Success in Major Transport Infrastructure Projects

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Abstract—**Major transport infrastructure projects have a calamitous history of cost overruns, delays, and overestimated travel demand forecasts. Costs and construction periods for major transport infrastructure projects are frequently underestimated, and benefits overestimated. This leads to suboptimal prosperity, decreased faith in governments and infrastructure projects, and unfair situations. We need to better understand how to make major infrastructure projects successful.**

I. Introduction

One of the most discussed phenomena in planning are major projects. Major transport infrastructure projects are being realised all over Europe, Asia, and the Americas. Media love to write about cost overruns, bridges to nowhere, seemingly endless construction periods, and other failures. Some of the more famous problematic examples include the Channel Tunnel, Jubilee Line extension, and Denver International Airport.

Even though we keep building more major projects, the performance of the realized projects is not always a justification to build new ones. The Channel Tunnel actually cost over 80% extra to build, with over 140% extra financing costs. Revenues meanwhile were less than half of the projected revenues[1]. The Jubilee Line extension of the London Underground cost 84% more than expected[2], and Denver's international Airport had a cost overrun of almost 200%, while passenger traffic was only 50% of projected values[3]. However, we continue to build more major transport infrastructure projects[4].

In this paper, success of major transport infrastructure projects is discussed. In part II the problems we are dealing with is sketched, as well as the consequences thereof. Part III deals with success in major transport infrastructure projects; it deals with the various definitions and the current state-of-the-art in literature.

II. Problem outline

A. Cost overruns, delays, and overestimated benefits

Hall[5] refers to Merewitz when he states that cost overruns in infrastructure projects average slightly more than 50% of the original forecasts. Flyvbjerg et al.[6] investigated a large sample of transportation projects: 258 projects. They found that 86% of projects include cost overruns. On average cost overruns are 28% of estimated costs. However, this means that a minority of projects, 14%, are not subject to such cost overruns[7].

In many of the situations where cost overruns occur, these are actually related to delays in construction and implementation[8]. Conversely, cost overruns typically lead to delays as well, since securing funds usually requires additional time and planning, causing construction to be halted and projects to be rescheduled[9].

Furthermore, benefits of major transport infrastructure are frequently overestimated. 9 out of 10 rail projects are subject to overestimates of traffic demand forecasts[10]. For road projects overestimates are less extreme with traffic forecasts that average an actual underestimate of 8.7%[11]. However, 50% of all road projects have a difference between actual and forecasted traffic of over 20%[12]. The striking difference between road and rail projects may be related to the difference in performance between the two. Road projects typically perform better in cost benefit analyses and thus require less positive traffic forecasts in order to convince policy-makers of their necessity. This may well be related to the procedures that apply to project funding, where competition for funds is more pronounced for rail projects than for road projects[13].

B. Effects of cost overruns, delays, and overestimated benefits

There is an odd logic behind major infrastructure projects. The smaller the costs are estimated, and the bigger the benefits the more chance of a project being realised, because they look more attractive. Project promoters who underestimate project costs and overestimate benefits have an advantage in the planning stage of infrastructure projects over those who estimate costs and benefits accurately. Their projects will be more attractive, because the cost-benefit ratio appears favourable. In some cases this may be an optimism bias, but it seems as though this is done on purpose in some cases. Flyvbjerg calls this, somewhat euphemistically, strategic misrepresentation[14]. One may also refer to it as misguiding, deceiving, or even plain lying.

High construction costs generally lead to high costs to society. When a decision is taken to build large-scale infrastructure on the basis of and underestimations of costs and construction time, this leads to a suboptimal choice. Especially when benefits are overestimated as well. It would

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be best if all costs and revenues are known in advance, so as that a fully informed choice can be made. If this is not the case, a suboptimal use of public money may be the consequence. Public money could instead have been used for other projects that appear to have a lesser cost-benefit ratio but are actually better, or for completely different purposes, such as education, welfare, public safety, or tax reforms.

A connected problem is the effect cost overruns and other problems have on public trust. When negative news on large-scale projects is presented in the media continuously, this may lead to a general feeling of mistrust. Mistrust and unease towards large-scale transport infrastructure projects and towards large-scale projects in general. This may culminate in protests against future major projects. Furthermore, mistrust may rise towards the people involved in these projects. This mistrust is guided towards planners, bureaucracy, policy makers and politicians in general, but also towards the decision-making process in general and even more general dissatisfaction. As we have seen, this mistrust is not misguided in all situations.

These societal problems make it crucial to learn about large-scale projects. We need to understand better how to create successful projects, and to avoid unsuccessful ones.

III. SUCCESS IN MAJOR TRANSPORT INFRASTRUCTURE PROJECTS

The field of cost overruns in major projects has been thoroughly investigated. Many examples and cases have been reviewed and the flaws of these projects have been scrutinized. Massive cost overruns, delays, and overestimation of use and effects of these megaprojects do give occasion to investigate these flaws, and findings have been crucial for our understanding of megaprojects. Here, however, a different approach is taken: looking at successes.

In order to investigate the phenomenon of success in major transport infrastructure projects, we need to define the concepts in this topic. We are concerned here with 2 different concepts: success and major transport infrastructure projects.

A. Definitions of major projects and transport infrastructure projects

There are many different definitions available of major projects[15]. Some definitions are vague. They, for example, deal with the size of a project relative to the region or country they are located in. Alternatively, they are described in terms of 6 C's: colossal, captivating, costly, controversial, complex, and control issues[16]. Other definitions are more tangible. One such definition is to define megaprojects as projects costing over 1 billion euro or dollar and major projects costing over 100 million euro or dollar. Even this definition obviously is a bit fuzzy, because these currencies are subject to exchange rate variations. However, most authors are reluctant to define this concept at all. They do use the 100 million dollar definition when they speak of major projects, but hardly ever seem to explicitly define it.

For transport infrastructure projects definitions are even more vague[17]. However, the most obvious, and most practical definition seems to be to restrict it to line infrastructure. Harbours, airports, and IT projects are very diverse in terms of scope. Evidence exists that these projects have very different qualities than line infrastructure projects. For practical purposes, we will restrict our definition to 4 types of line infrastructure: road projects, rail projects, bridges, and tunnels.

Major transport infrastructure projects are for the purposes of this research defined as line infrastructure projects, which cost over 100 million euro.

B. Definition of success in major transport infrastructure projects

A definition of success is an even more complex issue. For success in infrastructure projects, many definitions exist[18]. The most elaborate success definition would include a complete ex post cost-benefit analysis. The result of this should include not only a cost-benefit ratio of over 1 (cost/benefit), but also a ratio that would compel with the forecasted cost-benefit ratio. A less strict definition would be to allow a case to have a cost-benefit ratio of less than 1, if the forecasted cost-benefit ratio would also have been less that one. Alternatively, a case could have a ratio smaller than forecasted, as long as it's still larger than 1.

This broad definition is not very useful for the purposes of this research project. Not only would it require a complete *ex ante* cost-benefit analysis, but it would also require a complete cost-benefit analysis *ex post*, which is not frequently done. Furthermore, the *ex post* cost-benefit analysis would have to be done before selecting a case, in order for the case to be allowed as a success case. This is very difficult to realise, time-consuming and open to discussion, because the methodology for rating economic effects and other effects of transport infrastructure are very controversial.

From the cost-benefit analysis approach we can however derive a less complex, and more compelling success criterion. The cost of construction is crucial in a cost-benefit analysis. This therefore should be included in the success definition, and is the main criterion for success in this dissertation.

The benefits of a transport infrastructure project depend largely on the usage of the infrastructure. If forecasted usage equals estimated usage, benefits to a large extent also would. Other factors, like economic en environmental effects, are much more difficult to assess, and they cannot be influenced by project developers. We could thus include actual traffic demand in the definition of success. However, in not all cases the traffic demand is the main reason for constructing a transport infrastructure project. In some cases, other economic effects, landmark building, environmental concern, or even other political goals may be the main reason for the construction of a major transport infrastructure project. We should therefore consider traffic demand as a success factor, but not one that is as important as the costs.

Another aspect is construction time. The time it takes to build something influences both the costs and the actual benefits of a project. If a project is delayed, this usually leads to increased costs, and postponed benefits. It should therefore be included in the success definition as well, but like the traffic demand, this is not as important costs.

Success thus consists of 3 different criteria: construction costs, construction time, and traffic demand. In order for a project to be included as a case in this dissertation it should at least be successful in managing construction costs, allowing for no more than a 10 percent margin, and it should be successful in either time planning or traffic demand forecasting, again allowing for a 10 percent margin.

Cost success is thus determined by dividing the actual costs (C_A) by the cost as forecasted at the moment of the official decision (the expected costs = C_E). To be successful the case must have an C_A/C_A of 1.1 or less.

In formula:

I. $C_E/C_E \leq 1$
II. $C_A/C_E \leq 1.1$.

A similar method is used to determine planning success. Actual construction time (P_A) divided by the expected construction time (P_E) determines planning success. To be successful, the case must have an P_A/P_E of 1.1 or less.

In formula:

III. $P_A/P_E \leq 1$
IV. $P_A/P_E \leq 1.1$.

The final criterion is demand success. Here, success is measured in a slightly different way, because more traffic than planned is obviously considered better. Actual traffic demand (D_A) divided by the expected traffic demand (D_E) determines success. To be successful the case must have an D_A/D_E of 0.9 or more.

In formula:

V. $D_A/D_E \geq 1.0$
VI. $D_A/D_E \geq 0.9$.

In order for a case to be considered a success in this dissertation it should at least qualify for criterion II. It should also qualify for either one of criteria IV or VI. This means a project should be successful in terms of cost control and at least successful in either completion time or traffic demand forecasting, every time allowing a 10 percent margin.

C. *Success in literature*

Little is known about success in the current state-of-the-art in literature. Magnussen and Samset see the choice of concept and fundamental design as key to successful projects[19]. Tam describes two cases that are successful according to our standards: the Hong Kong Eastern Harbour Crossing, and the Hong Kong Western Harbour Crossing[20]. He ascribes success in BOT (Build Operate and Transfer) projects to six different factors. (1) The project should offer a reasonable rate of return in order to attract private investments. (2) There should be a proper, and secure, mechanism to fix and to adjust toll rates. (3) Projects need a committed and strong consortium for development of the project, which is (4) also technically competent. (5) Local government needs to be equitable and experienced and (6) uncorrupted. These factors apply primarily to BOT projects, and are clearly focused on the Southeast Asian situation[21].

Beyond the here described fragmented type of planning, project management and general advice, there is no coherent theory, theoretical framework, or guide to success in major transport infrastructure projects. This research project is aimed at creating such a framework or possibly even a theory of success, that is applicable to major transport infrastructure projects worldwide.

IV. Research Methodology

A. *Case study*

Case studies are particularly useful for research where no control of behavioural events is available. Investigating major transport infrastructure projects is a typical situation where little control over events is available to the researcher. Case studies allow one to answer questions about the way things work exactly; to answer the ‘how’ and ‘why’ questions, rather than quantitative questions alone. They allow for understanding and developing thoughts, ideas, hypotheses, and theories, where qualitative research is particularly useful for testing hypotheses and comparison between cases or institutional settings. For these reasons, case study research is often used in planning studies, where the phenomenon and the context always converge, and where research is mainly done on contemporary cases.

In this research project the focus is on case-study research. Yin defines the case study as “an empirical enquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident. [...] The case study enquiry copes with the technically distinctive situation in which there will be many more variables of interest than data points, and as one result relies on multiple sources of evidence, with data needing to converge in a triangulating fashion, and as another result benefits from the prior development of theoretical propositions to guide data collection and analysis”.[22]

Often cases are perceived as though they would provide little basis for scientific generalization[23]. However, some of the most valuable theories are based on single-case findings. They were later proven by series of cases or by experiments. Flyvbjerg states: “One can often generalize on the basis of a single case, and the case study may be central to scientific development via generalization as supplement or alternative to other methods. But formal generalization is overvalued as a source of scientific development, whereas "the force of example" is underestimated."[24]

In everyday life, much information we possess as human beings is acquired through case studies. We learn by partaking in events and from each of these events we distil specific, generalised information. This information is the foundation for most of our knowledge. Other types of information, like information we perceive through the media, are often created on the basis of this type of "research". They're built upon experiences with cases.

In fact, valuing theoretical knowledge higher than concrete practical knowledge is somewhat of a misunderstanding. Every expert bases his knowledge on a sample of cases, sometimes a grand number of cases. Rule-based, context-independent knowledge can be very useful, but it needs to be combined with practical context-dependent experience. In fact, in the social sciences there only exists context-dependent knowledge. As Flyvbjerg states, "Predictive theories and universals cannot be found in the study of human affairs. Concrete, context-dependent knowledge is therefore more valuable than the vain search for predictive theories and universals"[25]. Beveridge states that there are more discoveries stemming from intensive observations, than from statistics applied to large groups[26].

B. *Information oriented case selection*

Different strategies are available for doing case study research. One such strategy is random selection of cases. This can help avoiding systematic biases in the sample and allows for generalizing towards the entire population or specific selected subgroups. Another strategy is an information-oriented sample, where cases are selected on the basis of expectation about their information content[27].

In selecting cases the goal is to maximize the utility of information, which Flyvbjerg calls "information oriented selection"[28]. This strategy allows us to fully realize the potential of the case study. The various information oriented selection strategies, which are not mutually exclusive, can be combined, as they will be in this multiple case-study research project.

This research project will focus on a specific kind of cases: cases that can teach us about the nature of success. In order to do so we must find cases that possess specific qualities. The ultimate goal would be to find a paradigmatic case, a case that will allow for more broad generalization. This case would be able teach us about success in general, or about infrastructure in general. These cases are difficult to select, a process that entails intuition rather than systematic selection. In the end, a truly paradigmatic case might actually never be found.

The project however will be about specific cases. All cases studied here have a specific character as opposed to other large-scale transport infrastructure projects: They are successful. They possess this specific quality that most cases do not. No matter what else we can say about these cases: something went right here. And no matter which problem was encountered: it was solved. This means any one of these cases would be a good case study in and by itself. One could say that these are all critical cases; they are all exemplars.

However, to maximize the information gathering in different cases, various strategies will be combined. The cases will be varied, so the different circumstances and outcomes will be visible. We want to find unusual success projects; atypical and extreme cases, where rather specific information can be found. In-depth study of these cases can lead us to their specific contexts, problems, and solutions, and will allow us to generate ideas on success mechanisms.

Finally, for the ideas derived from this research project to be applicable worldwide, a range of projects must be selected from different countries.

V. Conclusions

Currently, knowledge of success in major transport infrastructure projects is lacking. There is no framework of knowledge available that is aimed at success as such. The dissertation will aim at filling this gap in knowledge, and further our understanding of major projects as such. This will be achieved through case studies, in which success projects (road projects, rail projects, bridges, and tunnels) are scrutinized. This should lead to a theoretical body of knowledge of success in this type of project.

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