The Erasmus Bridge: Success factors according to those involved in the project

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Abstract

This paper describes a case study of a successful major transport infrastructure project. There is relatively much literature on unsuccessful infrastructure projects and the subsequent lessons learned. In contrast there is hardly any literature on successful infrastructure projects. This paper wants to contribute in filling this scientific gap. The case is the Erasmus bridge in the Dutch city of Rotterdam which connects the banks of the Meuse River. This bridge is a success story for three reasons. The first two reason for success are that the bridge was built on time and within budget. The bridge cost about 163 million euro (1996 prices), with a budget of 165 million (1991 prices), and was opened on the precise date as planned. Its main goal was not to solve a traffic problem, or to expand the existing network. One of the main reasons for constructing is that the bridge should function as a landmark, and that is the third reason for success: the bridge has indeed become a trade mark for the city of Rotterdam.

Based on interviews with people involved in the project, the main reason for success appears to be the culture of realistic estimating at the municipality of Rotterdam: an estimation culture that was aimed to be as accurate as possible. Two elements are crucial, as the interviewees have explained: a refusal to make lower estimations in order to help getting the required funds from local or national government and the ability to make very accurate cost estimations. To be able to make accurate estimations in turn requires experience; experience with doing estimations, building bridges, with problems associated with major projects and experience with dealing with contractors. All of these ingredients were according to the interviewees available when planning the Erasmus Bridge and contributed to making this bridge a success story.

1. Introduction

There is an abundant amount of case studies worldwide that show that many major transport infrastructure projects are unsuccessful: the unsuccessful cases often cost more than expected (Skamris & Flyvbjerg, 1997, Flyvbjerg et al., 2003b), take longer to construct than expected (Morris and Hough 1987, Cooke-Davies, 2002), and do not deliver the expected benefits (Hall 1980, Flyvbjerg 2005). These problems allow for an inefficient use of public funds, and lead to a growing lack of confidence in building large projects, in planners and politicians involved and in politics in general.

Related to the case studies, much has been written about the causes of failing to build projects within budget and within schedule (see for example Flyvbjerg et al, 2003a), leading to interesting results and advices. Perhaps, investigating success stories can teach us valuable lessons too. However, the approach to look at successes in major transport infrastructure projects is much less explored.

However, it seems to us important that we learn more about successful major transport infrastructure for several reasons:

1. The performance of major transport infrastructure projects is an important issue in society. The costs of major projects are often dazzling, paid for by the public. It is important to learn more about major projects and to improve their performance.
2. When we gain knowledge on failed projects, we learn more precisely what not to do. However, we do not automatically know what we should do. Investigating success projects can teach us more about what we should really do to make projects successful.
3. When we combine our knowledge on success projects and on failed projects we get a contrast between what we should do and what we should not do. The combination of knowledge of success projects and of failed projects may provide a broader scope of policy-relevant information.

This paper describes the first case study of a series of successful major transport infrastructure projects in the course of a PhD research. The case is the so-called Erasmus Bridge in the city of Rotterdam. This case study research was done through interviewing seven people involved in planning, designing and constructing the bridge. Documentation of the preliminary conception, planning and construction processes was analysed, as well as newspapers and other publications related to the bridge. The results are presented here as a single case study.

This paper aims to answer three questions:

1. Is the Erasmus Bridge a success story?
2. How did it become a success?
3. Which factors influenced the success of the Erasmus Bridge?

The Erasmus Bridge was selected as a case for several reasons. The bridge is a success in terms of costs and schedule. It is probably more beneficial than foreseen when the decision to build was made. A remarkable aspect is that the bridge was not built primarily to serve a transport function. The symbolic value of connecting the south head to the city centre was the main reason for building this project. In

defining success, we will take the aim of the symbolic function of the bridge into account. Furthermore, the project has been controversial, and it is not widely accepted as a success story. Finally, yet importantly; Rotterdam is a location that produces consistent success: many projects are built within budget and schedule, and it is interesting to find out why this is the case.

Section 2 treats the history of the Erasmus Bridge briefly. Section 3 will give the conceptual framework and discuss our success criteria. Section 4 will discuss whether the Erasmus Bridge is a success. In section 5 success factors will be discussed, while in section 6 the results will be discussed and related to our general knowledge of success, success factors and success cases.

2. Erasmus Bridge

The Erasmus Bridge is located in Rotterdam, in the Netherlands. The bridge connects the city centre of Rotterdam with the Kop van Zuid (South Head in Dutch) on the south bank of the Meuse. Of course, the bridge serves a traffic function, but the main goal of the project was a symbolic connection between the city centre and the new neighbourhood Kop van Zuid (interview A, D, E & G). The bridge only has two one-way lanes for cars, while the middle section of the bridge contains two-way tram rails; used by 3 different tramlines, there is a bicycle path, and also a pedestrian lane. The bridge thus is truly a city bridge (Webbers, 1996).

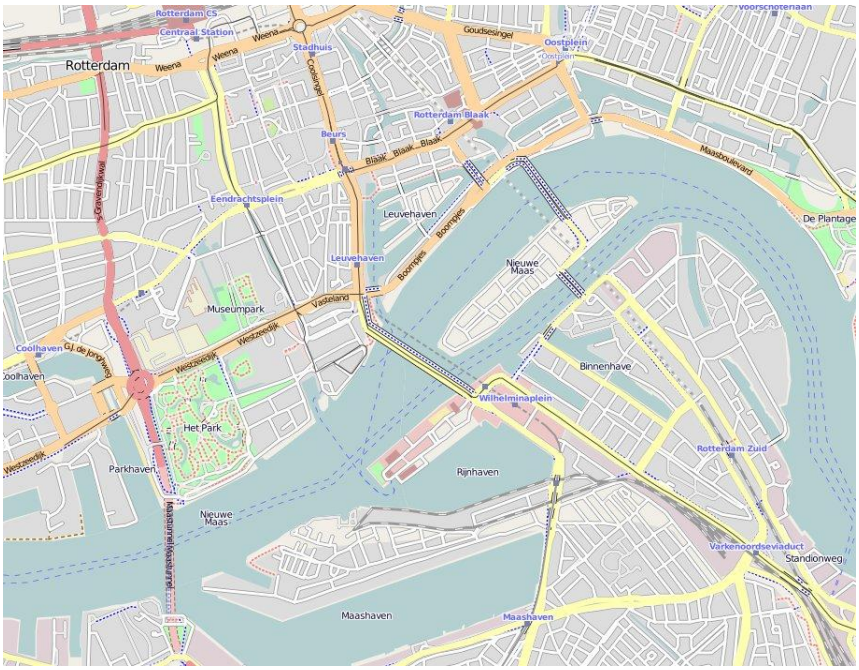

Image 1. Location of the Erasmus Bridge in Rotterdam (in the centre)

The bridge was largely funded through the FES funds (*Fonds Economische Structuurversterking*). This is a infrastructure fund financed out of the Dutch national benefits from Gas exploitation in the North Sea. The funds were relatively unknown, which allowed for little competition for the funding (Interviews A & G). This resulted in strict time deadlines for application for the funding and for realisation.

Image 2. The Erasmus Bridge

Since the completion of the bridge, it has become a bridge well-known for its design, for the many events that were held on and around the bridge (including the tour de France). The bridge is not so much iconic for the Kop van Zuid, as it is for Rotterdam as a whole. It marks the transformation of bridge design as an engineering process to an architectural one. The bridge was initially designed by engineers who focus on effectiveness of construction, rather than on the architectural qualities. Some engineers have serious objections to the way the Erasmus Bridge has been designed (interviews A & D).

3. Conceptual framework and definition of success

3.1 Conceptual framework

The development of transport infrastructure projects involves many aspects. The conceptual framework for success used in this paper distinguishes three different aspects: Process, Outcomes and External influences. The framework is partially derived from Turner (1997) and Hertogh en Westerveld (2010). The process consists of all activities that are "internal" and part of the process towards completion of the project. This includes the planning, organisation, management and construction of the project and all aspects related to these factors. External factors include political continuity, market dynamics, and other external factors influencing a project. The outcomes are defined as the effectiveness of the project; its effects. This includes aspects such as costs, benefits, time of completion and quality. The results are influenced by the process, and by external factors, which in turn influence each other as depicted in figure 3.

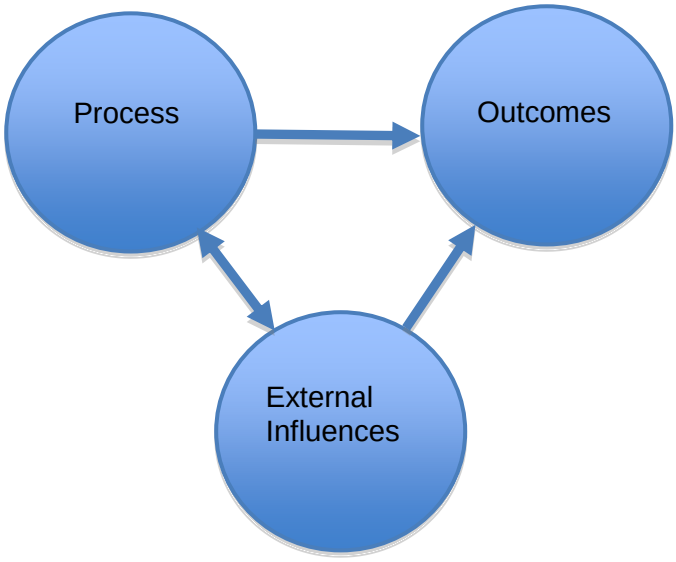

Image 3. Conceptual Model

In this paper, success is defined in terms of outcomes that are as good as predicted when the project was decided upon. Success factors in turn influence the outcomes, and can be both part of the process or part of the external influences.

3.2 Defining success

There are many ways of defining success. Different actors have different goals, and the success definition depends on these actors. For project advocates and for businesses involved in realisation of major projects, a success project often is a project that is realised (De Jong, unpublished). From a broader societal perspective – the general taxpayers perspective – projects that have more societal benefits than costs could be considered successful. The societal costs and benefits are difficult to measure, because political goals can be broader than objectively quantifiable aspects, and because they may arise over a long period. Therefore, in this paper another approach of success is used which is more measurable. A realised project is a success if it has remained within construction budget has been realised in time and has delivered its main benefits, as was expected when the project was decided upon in the final decision-making. In most cases, the main benefit will be attaining a certain level of traffic. However, in the case of the Erasmus Bridge the main goal was not traffic demand realisation, but to build a landmark. In order to be successful the bridge needs to have attained this goal.

To measure success there are some clear criteria. The budget and schedule expected at the moment of decision should be achieved, as well as in the case of the Erasmus Bridge the effect of the land mark as expected when the project was decided upon. To estimate costs success, the realised costs should be monetarised to the year of estimation. This is done through the use of a construction cost index. To assess the building schedule success the estimated construction time frame is simply compared to the realised time frame. In our view planning a major transport infrastructure project is a highly complicated endeavour. Therefore, we are not looking for a perfect

fit between goals and realization: a project with an overrun of cost or schedule of 10% or less, or a benefit shortage of 10% or less, is still considered successful.

4. Success

4.1 Budget Success

In terms of budget and schedule, the project is a clear-cut success story. The bridge was estimated to cost 365 million Dutch guilders, but was cheaper even in real terms (see table 1). From a purely transport engineering perspective we could consider the Erasmus Bridge a rather expensive bridge. This is indeed the perspective that some engineers from the municipality of Rotterdam have on the rather expensive bridge (interviews D & E). The decision to build the bridge in this expensive fashion therefore was not an easy one, public debate before the construction of the bridge was intense.

Table 1. Costs of the Erasmus Bridge compared to the estimates. Calculation of the 1991 and 1996 prices levels was done according to road construction price indices from Statistics Netherlands.

Costs	Million Dutch guilders	Million Dutch guilders (1991 prices)	Costs in million Euro (1991 prices)
Estimate (1991)	365 (1991 prices)	365	165.6
Realised (1995)	362 (1996 prices)	317	143.9
Ratio			0.87

4.2 Schedule Success

The bridge was completed on September the 4th, in 1996, as planned (see table 2). The bridge did have several problems at first, including aerodynamic instabilities, which cost the bridge to close temporarily, but this problem was fixed in due time, the bridge was closed for only a short period of time. The shivering got bad publicity in the media, but was not as problematic in reality. It was known on advance that the bridge could start shaking, but it did not need to (Interview D).

Table 2. Schedule of the Erasmus Bridge

	Schedule
Construction start	September 1st, 1993
Construction completion	September 4th, 1996
Total construction period	3 years and 3 days
Ratio estimate and realisation	1

4.3 Benefits: Landmark

The bridge was not primarily built to accommodate traffic, but to serve a symbolic function. In creating a landmark the Erasmus Bridge succeeded. Perhaps, we could state: very much so. The bridge has become an icon of the city, as previously the Euromast was, and to a lesser extent the Willemsbrug. The Erasmus Bridge functions as a symbol for the city, as well as for the Meuse River, Urbanity and Architecture in Rotterdam, with many events held around the bridge, and the bridge being used as a logo for different events and organisations (Moscoviter 1997).

According to most interviewees the bridge has succeeded in becoming a trade mark for the city of Rotterdam. One interviewee states that the Erasmus Bridge is truly a success project, because the bridge is in his view 'alive'. In his view the bridge even

started moving, but it never crashed. This kind of thing allows people to get attached to a bridge, because, according to the interviewee: people get attached to imperfections. During the relatively harsh winter of 2009-2010, Rotterdam people talked for days about an icicle that formed on a bridge pylon, leading to the bridge being closed for a day, in order to remove the dangerously large icicle. The bridge has really become a city bridge, with people walking, running, and bicycling over it and people using it to cross it by tram. The talk and use makes the bridge into a real city bridge (Interview A). People attach meaning to it.

With respect to creating a symbol for the neighbourhood "*Kop van Zuid*" (South Head), as the local government aimed, the bridge is perhaps not as successful. The South Head has been developing very slowly, particularly during the 1990s, and although the Erasmus Bridge does connect the South Head to the city, it may not have been the big symbolic magnet for the South Head.

The problem in evaluating the landmark success of the bridge is that the evidence is qualitative. There are methods to quantify the landmark benefits. Using techniques like hedonic price method or stated choice experiments, the willingness to pay for landmark value may be estimated. These approaches will be explored in additional research.

5. Success Factors

5.1 Introduction

The primary goal of investigating success projects is that we want to learn how to build successful infrastructure projects. This section deals with the success factors that can be derived from this case. The success factors are based on explanations given by the interviewees. Success factors were mentioned by at least one of the interviewees, and categorised and grouped by the authors, to provide an overview of possible factors influencing the success of the bridge. First, the factors related to the process (see image 3 and table 3) will be discussed, and then the external factors (see image 3 and table 3) will be discussed. There is no hierarchy in the success factors, they are primarily given as the results of this one case study, in a later stage of the research a more elaborate overview of success factors will be given, based on more cases.

Table 3. Success Factors Erasmus Bridge based on 8 interviews with 7 interviewees.

Process	**(5.2)**			**External influences**	**(5.3)**
Risk Analysis	(5.2.1)	Time pressure	(5.2.5)	Political Continuity	(5.3.1)
Planning culture	(5.2.2)	Comprehensive Scope	(5.2.6)	Market Dynamics	(5.3.2)
Combining different personalities	(5.2.3)	Good Construction Supervision	(5.2.7)	No Major Problems	(5.3.3)
Experience and Expertise	(5.2.4)	Innovative techniques	(5.2.8)		

5.2 Process

5.2.1 Risk analysis

For the Erasmus Bridge a full risk analysis has been made, including all different risks, estimates of different parts, which were all calculated. The risk analysis was required by the municipal council once they agreed to spend an extra 40 million on the bridge in order to build the more daring architectural version (Interview E). The

risk analysis has led to an overview of all required risk management measures (Interview G). An important part of the risk analysis focused on the design, which was considered risky in terms of construction. However, it was concluded that this bridge would be constructible, as it would conform to all rules normally applicable in civil engineering (Interview E).

Several interviewees consider the risk analysis as carried out important for the success of the bridge. However, there is disagreement. Other interviewees consider the risk analysis to be less important. According to interviewee D the risk analysis is often given too much credit. When a new type of construction is made, little material for comparison is available, in his view. This was a problem in particular because there was not much experience with making risk analysis in the project team at the time (Interview D). Furthermore, according to interviewee E, for a risk analysis to be a success, it is important who makes the analysis. Good and independent data are required. In E's view, these data were largely unavailable at the time. Therefore, the risk analysis was not done adequately. Only known risks were included, there was no real quantification of risks with lower probabilities to occur (interview E).

5.2.2 Planning culture

According to different interviewees, both inside and outside Gemeentewerken, there is a culture of estimating realistically in this organisation. It is considered honourable at Gemeentewerken to estimate as close to the eventual costs as possible. This was a form of pride for the people involved: the art of estimating was taken very seriously (interview B, D and G). What is very particular at Gemeentewerken is that in every estimate that is made for a project, the costs of the work of Gemeentewerken have to be assessed as well, quite unique for a public organisation. This supposedly creates cost awareness, and allows us to keep an eye on our spending. Cost consciousness is a given for contractors, but not for their clients (Interview D).

When it is considered honourable to build projects within budget, this is particularly interesting, because it can be a counterweight against the pride that people can have building large projects.

5.2.3 Combining different personalities

Furthermore, the interviewees considered the combination of different personalities in the project team to be important; from people focussing on details, to people with a helicopter view (interviews D, E & G). At Gemeentewerken the combination of different people, with different qualities were always working together (Interview D).

5.2.4 Experience and expertise

Another important aspect mentioned by many of the interviewees are experience and expertise (interviews D, E & G). The people working on the project have done many projects before, and many of these projects have been in teams where people know one another. Expert knowledge is considered conditional for a good project. It is crucial in terms of technique, project management and consists of both education and experience (Interviews D & G). Young people are likely to reinvent the wheel. That can be useful, but experience is crucial. Furthermore we need people who are careful, not scared, but careful (Interview E).

5.2.5 *Time Pressure*

One of the reasons the schedule was followed up very well was the fact that the money that was available through the FES funds included a deadline for construction (interview A). Projects delivered in time in turn often have less cost overruns as well, because project delay is very costly (Morris & Hough, 1987). The whole project from initiative to realisation was just 9 years, from the first marked out road drawings to the realisation in less than 6 years (Interview A).

5.2.6 *Comprehensive Scope*

Another success factor is the fact that the scope of the project as included in the budget as rather comprehensive (Interview G). The connections of the bridge towards both sides of the city were included from the beginning, as well as the quays. Interviewee A considered the inclusion of the Quays most important for the success of the bridge.

5.2.7 *Good Construction Supervision*

Independent supervision on construction is considered important as well (interview D & E). To have good people as inspectors is important. The inspector should know where to look, and when (Interview D). A good inspector has experience and expert knowledge, but also and a sixth sense for trouble. Some supervisors without this sense are good too, but they are not the best. Technical control is important, from the drawings to checks (interview E).

5.2.8 *Innovative techniques*

Computers were used for designing the bridge, and doing analysis, the bridge was one of the first where this was done (Interview D). The use of the computer in designing every detail of the bridge was important for the success (Reusink & Kuijpers, 1998, interviews C & E). At the time a very rough computer model was being used, that was not capable of calculating the effects of large plates of steel. However, during the design process one of the subcontractors for the design came up with more advanced software, that powerful enough not only to completely design and calculate the construction, but even to use to cut the steel plates directly form the drawings, allowing all steel plates to fit seamless (Interview E).

5.3 External influences

5.3.1 *Political Continuity*

Both local and national government have supported the project generously, which led to a budget that seemed to be more than adequate. This of course makes it much easier for a project to be constructed within budget.

However, one party was opposed to the construction of the bridge in the architectural design version, rather than the more conventional bridge. This was Gemeentewerken; they were opposed to the project in this fashion. This also means there was no lock-in until the final decision by the municipal council. Only when they decided for the architectural design, the process was shaped towards construction of this particular bridge (Interview A).

Another advantage was that the Erasmus Bridge was located in one city. In other major projects often many different governments are involved, national government,

municipalities and other authorities. Here only the municipality of Rotterdam was involved (Interview G). What may have helped here as well was the relatively well-developed neighbourhood management (*omgevingsmanagement*, interview E). Although this is a success factor more related to the process it is a very effective tool of managing the influence of the direct surrounding on the project.

5.3.2 Market Dynamics

During the period the bridge was built, there was an economic downturn. This has led to relatively low offers from construction companies, who were facing a shortage of assignments (interview E). This is of course something that needs to be regarded in the process, but almost completely impossible to influence.

Making estimations requires dealing with changing market conditions as well. Once there is a lot of work, projects tend to get more expensive. At times of recession the opposite is the case. Steel prices also fluctuate continuously, however, these are only a tenth of the costs involved: the costs around the steel price are crucial (interview E).

5.3.3 No Major Problems

Another success factor was a bit dull. No major problems arose during the project. This seems a bit obvious, but it was very important, and in many failed projects the opposite is the case. Building successful major projects is a matter of luck as well (interview E).

6. Conclusions

The success factors found in this case study are not definitive results. They are merely the results of one case study as depicted by the interviewees. To assume a more complete overview of all success factors more successful infrastructure projects need to be studied. Furthermore, quantifiable data needs to be obtained, in order to assume a more complete image of the weight of different success factors. Furthermore, the results need to be compared with unsuccessful cases, to be able to contrast the findings. On the basis thereof, we can create a clear picture of success: how can success be created, how can success stories be reproduced and this could perhaps even lead to a theory of success.

Interviews

All of the interviewees were in some way involved in the development of the Erasmus Bridge. The reactions of the interviewees were anonymized and termed A – F in the article.

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