope Creep (Altshuler et al., 2003; Shane et al., 2009)	Scope creep was prevented by a strong focus on building above ground. Mitigation was primarily done by simple noise reducing measures
Project Management	Predict & Control (Koppenjan et al., 2010)	Because the project team used proven techniques with which they had experience, it was successful in predicting and controlling risks
	Prepare & Commit (Koppenjan et al., 2010)	Because of the 'keep it simple' strategy, this type of management was not necessary. However, the Tour de Force program can be seen as an example of a prepare and commit strategy that was key in making the project possible

The costs of mega projects usually overrun because of optimism bias or strategic misrepresentation. However, the Beneluxlijn shows no such phenomena. It seems the lump sum agreement and transfer of risk, as discussed above, was successful in ensuring that the Rotterdam municipality made a correct cost estimate, and made sure that they kept to the budget. Failure to keep to the agreed financing mechanism would have meant financial disaster for the city. The municipality, for its part, had an experienced department that knew the difficulties of building metro lines. Because of the limited envelope of funding available, the project group and designers had to be very stringent in preventing scope creep. The only mitigation that was applied was noise reduction on some part of the route where houses and schools were close to the viaduct. Crucial for the public acceptance of this stance was a communication campaign. The practice of building above ground wherever possible was of course also important in keeping to budget by preventing scope creep. But this is not easily achieved as most outside interest groups will push at putting infrastructure underground. However, Rotterdam prevented the opposition of Schiedam by offering a small section in Schiedam underground or threatening to go around the center. The rest of the spatial context of this project did not require mitigation strategies as it was going through mainly low-populated areas. The ability to resist the pressures for going underground when it was not technically necessary enabled the project management team to limit the uncertainties associated with digging and thus kept better control on the time and cost of the project. Most likely, this choice reduced the chance of expensive contingencies, and in retrospect, meant that risk and contingency budget remained almost untouched.

The Beneluxlijn shows strong support for the technological sublime thesis proposed by Trapenberg- Frick (2008). The idea is that the motivation behind large projects is to leave the public in awe and wonder and that this requires techniques that are complex, unproven and often incorporate many uncertainties. This temptation of going where no man has gone before is something that is shared by politicians and engineers alike. The project of the Beneluxlijn is an adhering case in the sense that the technological sublime was resisted. The project leader deliberately did not use any new techniques and there is a strong indication that this is one of the main reasons that the project was able to stay within the budget and set time frame. "Sometimes people said: you are not innovating enough'. 'But that was something I absolutely did not want to do. With the Beneluxlijn I wanted to build upon the things we invented in the past" [Interview Project Management]. Using techniques with which there is strong experience strongly reduces the risks associated with a project.

The fact that the owner of the project (the municipality of Rotterdam) had a lot of technical expertise through its engineering department meant that it could keep tight control on the contractors and was well equipped to know the consequences of different techniques. As a result the project group could generally suffice with a predict-and-control management approach. Estimations on existing knowledge and experience were made. Because of the resistance to the technological sublime, it was also possible to predict the risks more easily than in many other projects where decision-makers and project managers have been seduced by technology. It does not mean that the project organization was not also suited for a prepare-and-commit approach but it was just not necessary. Interestingly, if we look at the Tour de Force program, this is an example of a prepare-and-commit strategy within the strategic spatial planning domain. The plans were in place for the moment a window of opportunity opened, the Beneluxtunnel in this case, and the city was already committed to the project. In addition the strong management of the municipal departments, meant that profit maximizing through scope changes or the filing of cost to the limit of the budget, as often practiced by private companies, could be kept to a minimum.

In conclusion, while the Beneluxlijn might be a deviant case from a time and money perspective, it is not in contrast with the theories discussed in the literature review. To the contrary, it supports many of the ideas presented about uncertainty, cost and time overruns, and project management. The case shows some clear opportunities for managing complexity and uncertainty in the planning, decision-making, and management of a mega project. The conclusion and discussion section will provide a summary of these opportunities and threats.

Conclusion and discussion

This project was developed with the motto: to keep uncertainty in the manageable domain. Optimism bias and strategic misrepresentation were effectively and intrinsically neutralized. The project used existing technique with which there was broad experience and kept the project purely within the transport infrastructure domain. The route was kept as much as possible above ground. This simple approach was combined with strong project environment management that focused on reducing worries and frustrations with the affected neighborhoods; something that was considered crucial in bringing the uncertainties from the environment from the domain of the unknown into the domain of risk. The project actually aimed to reduce complexity and keep uncertainties within the domain of risk.

Although the benefits are clear of reducing complexity and uncertainty, there are also some evident disadvantages that manifest themselves in a project of this type. Most importantly, a project could become too simple. The focus on keeping a tight control on time and budget could lead to an underperformance in integrating different sectors and influences that might add value to the project. The Beneluxlijn was developed primarily from a transport infrastructure perspective as a relatively uncontroversial, inexpensive and quick solution. Developing a strategic vision on land use developments along the route was a secondary concern to realizing the more narrow goals of the project. Hence, while the built quality of the project is good, the quality as a spatial project, or rather as a leverage for broader spatial developments, is very limited. Perhaps for the Beneluxlijn this was the best solution in order to make use of the window of opportunity provided by the Beneluxtunnel and the lump sum financing arrangement with the national government. I would argue that whether this should be the preferred strategy depends on the context of the project and the vision that is developed for the region as a whole. Form should follow function in these types of projects and not the other way around. Infrastructure should be an instrument to achieve particular goals and ambitions. Retrofitting a project later for future developments, like including a new stop, is generally a more expensive and complex solution. This means that it is important to have a clear view on the problems that the project will have to solve; both now and to a certain extent in the future. Often, and the Beneluxlijn is no exception, projects start as a project which becomes a goal in itself and not as the best possible solution to a particular problem (Priemus et al., 2008). But the project should also be a tool to fulfill the strategic vision and goals for an area. Because infrastructure is a very definite spatial intervention with a huge investment cost, it determines for a large part what is possible for the area it passes through for the foreseeable future. The risk of a strong focus on simplification or the reduction of complexity is that the strategic potential of a project is ignored. Feedback in the form of new ideas and critiques are filtered out to early on, and the adaptive and strategic capacity is lost (Bertolini, 2007).

Would the Beneluxlijn have benefitted from a more open strategic process? Perhaps, but, more likely, it would have just not been built. As outlined earlier, other extensions to the metro network would have been more preferable. Several respondents stated that the project was the least important one of the 3M report. However, the policy window opened with the decision to build the tunnel and the availability of the lump sum required swift action on the part of the local government. The strategic 3M document was aimed at infrastructure development, not an integrated land use and transport plan. And with the little time available, the process could not have been opened to external influences and plan development.

To conclude, the Beneluxlijn offers us an insight in what it might take to keep a tight control over budget and time. Although it might be argued that the Beneluxlijn is so straightforward that it is incomparable with other mega projects, this is however the case in point. Considering its size, the project could have also evolved into an extremely complex project. Yet, the project was purposely kept simple. The project managers and decision-makers worked hard to keep uncertainty within the manageable domain of risk. As a result, the project contrasts sharply with the wealth of mega projects that wildly exceed costs and time budgets. However, it can be also argued that the project remained at a pure infrastructure level and thus lacked a strategic vision of its place within the broader spatial development of the region. The project shows that a reduction of uncertainty through simplification can be very beneficial. The trick, however, might be to combine it with a more strategic phase earlier in which there is a potential to organize knowledge, input and thus complexity in a way that adds value to the early stages of a project without adding to the complexity during the execution stage. Thus a decision-making process that accommodates influences and strategic input from outside, but keeps strict control over techniques and design, can ultimately achieve the most value while keeping the project simple and stupid.

Antoniadis, D. N., Edum-Fotwe, F. T., & Thorpe, A. 2011. Socio-organo complexity and project performance. International Journal of Project Management, 29(7), 808–816.

Altshuler, A., & Luberoff, D., 2003. Mega-Projects: The Changing Politics of Urban Public Investment. The Brookings Institutions, Washington DC.

Bertolini, L., 2007. Evolutionary urban transportation planning: an exploration, Environment and Planning A, 39(8), 1998–2019.

Bosch-Rekveldt, M., Jongkind, Y., Mooi, H., Bakker, H., & Verbraeck, A. 2011. Grasping project complexity in large engineering projects: The TOE (Technical, Organizational and Environmental) framework. International Journal of Project Management, 29(6), 728–739.

Boschma, R. A., & Lambooy, J. G., 1999. Evolutionary economics and economic geography. Journal of Evolutionary Economics, 9(4), 411–429.

Bruzelius, N., Flyvbjerg, B., & Rothengatter, W., 2002. Big decisions, big risks. Improving accountability in mega projects, Transport Policy 9(2), 143–154.

Byrne, D., 2005. Complexity, configurations and cases. Theory, Culture & Society, 22(5), 95–111.

De Bruijn, H., & Leijten, M., 2007. Megaprojects and Contested Information. Transportation Planning and Technology, 30(1), 49–69.

Deutsch, K. W. , 1966. The Nerves of Government. Models of Political Communication and Control (2nd ed.). Free Press, New York.

Dryzek, J. S., 1987. Complexity and Rationality in Public Life. Political Studies, 35(3), 424–442.

Faludi, A., 1996. Rationality, Critical Rationalism, and Planning Doctrine. Center for Urban Policy Research, New Brunswick.

Flyvbjerg, B., 2006. From Nobel prize to project management: getting risks right. Project Management Journal, 37(3), 5–15.

Flyvbjerg, B., 2007. Policy and planning for large-infrastructure projects: problems, causes, cures. Environment and Planning B, 34(4), 578–597.

Flyvbjerg, B. , 2008. Curbing Optimism Bias and Strategic Misrepresentation in Planning: Reference Class Forecasting in Practice. European Planning Studies, 16(1), 3–21.

Flyvbjerg, B., Holm, M. S., & Buhl, S., 2002. Underestimating costs in public works projects: error or lie. Journal of the American Planning Association, 68(3), 279–295.

Flyvbjerg, B., Holm, M. K. S., & Buhl, S. L. 2003. How common and how large are cost overruns in transport infrastructure projects. Transport Reviews, 23(1), 71–88.

Flyvbjerg, B., Holm, M. K. S., & Buhl, S., 2004. What Causes Cost Overrun in Transport Infrastructure Projects. Transport Reviews, 24(1), 3–18.

Gerring, J., 2007. Case Study Research: Principles and Practices. Cambridge University Press, New York.

Innes, J. E., & Booher, D. E., 2010. Planning with Complexity: An introduction to collaborative rationality for public policy. Routledge, London.

Koppenjan, J., Veeneman, W.W.., Van der Voort, H., Ten Heuvelhof, E., & Leijten, M., 2010. Competing management approaches in large engineering projects: The Dutch RandstadRail project. International Journal of Project Management , 29(6), 740–750.

Kvale, S., & Brinkmann, S., 2009. InterViews: Learning the Craft of Qualitative Research Interviewing (2nd ed.). Sage Publications, Thousand Oaks, CA.

Leijten, M., Koppenjan, J.F.M, Ten Heuvelhof, E., Veeneman, W.W, & Van der Voort, H., 2010. Dealing with Competing Project Management Values under Uncertainty: the Case of RandstadRail. European Journal of Transport Infrastructure Research, 10, 1, 63-76.

Marchau, V. A. W. J., Walker, W. E., & Van Wee, G. P., 2010. Dynamic adaptive transport policies for handling deep uncertainty. Technological Forecasting and Social Change, 77(6), 940–950.

Miller, R., & Lessard, D., 2001. The Strategic Management of Large Engineering Projects: Shaping Risks,Institutions and Governance. MIT Press, Cambridge, MA.

Nelson, R. R., & Winter, S. G. , 2006. An evolutionary theory of economic change. Harvard University Press, Cambridge, MA.

Olsson, P., L. H. Gunderson, S. R. Carpenter, P. Ryan, L. Lebel, C. Folke, and C. S. Holling. ,2006. Shooting the rapids: navigating transitions to adaptive governance of social-ecological systems. Ecology and Society 11(1): 18.

Osland, O. & Strand, A. , 2010. The Politics and Institutions of Project Approval- a Critical-Constructive Comment on the Theory of Strategic Misrepresentation. European Journal of Transport and, European Journal of Transport and, 10(1), 77–88.

Priemus, H., 2007. Development and design of large infrastructure projects: disregarded alternatives and and issues of spatial planning. Environment and Planning B, 34, 626–644.

Priemus, H., Flyvbjerg, B., & Van Wee, B., 2008. Decision-Making on Mega-projects; Cost-Benefit analysis, Planning and Innovation. Edward Elgar Publishing. Cheltenham, UK.

Shane, J., Molenaar, K., & Anderson, S., 2009. Construction Project Cost Escalation Factors. Journal of Management in Engineering, 25(4), 221–229.

Shenhar, A. J., Dvir, D., Ofer, L., & Maltz, A. C. 2001. Project Success: a Multidimensional Strategic Concept. Long Range Planning, 34, 699–725.

Sommer, S. C., & Loch, C. H., 2004. Selectionism and Learning in Projects with Complexity and Unforeseeable Uncertainty. Management Science, 50(10), 1334–1347.

Sutcliffe, K. 2006. Mindfulness and the quality of organizational attention. Organization Science, 17(4), 514–524.

Swyngedouw, E., Moulaert, F., & Rodriguez, A., 2002. Neoliberal Urbanization in Europe: Large–Scale Urban Development Projects and the New Urban Policy. Antipode, 34(3), 542–577.

Terano, T. 2008. Beyond the KISS Principle for Agent-Based Social Simulation. Journal of Socio-Informatics, 1(1), 1–190.

Trapenberg Frick, K. 2008. The cost of the technological sublime: daring ingenuity and the new San Francisco-Oakland Bay Bridge. In H. Priemus, B. Flyvbjerg, & B. van Wee (Eds.), Decision-making on mega projects: cost-benefit analysis, planning and innovation. Cheltenham: Edward Elgar.Van der Heijden, K., 1996. Scenarios: The Art of Strategic Conversation. John Wiley, Chichester, Sussex.

Van Marrewijk, A., Clegg, S., Pitsis, T., & Veenswijk, M., 2008. Managing public–private megaprojects: Paradoxes, complexity, and project design. International Journal of Project Management, 26 (6), 591–600.

Vidal, L.A., Marle, F., & Bocquet, J.C. 2011. Measuring project complexity using the Analytic Hierarchy Process. International Journal of Project Management, 29(6), 718–727.

Ward, S., & Chapman, C., 2003. Transforming project risk management into project uncertainty management. International Journal of Project Management, 21 (2), 97–105.

Weick, K.E. & Sutcliffe, K., 2006. Mindfulness and the quality of organizational attention. Organization Science, 17(4), 514-524.