

Evaluating technological progress in public policies: the case of the high-speed railways in the Netherlands

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Main-stream evaluations of failed policies are geared towards finding a limited set of factors that are deemed to have caused the problem. This is particularly so in the case of high-profile public projects such as in technology and infrastructure development. While justified from the point of political accountability, this article presents an alternative view. Following insights from evolutionary economics and complex systems about the embedded nature of technological systems and the role of chance next to purposeful planning, we demonstrate that traditional policy evaluations are misguided when geared towards simplistic cause-and-effect relations. To this end, we analyze the reasons for the mixed results in the Dutch high-speed railway case. The findings show that, contrary to popular opinions in the political domain, technological progress did take place. However, misalignment between social practices and technological systems masked that progress.

Keywords: Innovation policy, complexity science, socio-technological innovation, policy evaluation

1. Introduction

High-speed railway projects are important in many ways. They enable people to travel longer distances in shorter time spans, which promotes economic activities. Cities that are connected to high-speed networks often benefit in terms of hub functions. High-speed railways are technologically advanced. It requires quality engineering to run a full train safely at 300 km/hr. High-speed railways also carry prestige and are an important means of profiling a country or even people such as ministers. Japan, France and Germany, and more recently China, have all embarked on such projects for such reasons. When all components fit together, high-speed railways constitute a valuable and durable infrastructure.

Deciding, planning and constructing high-speed railways can take decades. Meanwhile, many things may change; e.g. technologies may have to mature more, passengers may have changed their behavior, and alternative modes of transport may have cropped up. There are many hurdles to take before the first shovel hits the ground and many more before the first train runs. When the components don't line up the prestigious project can turn into an expensive problem. This is the case for the high-speed railways in the Netherlands, which ultimately costed almost twice as much as planned at the start. The Dutch government started thinking about high-speed rail in the Netherlands at the end of the 1970s. In the early 1990s the first concrete steps were made towards building of a high-speed rail; the so-called Hoge-SnelheidsLijn Zuid (high-speed railway link south or HSL-Zuid). After more than 20 years of deciding, building and constructing the first high-speed train, called Fyra, started revenue service on December 9th 2012. During the



weeks to follow many (safety) incidents occurred after which the rail operators decided to take the Fyra-trains off the track on January 17th, never to return anymore.

When things go wrong, as such mega-projects often do, common political sense dictates that it is time to evaluate and to pinpoint the ones deemed guilty for the mistakes. The logic of accountability in the public realm holds that, ultimately, responsibility can be traced to one factor or actor (cf. Teisman, 2005). Traditional ex-post policy evaluation serves two questions: whether the policy has reached its target, or whether the people working in a certain policy field or public organization have delivered what they were supposed to deliver (Parsons, 1995). In addition, there is also a tendency to understand that different components of the project as related but essentially discrete elements. In practice, policy evaluation runs into a collection of structural problems, such as establishing causality (Noordegraaf & Abma, 2005; Bressers, 2011), establishing consensus over what constitutes a ‘good outcome’ because of subjective appraisal (Bressers & Hoogerwerf, 1995), and the fact that any policy is faced with resource restrictions that can ruin the intended outcome (Parsons, 1995). Policy evaluations are often carried out for control and accountability purposes, which means that learning from unfavorable outcomes takes a backseat (cf. Guba and Lincoln, 1985 for a critique). When it comes to major public investments such as in infrastructure, policy evaluation is often only carried out when something has gone wrong and the evaluation is inevitably geared towards finding and blaming the ‘guilty’ person, who can then be punished accordingly (cf. Kerseboom, 2008, p. 7; KiM., 2009). The Dutch case is no exception, as exemplified by the following conclusions from the formal parliamentary evaluation report: “The intended service has not been established because other interests prevailed over providing the service. The State was too focused on monetary gains and NS was too focused on retaining its strategic position. Not only did that hinder passengers’ interest, it also meant an underutilization of the HSL-Zuid.” (Parlementaire Enquêtecommissie Fyra, 2015, p. 4)

Such statements are understandable from a legal or political point of view – the derailment of those projects provides an excellent opportunity for the opposition to show the world they had been right all along. While such evaluations fit comfortably with the reality of politics, they don’t deliver a genuine insight in the dynamics and mechanisms that govern such programs and projects. Indeed, the goal of establishing accountability could even hinder a better understanding of the actual causality behind the unfavorable outcome (cf. Verweij, 2015). The traditional policy evaluation perspective that tries to pinpoint the single cause for the problems ignores the configurational nature of socio-technological systems. That is, several socio-technological systems jointly make up the success or failure of programs and projects. Arguably all major infrastructural projects, and especially high-speed railway projects, take a long time to be realized from the first thoughts to the actual construction and operation. During the project many technologies will (co-)evolve as well as causing the projects to adjust accordingly to remain successful.

In this article, we will contrast the classical view of policy evaluation to an alternative one that builds on insights from evolutionary (economic) theories and the complexity sciences, with particular attention to technology transitions. That is, to understand the evolution of technological configurations we use a perspective in terms of technological transitions. The main question is: what will a complexity-informed evaluation provide in comparison to traditional accountability measures? To this end, we will focus on the development of the Dutch high-speed railway project, which – by all accounts – is considered a failure.

2. Technological transition theory

The general idea behind technological transitions (TT) (Geels, 2002; Rip & Kemp 1998; Kemp, Rip & Schot, 2001) is that analyzing technology implies understanding them as configurations, i.e. the alignments of a heterogeneous set of elements (e.g. Bijker, 1995; Moody, 2009; for an extended argument). Configurations are logically connected with the rest of society; e.g. it is embedded in items such as skills, routines, patterns of behaviors. In other words: “[...] societal functions are fulfilled by sociotechnical configurations.” (Geels, 2002, p. 1258)

Technological transition requires a change from one configuration to the other. Changing configurations means not only substituting technology but also all other elements in the configuration that are mutually connected and aligned. As long as there is no proper match between the established regulations, infrastructure, user practices, et cetera, new technologies will have a hard time breaking through as they are mismatched with the established socio-institutional framework (Freeman & Perez, 1988 in Geels, 2002, p. 1258). In other words, all components need to be lined up correctly for socio-technological systems to evolve. Stability of such configurations is the result of the linkages between the heterogeneous elements, which are the result of activities of social groups producing those elements and linkages (Geels, 2002, p. 1259)

To understand the coordination of the activities of the different groups the TT-perspective builds on the concept of technological regimes of Nelson & Winter (1977; 1982); i.e. coordination is the outcome of organizational and cognitive routines. A technological regime is formed if the organizations, and the actors involved, share similar routines, i.e. routine-based behavior. Technological regimes create stability because they guide the innovative activity towards incremental improvements along trajectories. Rip & Kemp add to the technological regime that it is the “rule-set or grammar embedded in a complex of engineering practices, production process technologies, product characteristics, skills and procedures, ways of handling relevant artefacts and persons, ways of defining problems.” (1998, p. 338)

In other words, the rules are not only embedded in the engineering practices, but also in the corporate governance structures, manufacturing process and product characteristics. This means many social groups are part of the community and as such the possible trajectory of the technology is influenced by many users beside engineers, i.e. policy makers, societal groups, et cetera (Kemp, et al., 2001, pp. 272-273). “Regimes are outcomes of earlier changes and they structure subsequent change.” (Rip & Kemp, 1998, p. 338) As such ST-regimes may change, but do so incrementally. This sociotechnical regime provides orientation and coordination to the activities of the involved actors. The sociotechnical regime then functions as a selection and retention mechanism (Nelson & Winter, 1982) providing stability of the respective sociotechnical configurations.

The sociotechnical regimes function within the context of the sociotechnical landscape. These landscapes constitute the wider factors relevant for the respective ST-regimes, and at this macro-level the landscapes change extremely slowly. More radical innovations occur at the micro-level of local practices, i.e. the so-called niches (Rip & Kemp, 1998, p. 338; Kemp, et al., 2001, p. 275). There is feedback surging through the nested hierarchical levels. The meso-level of ST-regimes accounts for stability of existing technological development and the occurrence of trajectories. The macro-level of landscape consists of slow changing external factors, providing gradients for the trajectories. The success of a new technology is governed by what happens within the niche, but also by the developments in the sociotechnical regimes and landscape; e.g. changes at the landscape level may put pressure on the sociotechnical regime creating an opening

for a new technology niche (Geels, 2002, p. 1261). In short, technological transitions occur as the outcome of linkages between developments at multiple levels, but also at multiple technologies.

Alignment between levels creates a window of opportunity for successful technological transitions; i.e. all components need to be lined up correctly – something that can only be partially managed because certain elements are relegated outside of policy control. This is the main theme in understanding technological change. The transition perspective can be used to evaluate policies: within the larger policy landscape different regimes play a coordinating role for different policies or policy instruments to be successfully implemented. For the regimes to function as coordination all components and networks must be lined up (Bressers, 2011). Systems can keep each other going but are also highly dependent on each other, i.e. when one misfires, others will misfire too. For a better understanding of why the Dutch high-speed railways project failed, it is necessary to assess how and to what extent all systems components aligned.

Data for this research was collected from multiple archival records: 1191 newspaper articles about the case retrieved from the Nexis-database; 40 policy papers issued by the Ministry of Transport; 28 policy briefs issued by the Parliament; and 14 scientific and professional reports published by third parties (more details about the data can be found in Gerrits and Marks, 2014). In addition, we consulted approximately 50 websites.

3. Socio-technological transitions in the case of high-speed railways in the Netherlands

The following sections will describe the formation of the landscape and the evolution of various niches that, together, lead to the emergence of high-speed railway technology in general, and its deployment in the Netherlands specifically. This overview is derived from a more extended reconstruction that is available upon request.

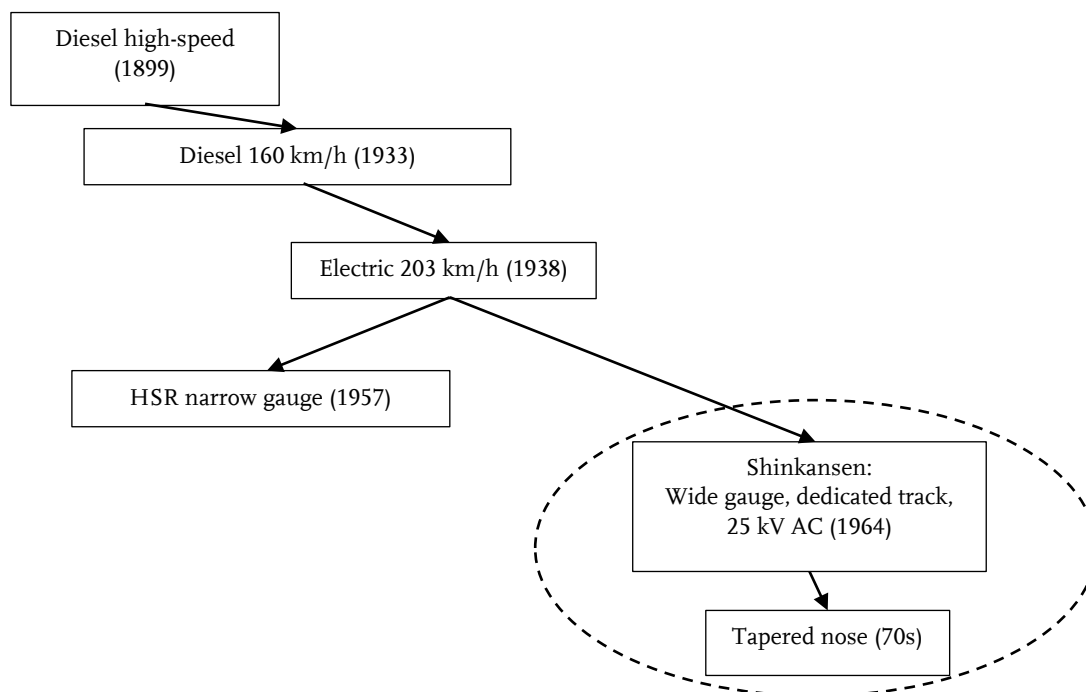


Figure 1 - Historical build-up of the high-speed rail landscape

3.1 Setting the standard: landscape formation

The development of the Dutch high-speed railways is embedded in the landscape of (high-speed) railways that evolved from 1899 into the standard-setting Shinkansen service between Tokyo and Osaka that opened in 1964. This line featured continuously welded rails in a 25% wider gauge designed for 250 km/h. Figure 1 shows the evolution towards the standard-setting Shinkansen that has had a defining impact on the technological high-speed railways landscape as it is today. The core elements of all such systems are a set of high-speed rolling stock and a dedicated high-speed line to accommodate that rolling stock. The track is to be continuously welded in order to reduce vibrations and misalignment, and to be bolted on semi-continuous concrete bedding for stability. The 25kV AC power is provided via the overhead catenary, tight radii are to be avoided, and level crossings are not allowed. The last standard-setting came after the early years of the Shinkansen, when the train's nose changed from a bullet shape to the tapered shape to reduce air resistance when traveling at high speeds and to deal with the shock waves when entering tunnels.

3.2 Short distance high-speed railways: regime definition

The Netherlands wasn't a front-runner when it comes to high-speed railways. The development of the French high-speed trains or Train a Grande Vitesse (TGV) in 1972 sparked a discussion among Dutch politicians, civil servants and Netherlands Railways about having high-speed trains, too. Thus in 1973 the first proposal by the Dutch government was made to connect Amsterdam through Rotterdam with Belgium, the so-called AmRoBel-plan. The idea was extended with proposals to improve national and international rail traffic in an attempt to offer a viable alternative to long distance road and air traffic. The formal planning procedure was started in 1987 and encompassed three major studies concerning the creation of a so-called corridor running from Amsterdam in southerly direction to Rotterdam (the Netherlands) and Brussels (Belgium), i.e. the HSL-Zuid. The studies encompassed a formal feasibility study, the environmental impact assessment of all possible variants, and the route decision. There were multiple alternatives for track alignment. However, in line with the landscape development mentioned above, a new and dedicated track that would be as short as possible (i.e. from Schiphol to Rotterdam in a fairly straight line), that would allow a maximum speed of 300 km/hr was the selected option in 1993. What was really new about the HSL-Zuid compared to all other high-speed rail lines that time was that it is essentially a short-distance high-speed connection; i.e. the dedicated track is 212 kilometers long of which only 85 kilometers in the Netherlands and 35 kilometers in Belgium allow for high-speed, and the line has several stops, from north to south: Amsterdam Central Station, Amsterdam Airport, Rotterdam Central Station, Antwerp Central Station, and Brussels Midi. Due to these factors the average speed on the line is 120 km/h, far below the maximum design speed.

The socio-technological innovation of short-distance high-speed rail travel will function as the coordinating regime for the necessary technological innovations in the various niches. Within this regime, the most important socio-technological innovations are: 1) public-private partnership; 2) building technology; 3) safety and interoperability; 4) market demands; 5) rolling stock. We will analyze these different socio-technological innovations since after the decision was made in 1993 to go for the shortest route possible allowing speeds of 300 km/h until the collapse of high-speed service on HSL-Zuid in 2013.

3.3 Niche 1: public-private partnerships

After the initial decision where the HSL-Zuid would be build, the ministry of Transport had to decide how and in which manner to finance the building. Inspired by the developments of privatization in UK in the 1970s, privatization of public tasks had become increasingly accepted in continental Europe as a manner to improve fiscal deficits, but also as a requisite to join the European Union (Bortolotti & Milella, 2006). The wave of privatization in transport caused deregulation and privatization in airlines, ports and airports in several European countries (Phang, 2009, p. 23). The privatization idea took off in the Netherlands at the end of the 1980s and meant that new forms of financing were now viable; i.e. tendering of tasks and public private partnerships in projects. "It was clear at the time that there were insufficient public funds available to meet the various desires, so private contributions to public projects were considered as a possible solution." (Koppenjan, 2005, p. 136) The Dutch government made steps in corporatizing certain state owned organizations and putting them at more distance, but were hesitant about full privatization (The Economist, 2002).

Initially, the construction costs were projected at approximately 3 billion Euros. Congruent with the discovery of the possibilities of private market mechanisms, the Ministry of Transport aimed at a public-private partnership with construction and financial companies to share the costs and benefits of the project. The minister expected € 600 million to be financed by private parties. After some attempts to get parties interested in financing, building or operating parts of the HSL-Zuid either completely or in some form of public private collaboration, the Ministry decided that (a) tracks, catenary, noise barriers and signaling systems would be put to tender in DBFMO contracts (Design, Build, Finance, Maintain & Operate), (b) the construction of the foundation and track bed to be put into six separate tenders on the basis of D&C (Design & Construct) contracts, and that (c) the concessions to operate the HSL-Zuid would be tendered out.

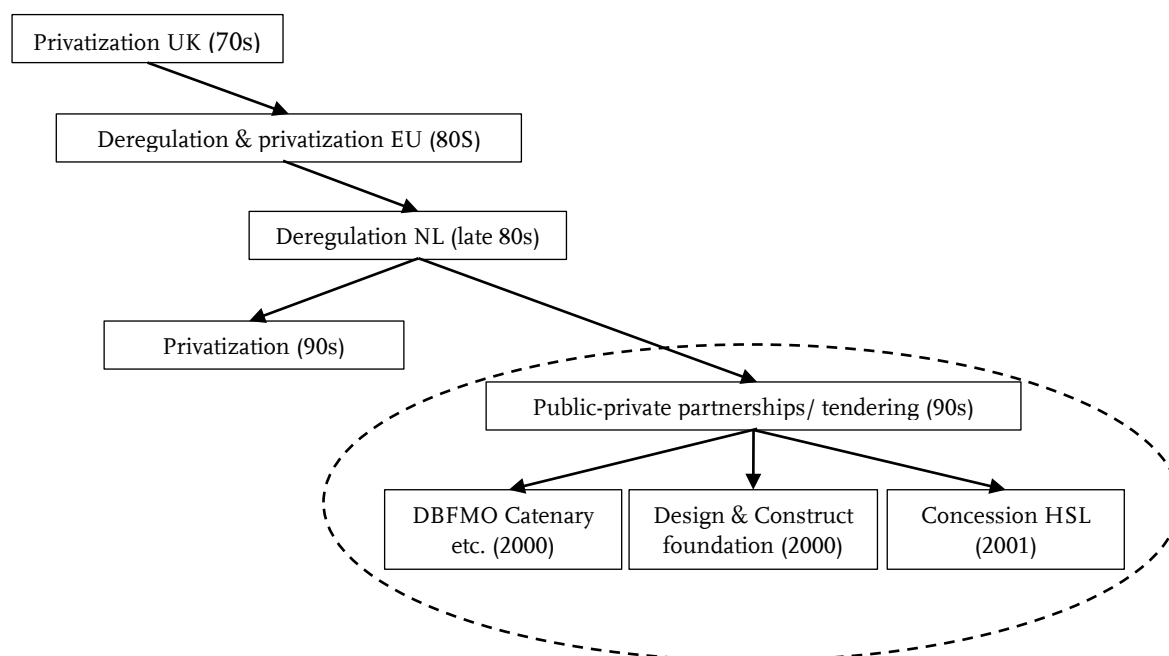


Figure 2 - Trajectory of niche-cumulation for breakthrough tendering

The value of the various DBFMO-contracts added up to around € 700 million and another € 700 million was needed for the maintenance fee for 30 years. High construction risks in conjunction with a risk-averse stance from the private companies lead the minister to decide that the State would build the foundations, tunnels, et cetera through traditional design & construct contracts. This would cost around € 2.7 billion, split over the six separate lots. The costs for building the foundation eventually run as high as € 1.9 billion, which is € 250 million higher than estimated. This was due to builders having strong negotiation positions by having formed illegal cartels.

The tendering process for the operation concession turned out to be even messier because the Ministry had initially allowed the previously state-owned Nederlandse Spoorwegen (NS) to make an uncontested bid for the contract. This bid was declared inadmissible because the Minister deemed it too low. A public tendering process was started but political pressure from the House of Representatives forced the Minister to grant the concession to NS – this time in a consortium with KLM (Royal Dutch Airlines) and Schiphol international airport. This opportunity was then retracted because it trespassed the European regulations for the single railway market. Hence the public tender was reopened. Four parties made it to the final round. Ultimately, NS won the concession by outbidding everyone else with an offer of € 178 million annually, € 78 million higher than the next bidder. In the final negotiations, the annual fee was lowered to € 148 million annually because the Ministry feared that NS would go down if it would stick to its original offer. The final amount was still considerably higher than what other operators had offered.

3.4 Niche 2: building techniques

The construction of the foundation encountered some persistent problems, forcing builders to innovate their building techniques: (1) the soil in the Netherlands is prone to subsiding, while fast trains require stable and level tracks, and (2) the track was aligned through a more or less pristine natural area called the Green Heart, for which a large tunnel had to be built in order to preserve its natural state. However, there was no prior experience with building a large tunnel through such suboptimal ground conditions.

Nearly the full stretch of the HSL-Zuid is founded on piles of reinforced concrete, on top of which are concrete slabs to which the rails are attached creating a continuous and level track. The curves have a minimal radius over 4500 meters and bank to enable high speeds. Some wide water bodies needed to be crossed, especially the Hollands Diep, with very long and rigid bridges to keep the gradient under the required 2 percent so trains can go up to 300 km/h while crossing the bridge without dangerous vibrations. High speed trains require considerable energy to run. The standard current (1500V DC) wouldn't suffice so a separate energy infrastructure for 25kV AC needed to be build. The technologies required for these points, in combination with the build of the Green Heart Tunnel (next sections), meant that the maximum speed could be raised from the conventional (Van den Brink, 2002, p. 22).

In the densely populated country, tunnels had to be built in addition to level tracks and bridges. A 4 kilometer long tunnel between Rotterdam and the northern outskirts of the city was built using traditional cut-and-cover technique. The tunnels under the rivers Oude Maas and Dordtsche Kil both consisted of immersed tubes of reinforced concrete. However, the tunnel through the Green Heart was to be built under strict environmental conditions; no damage to the landscape was allowed and most of the building nuisance had to be avoided. As such the traditional methods would not suffice. Hence the 7 kilometer long tunnel had to be drilled using a

Tunnel Boring Machine (TBM). The evolution of the TBM used for the HSL-Zuid is depicted in figure 3. The Green Heart Tunnel had to be built in a sand layer, which is very non-cohesive soil that falls apart when digging (Crok, 2002, p. 32). Due to this geology and to counter the ground water pressure a Slurry Shield type TBM was to be used. The French-Dutch consortium of Bouygues/Koop developed the TBM Aurora specifically for the ground situation of this project. The Green Heart Tunnel was only the fifth tunnel in the world that was built using a Slurry Type TBM, but the Aurora was unique because of its massive diameter of 14.87 meter, creating the biggest single tube tunnel in the world at the time. Aurora would dig 2 meters and then tunnel segments of two meter length would be placed, after which the machine would dig for another two meters pushing itself forward on the placed tunnel segments. After some initial delays, the Aurora was able to drill quite rapidly and made up for the time lost by drilling more meters per day (20 meters on average) than originally planned. As such the drilling process was concluded before the agreed deadline; which made it one of the most successful innovations of the project.

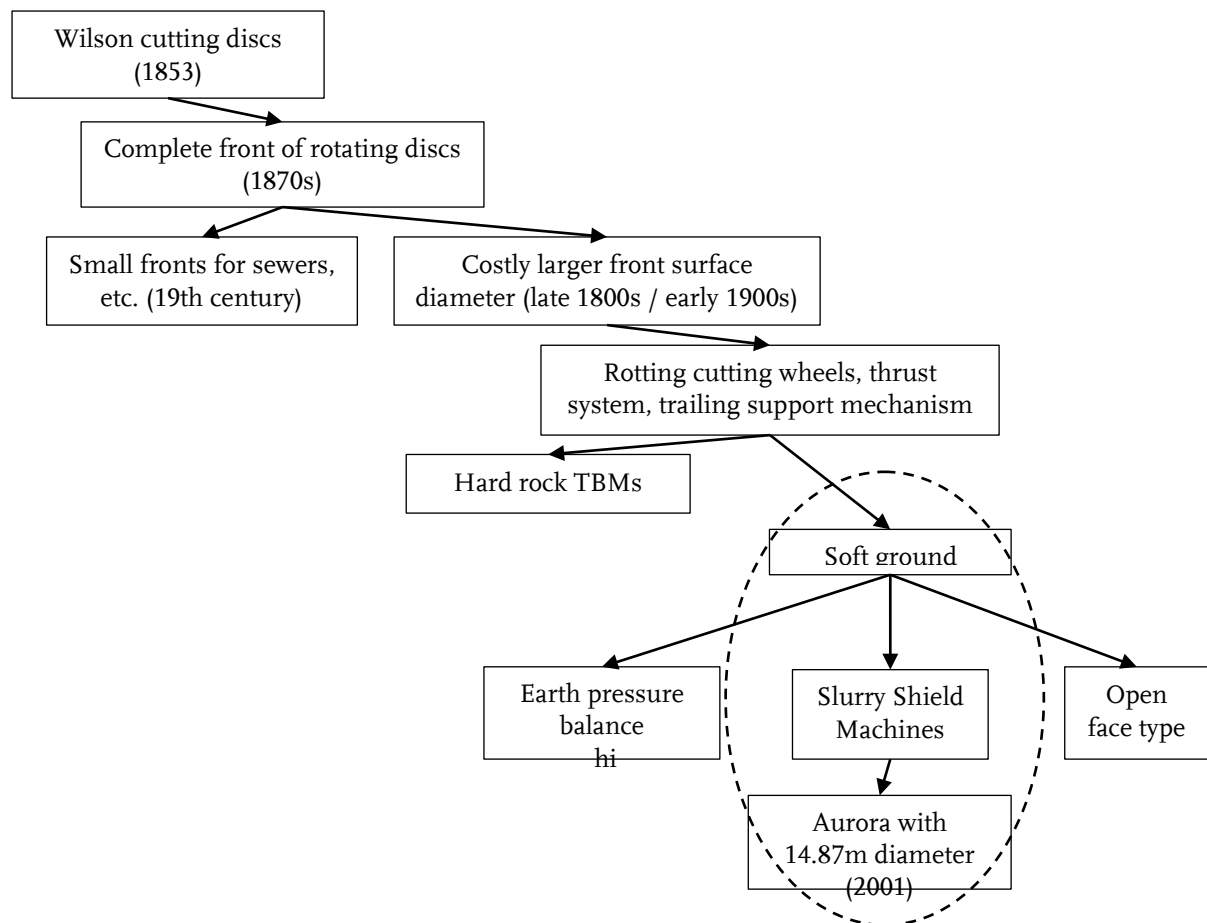


Figure 3 - Trajectory of niche-cumulation for breakthrough Large Slurry Shield TBM

3.5 Niche 3: Safety and interoperability

Once the foundation and other infrastructures were completed a safety system that would fit the requirements of high-speed rail would have to be installed. Such safety systems have been in development since 1901. In the 1950s and the following decades, innovations in radio-based signaling and innovations in traction technology that enabled faster trains, lead countries to develop so-called continuous cab signaling systems. At the end of 1980s, there were 14 different control systems in use across Europe. These control systems all had different specifications and as such were incompatible. This meant that trains passing borders from one country to another needed to have multiple systems installed or change locomotives, the latter being the common option. This was impractical because international services were becoming popular. Changes of locomotives cost time: multi-system locomotives were overly complex and not as well-developed as they are now. In addition, it is near impossible to read exterior light signals communicating track states at high speeds. In 1989, a working group including Transport Ministers created a master plan for a trans-European high-speed rail network, in which a European Train Control System (ETCS) was to replace the incompatible national systems, was suggested. Early 1990s, this led to the creation of the Technical Specifications for Interoperability (TSI). The baseline for technical specifications were published and tested as part of the European Rail Traffic Management System (ERTMS) by six railways since 1999. ERTMS is not a product but defines the TSI such that any company can develop ERTMS devices whilst maintaining interoperability. The idea is that equipment is mainly built into the train and less at the trackside. At levels two and three the communication between train, track and central post are communicated by GSM reserved for the railways. The first ERTMS specifications were published in June 2000, and have been amended since then to fit the needs of railway companies and administrators.

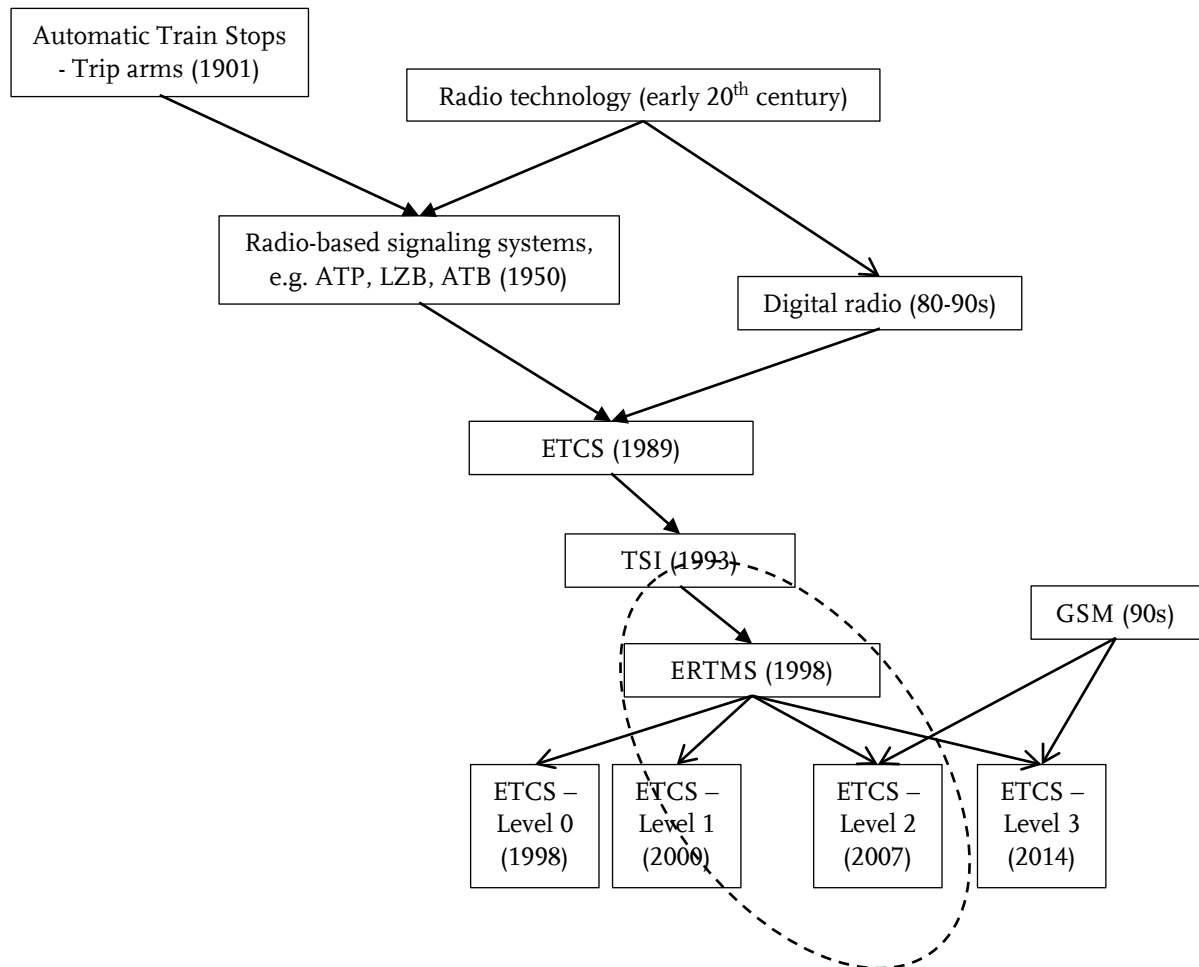


Figure 4: Trajectory of niche-for breakthrough European Train Control System

While the building of the HSL-Zuid is well on its way during May 2004, the Minister announced that she opted for ERTMS (ETCS level 2) as the only safety system for HSL-Zuid even though that standard was not fully developed at that time. A year later, the Minister announced that the completion of the complete HSL-Zuid was delayed as the implementation and testing of ERTMS needed more time. It turned out that implementing ERTMS in the Thalys, a train that would be operated by the joint venture of SNCF, DB, NMBS & NS, would take at least six months longer. The problem was bigger with the new high-speed train-sets that NS wanted to order. As long as the ERTMS specifications were still unclear, or constantly being updated (see section 3.7), no trains could be ordered. At the end of 2005 it turned out that ETCS was causing problems for high-speed rail all around Europe as it was delivered too late everywhere and that the system would often malfunction when implemented. The problems were mainly caused by operators and the European commission constantly making alterations to the ERTMS-specifications. The development and implementation of ETCS has been greatly underestimated.

3.6 Niche 4: Market demands

The 1993 decision to build the shortest alignment through the Green Heart was partially based on the estimated amount of passengers who would be offered a proper alternative to flying or driving. HSL-Zuid was seen as a proper competitor to short to medium distance air transport services because of the lower terminal times and the ability to reach directly into the city centres (Rodrigue, 2013).

However, the Dutch government did not anticipate that the European Open-Skies treaty of 1992 would allow any airline to fly anywhere without a government approval. This regulation caused the entry of many low-cost carriers (LCC) in the European market. This unforeseen development had a major impact on the future of the HSL. At the start of the project the idea was that HSL-Zuid would service 10 million passengers that otherwise would fly from Schiphol airport. However, this idea became unrealistic due to companies such as EasyJet and Ryanair entering the Dutch market - not only via Schiphol, but also via regional airports like Rotterdam-Den Haag Airport. Because these airports were in the vicinity of relatively large cities and because they also provided quick boarding times and offered good alternatives for short European trips, i.e. the market that was assumed to be the domain of HSL-Zuid.

In addition, it also became clear that the expected travelling times between Amsterdam and Brussels would be longer due to calculation errors on the Belgian section of the track and because certain track upgrades between Antwerp and Brussels had been postponed until 2012. In 2004 McKinsey reported that due to these developments the passenger volume would probably be 17% to 32% lower than expected in the concession agreement from 2001.

Revenue service between Amsterdam and Rotterdam started on September 7, 2009, with operator NS using Traxx locomotives and coaches, running at a maximum speed of 160 km/h because the dedicated V250 trains were still not ready to run. The travelling time between Amsterdam and Rotterdam was reduced by 20 minutes due to the almost straight route and the somewhat higher speed. Once the Thalys and V250-Fyra would start servicing the travelling time could even be further reduced. However, ticket prices were significantly higher than regular train services as NS needed to get some returns on its exceptionally high concession fee; the price hike was 60%. As it turned out, passengers were not willing to pay the surcharge on top of the fare price for each single trip between Amsterdam and Rotterdam. Consequently, NS lowered the prices of the tickets but that didn't attract much more passengers. January 31st 2011 NS again lowered the surcharge because the service was now running at a loss and needed more passengers. Also the regular train service between Amsterdam and Brussels was taken out of commission as the high speed rail service took over that service. All to no avail as passengers were still not eager to get into the more expensive high-speed rail. After the V250-Fyra trains were taken out of service and no alternative high-speed trains available, the former slower service between Den Haag and Brussels was restored using Traxx locomotives with coaches. A very modest surcharge was asked for the 20 minutes travel time reduction. Since then the amount of passengers on HSL-Zuid has picked up.

3.7 Niche 5: Rolling stock

The standard set by the Shinkansen, which initially only had a high speed of 210 km/h, made it possible for manufacturers to evolve the technology for trains to run at 300 km/h and even higher. However, there are only a handful of manufacturers that are able to mass produce stable

platforms of high-speed technology for the same reason as there are few aircraft manufacturers: the development cost of new models are immense. The first decades after the launch of the Shinkansen very few manufacturers developed and built high-speed trains. Recently, more companies have entered the market.

By spring 2002 the new concession holder started an international tender for high-speed rolling stock; i.e. 23 high-speed trains. The most important criteria were 'maximum speed of 220 km/h', 'price per seat' and 'between 450 and 550 seats per train'. Four manufacturers submitted a proposal; French Alstom, Canadian Bombardier, German Siemens and Italian AnsaldoBreda. Of these four only Alstom and Siemens had actually developed and built high-speed trainsets themselves. Bombardier proposed regular locomotives made suitable for higher speeds. These three manufactures offered modifications of existing stock because designing a new train from scratch for such a small series would not make an interesting business case. AnsaldoBreda was the only manufacturer that offered brand-new stock. However, AnsaldoBreda had only built high-speed trains that were designed by other manufacturers, so this would be their first in-house design.

In 2003, the Minister of Transport announced that she would hold NS to their contracted travel time between Amsterdam and Brussels. According to her calculations, the speed of 220 km/h was insufficient. These stringent requirements as well as the number of seats and the requested exclusive looks, defined a kind of train that didn't exist at that time and one by one the manufacturers pulled out of the bidding process. In the fall of 2003 two candidates remained: Alstom with trains running at 220 km/h and AnsaldoBreda with trains running at 230 km/h. During negotiations close to the deadline AnsaldoBreda offered an alternative that supposedly could run at 250 km/h, i.e. V250. Later that year, the concession holder decided that they would require fewer trains because of the much lower demand. Therefore, they ordered 12 instead of the initial 23 trains. Alstom pulled out of the tender because the order would be too small to justify the development costs. Consequently, AnsaldoBreda won the order for twelve V250s. The order should be delivered by April 2006.

The V250 was designed as an 8-car trainset, of which 3 coaches are used for first class accommodation, giving 127 first class seats out. The total train has a seated capacity of 546. To be able to operate on both Dutch and Belgian electrified networks the train was designed to operate on 3kV DC, 1.5kV DC and 25kV 50 Hz AC overhead power supply. The actual delivery date was postponed several times due to various reasons such as the late decision to implement ETCS-level 2. Then there was also the fact that AnsaldoBreda had never designed a high-speed train before. The company had great difficulties in complying with safety requirements and with maintaining build quality and engineering standards. Many components were (re)designed during the construction phase, and none of the trainsets were built completely equal.

The inaugural service with the V250 took place on Sunday December 9th, 2012. During the weeks to follow many trains experienced delays or simply didn't enter service due to various defects and operating errors. The winter snow of early 2013 damaged the trainsets to such an extent that they were banned from the tracks by the Dutch and Belgian certification institutes. Consequently, the old intercity services were reinstated as a temporary replacement for the V250-Fyra, while AnsaldoBreda indicated that it would require several months to fix all problems. The contract with the manufacturer was finally terminated by June 3rd, 2013, as they were not able to fix the problems. The trains have been returned to the manufacturer by September 2014.

3.8 Niche alignment in the short distance high-speed regime

The five niches described above show mixed results. Figure 5 shows the discrete contributions of the five niches to the outcome of the short-distance, high speed train travel in the Netherlands. The solid lines mean successful innovations, while the dashed lines mean unsuccessful innovations.

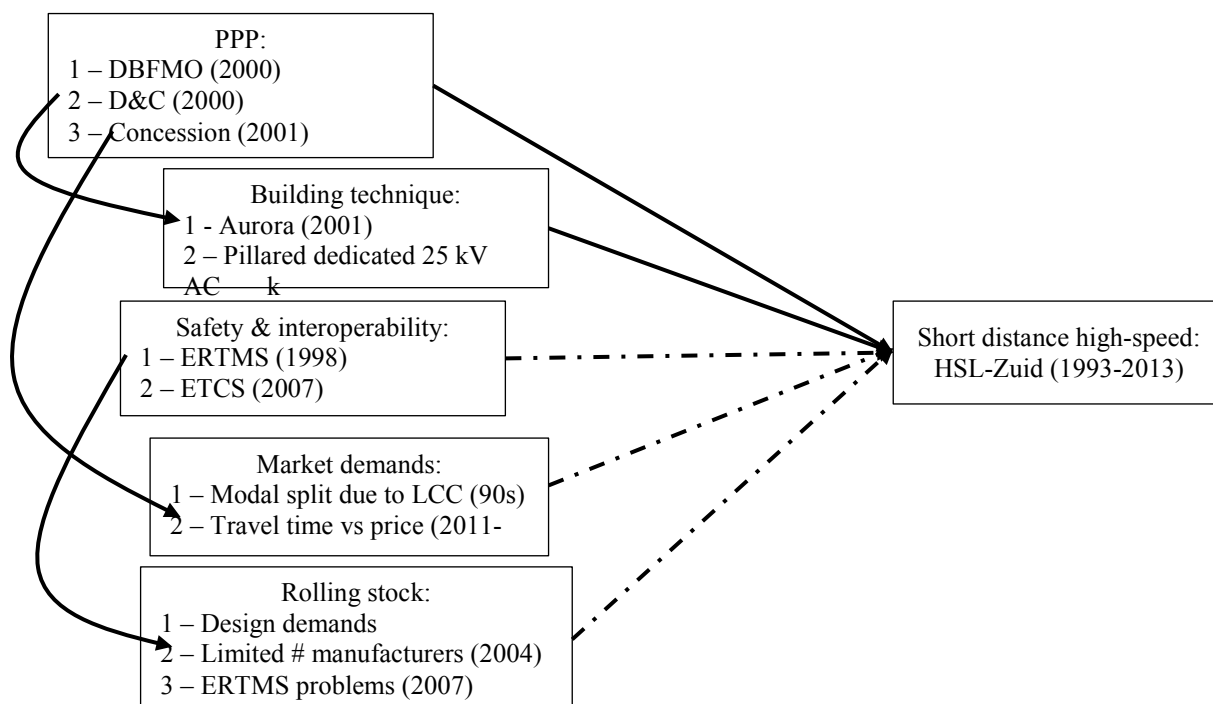


Figure 4 - Regime buildup through niches

Public-private partnerships were relatively successful when it comes to the different DBFMO-contracts for building rails, catenary et cetera, and the design & construct contracts for the foundation. The former is very successful when it comes to the development of a new record breaking diameter for the tunnel boring machine Aurora. However, the latter did significantly costs more as the builders were able to form cartels, exchange information and influence the bidding process. The tendering for the concession was a success as the State extracted a much higher price than anticipated. However successful for the State, it impacted the ticket price NS would charge and as such affected market demands. All in all the public-private partnership innovation had a mildly positive effect on the design and development of the infrastructure.

The building technique is clearly successful as the Aurora was able to dig faster than planned through difficult ground conditions and the Green Heart Tunnel was finished before the

agreed deadline. The other techniques, e.g. a completely pillared track or long bridges, also contributed to the successful build of the track.

The development of a European wide safety system took significantly longer due to many factors ranging from unclear definitions by the European Commission to unstable software releases and equipment failure. That is, the ERTMS / ETCS innovation delayed the building of both the track and the trains and significantly influenced the costs of building and operating HSL-Zuid.

The idea of using high-speed trains in order to affect consumer behavior and force a change in the modal split failed completely as travelers did not find the high-speed service compelling enough to pay a considerable surcharge in comparison to the price of car travel or regular train services. In addition, the unforeseen emergence of low cost carriers meant that travelers could now board faster, nearer to their homes at relatively low prices. As NS and the Dutch government learnt: high-speed railways are not automatically considered superior to other modes of travel.

Lastly, the strict design demands as dictated by the concession, lead to a botched tendering process that drove NS into the arms of AnsaldoBreda and its untested, hurried proposal for the V250 trainsets. The problems with AnsaldoBreda were intimately connected to the problems with ERTMS problems and with a lax quality assessment on behalf of NS and by the certification institution. The trains arrived 6 years after the deadline, to be taken out of commission a couple of weeks later.

Ideally, niches all add up to a successful socio-technological innovation. In this particular case, it didn't happen. The case very clearly demonstrates that the technological and social dimension are mutually dependent. It takes alignment of all niches – e.g. agreement over ERTMS and the technology to build trains – to move a step forwards. Even though certain socio-technological innovations were successful they were not properly aligned with policy innovations such as public-private partnerships in such projects. Ultimately, NS had to be saved from bankruptcy three times by the Dutch government in the years to follow. The current situation sees NS running make-shift services at a loss with a solution still being far away.

4. Conclusion

We started this article with the observation that classical policy evaluations are geared towards finding that one variable that supposedly controls for all the problems encountered. In the political arena, this often boils down to pinpointing and blaming a person or organization, implementing an extra set of rules, and to move on. While we don't want to fully deny the idea that someone can just have committed a grave error, we do believe that major public projects that includes innovative technology, such as HSL-Zuid, cannot be judged on the basis of simple premises about causes and effects. The case demonstrates that success of the newly developed short-distance high-speed railways depends on the alignment of underlying coevolving technological as well as social niches. Misalignment of these niches means that the innovation at the regime level takes place in starts and fits. It may also mean that the innovation in one niche propels or hinders the innovation in another niche, making the innovation at the regime level fail. This is not to say that innovation doesn't take place at all – after all, progress has been made since the first ideas to launch a high-speed railway service in the 1970s – but that progress is haphazard and did not take place according to the policy goals and planning. Arguably, the socio-technological innovation framework provides insights into why certain public policy innovations



were successful or not, without having to nail the failure to human error. That is, complexity-informed theories about socio-technological innovation as the cumulation of evolving niches can lead to a considerably advanced appreciation of the complexity of public policies.

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