Incentives to Innovations in Road and Rail Maintenance and Operations

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Abstract

Worried voices in the Swedish road maintenance and operations industry claim that innovations and technical development has ceased in the last decades. One hypothesis is that it is an effect of the public tendering reform introduced in 1992.

Since 2001, the Swedish railroad industry has also introduced public tendering and awarded contracts to private contractors.

This study examines the validity of these claims by analyzing the incentives to innovation in the past and at present. The analysis is concluded by proposals how the innovative climate can be improved between the road and rail administrations and their contractors.

Acknowledgements

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The project has been coordinated by CDU, Centre for research and education in operation and maintenance. Supervisors at KTH, the Royal Institute of Technology in Stockholm, have been Folke Snickars, professor and co-supervisors Johan Silfwerbrand, professor and Fredrick Lekarp, PhD.

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In addition to the financers and the reference group, interviewees in the reference list, unlisted interviewees and colleagues at KTH have contributed greatly and amicably to the study. It has been a pleasure to find so many with an altruistic and genuine interest for technical development. The older generation has expressed concern for the younger generation and the younger generation has expressed admiration of their older colleagues. The study could not have been possible to pursue as deeply into reality, and the findings would not have been possible to present as openly, without the sincere wish to find the reasons for lack of innovations that has been encountered almost everywhere.
1 Introduction

“The recipe is to remove the obstacles to growth, rather than to create new entrepreneurship by political means. The problems are the attitudes and the incentives. To assure growth and welfare, we must find the Porsche-effect: If my neighbor and my colleague could do it, why not me, who is so much smarter than them”.
Maryann Feldmann (Ekdal 2004)

1.1 Definition of Terms

The following definitions clarify how the words in the title are to be understood within this study.

Incentives

Incitamenta, Incitantia (latin) means stimulus to do something (Meyers 1897). The incentives to perform or develop the own task can be positive in the form of rewards, or negative in the form of penalties.

Innovations

Innovation (latin) means something new, a new generation, a new version originating from the old (Meyers 1897). In this study, profitability of the innovation is more important than its scientific or technical height. Any profitable idea not mentioned in the specification or currently in use, unless consciously abandoned, is regarded as an innovation. This enables a larger community to take part in the creative process and is based on the philosophy that encouraging small steps is a prerequisite for creating the innovative climates that are necessary to produce the really important innovations.

Operations (Service)

Operations refer to routine maintenance activity without long-lasting effect. In the road sector, operations measures are defined as lasting less than one year. Typical examples are snow and ice to be removed, malfunctioning signals to be repaired and vegetation to be cut. The operations activities have in common to keep the road, or the track, operable for vehicles by maintaining visibility and accessibility. Repairing cracks, potholes, rail and switches are to some extent included in operations, but only as urgent action, called for from a traffic flow and security perspective, not as means in order to maintain the road and rail capital in the long term. In the railroad sector, operations are also referred to as service. Please note that the rolling stock is not included in this study, only the surface on which the rolling stock rolls.

Maintenance

Maintenance refers to more long-lasting repairs than those included in operations above. Maintenance activities intend to bring the equipment back to its original state and function. In the road domain, resurfacing of roads every 10-12 years is a good example of maintenance. These activities have not been studied in this report. In the railroad domain, maintenance and service are not clearly separated, but treated in a similar way in Banverket’s accounting.
1.2 Background

Public tendering has been gradually introduced in Sweden during the 1990s both for road and railroad track operations and maintenance. Its objective was to spur efficiency and technical development by opening up a previous monopoly market to the private sector. There is however a feeling of disappointment. Many, in particular on the client side of the operations and maintenance industry, express that innovations were much more frequent before the public tendering reform (Österberg 2003). What went wrong?

Vägverket, the Swedish road administration, started the reform process in 1992. Since 1996, all operations and maintenance of roads is submitted to public tendering (VV 2003a). The process has gradually developed towards performance-specified contracts. The philosophy with these approaches is to enable alternative methods in order to spur innovations and achieve the most value of taxpayers’ funds.

Banverket, the Swedish railway administration, was separated from SJ, the state-owned company operating the trains, in 1988 (BV 2003a). An independent production unit, Banverket Produktion, was separated out of Banverket, but kept monopoly to undertake all operations and maintenance until 2001. The model with principal and contractor was introduced in the organization in 1998, but contracting out to private competitors did not happen until 2001.

Vägverket (VV 2003a) hopes it will benefit from the study by higher quality of the road operations, smarter methods, less time on the road for the machinery, saving costs without loosing quality, innovations in the safety and working environment for road workers and becoming an attractive employer.

Banverket (BV 2003a) hopes the study will help it to formulate a procurement strategy. At present Banverket has a policy but no official strategy. It is often locked in with the original supplier who developed the tailored technical and security systems once upon a time. Often the technical installations demand a lot of service. Why no innovations? No incentives? Insufficient rewards? Both parties must gain from being innovative. At present, the service provider maximizes his profits by not solving the problem in a sustainable manner. Banverket hopes the study will provide incentives for employees at all levels to take responsibility for the long-term development. Today there are few incentives to fix problems in the long run and too little learning from experience.

Contractors (NCC 2003, BVP 2003a, VVP 2003d) hope the study will contribute to an innovative climate in the industry. The present strict focus on price by the principals, and inability to develop the specification and delegate responsibility, favor short-term solutions. It creates too little incentives to innovations. It reduces the attractiveness of the industry when recruiting personnel. Performance-specified procurement, partnerships between principal and agent, and appraisal of soft variables are approaches of great interest from the contractors’ point of view.

Employees feel less loyalty to the employer today. Competence is difficult to keep, as well as people’s feeling of responsibility. People want new, pleasant and interesting jobs. The old supervisor who is pointing is gone. People require planning their work themselves and working on projects (VV 2003a).

1.3 Purpose and Research Questions

For science, the study is intended to provide some answers and guidance regarding the influence of incentives on innovation performance, and how to measure the value if an innovation to society. Do incentives contribute to the definition and performance of an
innovation system? How? How can innovations be compared? How can innovations be stimulated?

For the industry, the study is also intended to provide some answers and guidance regarding how innovations can be stimulated. Has technical development ceased or slowed down since public tendering and contracting out began? If so, why? If not, why does it seem so?

The reader may also find the following four hypotheses gradually being answered as a main thread through the study. Is all already invented? What does an innovation look like? Are there any incentives to be innovative? Is there any advantage for innovators to reveal their innovations?

1.4 Delimitation

We have assumed that a focused approach on an activity in an individual industry is beneficial from a scientific point of view. The results of the study will be more precise, repeatable, valid and useful operationally than a more general approach. We hope the study will inspire others to similar studies of other industries, which would gradually allow a more general, scientific understanding of forces for technologic development to take form. This study is delimited to road and railroads operations and maintenance.

Within the innovation system concerning road and railroads operations and maintenance, all actors can spur innovation within their own organization. They can also establish incentives to their suppliers. In this study we focus in particular on the incentives in the relation between principals and their main contractors, although the other relations in the supply chain are also briefly commented.

The term monopoly (state monopoly) used in this study may be slightly misleading. The correct term should be monopsony rather than monopoly, since we are, in the relation studied here, analyzing a single buyer, not a single seller. It can also be argued that the buyer is not the only buyer on the market. Vägverket runs 23 % of the roads, the main ones, but municipalities own 10 % of the roads and remaining 67 % have private principals. Also some rail track networks are owned by municipalities and private companies. This study is however delimited to the two state principals, Vägverket and Banverket.

We seek incentives primarily within the public tendering – contracting out context. In Chapter 5, however, we relax this delimitation by comparing with France, which is still carrying out operations and maintenance in-house.

All opinions and aspects are not represented since only a limited number of industry representatives, approximately 50, have been interviewed. No statement should be taken as the ultimate truth. A general assumption, however, that the interviewee would not have uttered it unless there was something in it, has been enough to allow the statement publication in this report.

We have assumed it being beneficial for the industry that as many different opinions as possible are mentioned. We have tried to hear both sides of the same aspects, by forwarding claims and statements to the other party of the contractor – principal relation. The publication of this study is also part of this strategy. Having heard how the other party looks at the same issues will hopefully create a constructive basis for improvements of the incentives and the innovative climate. Since the principal is only one and the private contractors are multiple, the private contractors may have received
more space than they should have had in the report from a “fair” point of view. The same applies to the relation between the private contractors and the public contractor.

The examples of innovations, as well as examples of research areas, in the current and in the past are also published in the same, qualitative, spirit. The reported innovations and research domains were mentioned and discussed in interviews or in published material. Many unmentioned areas are also researched on and some of these may be just as important or even more important than those mentioned. Managers and white collar are overrepresented among the interviewees as compared to people out in the terrain. This may give advantages regarding overview and priorities, but disadvantages regarding detail and the actual effects of measures, policies, competition and innovations.

### 1.5 Method

Lind (2003) lists five main types, or stages, of scientific study:

1. Build mathematical models and verify causal relationships in these models;
2. Run statistical analyses of existing data with econometric methods;
3. Make laboratory experiments;
4. Interview central actors;
5. Participatory observation.

Depending on previous knowledge, each methodological approach above carries a marginal utility. The researcher should choose the method with the highest marginal utility. Each study using a certain method will usually reduce the marginal utility for that method for future studies. If not, further studies with the same method should continue until its marginal utility falls below one of the others.

Usually only one of the five method types will be used for the empirical study, but there is no apparent reason to exclude using more than one, switching method within the study as soon as its marginal utility falls below another method. Having used almost all of the above in the same study is not an objective in itself, and probably rare, taking in consideration the span from qualitative to quantitative methods. Perhaps a sixth method, survey (inquiry, investigation), should be added to the list, being a special form of (anonymous) interviews with more standardized questions and answer alternatives than personal interviews.

Interviews, participatory observations, an experiment and a survey were methods used in this study. First, in a situation of relatively small initial knowledge, the assumption was that the highest marginal utility would be from interviewing central actors. Knowledge growth during this stage was considerable. Each interview’s addition to the knowledge-base exhibiting diminishing returns, it was later assumed that the marginal utility had become higher for participatory observation.

The following period was characterized by a method related to participatory observation. Two operational units of Vägverket and two of Banverket were selected as reality study objects. The participatory observation consisted of studying past and actual tender documents, processes and meetings with procurement staff.

It would be rational to assume that also this method would suffer from diminishing returns, since each attended meeting would bring less and less new knowledge. The participatory strategy was therefore gradually blended with preparing for the third
methodological stage, the experimental one, in Vägverket, and a seminar including a survey with the research questions, in Banverket.

A more quantitative method would have been better suited to measure the innovation rate at present and in the past. The reason why we skipped it, was the *so what* and *ex post only* - aspects of such an investigation. An ex post determined rate of innovation often gives just little guidance to how innovations are stimulated ex ante (in the future). Whether low or high, steady or decreasing, the resulting action would probably be the same: How can we stimulate to more innovations?

The answer to that question, how innovations can be stimulated, can never be complete. Our findings must be regarded as a partial result and contribution to the long-term understanding. A qualitative, explorative method was selected as expected to bring the most useful results. The sequence of interviews developed into a continuous brainstorming exercise. Since the researcher was the only always present participant, it seems appropriate to reveal the results of this brainstorming to the world, which is the primary purpose of this report. By participatory observation and a survey in Banverket and an experiment in Vägverket we have however tested some of the statements mentioned in the interviews.

An expected result of the study was to falsify that Vägverket did not listen to their contractors when innovations were suggested. Instead however, the result verified this and other areas where the principal can improve further.

The source is usually stated, but not always. Reasons for not stating a source can be ethical (discretion, allowing the person anonymity) or that it has, unfortunately and unintentional, been forgotten. Also in these cases we have still wanted to forward what was said to the world. It can also be that the source is the same as in the previous lines or paragraphs, or that the information is not controversial or crucial to this report. We have, in particular in chapters 3 – 5, found that the value of stating and in particular repeating the source has not been high enough to overrule the disturbance of the reading that each source reference inevitably creates.

The general rule, that non-referred statement refers to the author and his supervisors, can be assumed when the sentence starts with “it may be argued”, “we...”. This is common towards the end of a section and the final chapters of the report.

All Vägverket’s seven regions were invited to participate in the experiment. Only two were however convinced to participate. Out of these one had to pull out in the last minute. Fortunately, one region was left, still willing and able to participate in our experiment 1. The results presented in this paper should be regarded with the caution appropriate from the fact of having a sample size of only one sample. The result should also be interpreted with some reflection on the biases that might have been an undesired result from the selection process described above. These are reasons to see it primarily as an explorative study. This does not exclude, as with all explorative studies, that the imperfect selection methods may have happened to yield a correct result. Each reader may make this decision for himself or herself.
2 Innovations – Theory and Practice

In this study, we present a number of theory schools. Each school of theories has some relevance, and provide some guidance, for our research question, incentives to innovation. Still none of the theory schools fits perfectly, and there might be other schools with great relevance on the problem, not being treated. Behavior and motivation theory e.g., from the human resources domain, is not treated, although it could have provided interesting insights on the research question from a psychological viewpoint.

In the current chapter, Chapter 2, we will focus on theories defining innovations and actors in an innovation system. These definitions serves as an introduction of the actors and their interaction, further described actor by actor, in chapters 3, 4 and 5. In Chapter 6, some complementary theory will be presented, e.g. regarding the role of innovations and technical development for society. In Chapter 7, theory specific to this study is developed. All the three theory chapters serve as an introduction and basis for the empirical findings and their analysis in Chapters 8 and 9.

There are several major types of technical development. One might primarily think about new, sophisticated machinery, but this is not the only and may not be the most important field of innovation.

2.1 Various Ways to Classify Innovations

Innovations can be structured as suggested by Edquist (Fischer & Fröhlich 2001, p. 49):

![INNOVATIONS](image)

**Figure 2.1 A taxonomy of innovations**

Influenced by Schumpeter (1961), we may also structure them as follows:

![INNOVATIONS](image)

**Figure 2.2 Paradigmatic versus incremental innovations**

The two ways, Figure 2.1 and Figure 2.2, are not independent. The following example can serve to exemplify the difference between the two, at the same time weaving them together.

A first breakthrough, paradigmatic innovation, is followed by a series of less radical, incremental innovations, being small improvements and complementary products, of the
original idea. Often the breakthrough innovation is conceived as being a new product, and the incremental innovations would then be the gradual process to manufacture it more and more efficiently.

But Schumpeter may not object, if we use his ideas the other way around. In our case, the public tendering and contracting out can be seen as the breakthrough innovation, which has opened up a new field for innovations, both product and process innovations. Then the breakthrough innovation is of process/organizational nature, rather than a product.

Product innovations should not be confused with the object of innovation. The object of innovation can be improved with any of product, process or organizational innovations – most often a combination of all three.

Some objects of innovation in our industry (operations and maintenance) are:

1. The road itself (its endurance, drainage, smoothness and price can be improved)
2. On/around the road (fences, signals, road markings etc.)
3. Equipment and software for road condition maintenance, operation and supervision can be developed and improved
4. The machinery, procedures and the human capital.

These objects could be ordered in a hierarchy. Primary objects being the road and its surroundings (1 and 2 above), secondary (indirect) objects being the machinery and routines (3 and 4 above) to operate and maintain the primary objects.

These examples from our industry may shed new light on a third dimension (additional to Figure 2.1 and Figure 2.2) of innovations:

![INNOVATIONS Diagram](image_url)

**Figure 2.3** Jones (1975, p.157) defines technical progress by its effect in three categories.

Should the principal also reward qualitative innovations? Or are they beyond the scope of the contractors’ delivery? Defining what a qualitative innovation is may be a challenge. Still that challenge is easy compared to the challenge of calculating its value for society. These two challenges need to be developed in a separate study. Qualitative innovations were, at one point, not excluded from this study. Vägverket however changed our experiment so that they were expressly excluded. Only money saving innovations were allowed to influence the comparison values in the tender evaluations. An advantage with this delimitation was that it made the evaluation less complicated.
In the following matrix we have put an example of an innovation of each category.

Table 2.1 Examples of innovations using the categorization of Figure 2.1.

<table>
<thead>
<tr>
<th>Type of innovation</th>
<th>Principal Contractor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product</td>
<td>2+1 lane road</td>
</tr>
<tr>
<td>Process</td>
<td>GPS on-line supervision</td>
</tr>
<tr>
<td>Organization</td>
<td>Principal-contractor-model</td>
</tr>
<tr>
<td></td>
<td>Nozzle feeder</td>
</tr>
<tr>
<td></td>
<td>Same truck for salting &amp; sanding</td>
</tr>
<tr>
<td></td>
<td>Teams of 2-3 persons only</td>
</tr>
</tbody>
</table>

The various types will be further exemplified in the following sections.

2.2 An Organizational Innovation

Vägverket’s division into a purchasing and a production unit, the principal-contractor philosophy and public tendering could be regarded as organizational innovations. Following these new rules of the game, set by the politicians, Vägverket and Banverket have had to reorganize their activities substantially with major impact on both inputs and outputs.

Seen from the perspective of our industry, these three innovations seem paradigmatic. From society’s point of view however, perhaps, these new rules of the game were quite expected, natural and inevitable, a result of current trend towards allowing more room for market mechanisms.

If the change was inevitable given the circumstances, which there is reason to assume, it limits the choices for the future. Even if the liberalization of operations and maintenance would turn out to have disadvantages, the alternative to revert and turn the clock backwards probably does not exist. The same may apply for performance procurement (Section 7.1.6), although its adversaries may not have fully realized it.

Researchers generally seem to conclude, that innovation in operations and maintenance in the last decades, happen more often and are more substantial in the organizational field than in the technical field. To an engineering dominated industry however, there is a tendency that only technical innovations counts. The larger and more complex the machines, the higher would be the innovation value, and this to some extent could explain the general feeling that the industry is no longer innovative. It may simply be true that the era of conspicuous and materialistic road operations and maintenance innovation is passed. This does not mean that its general progress is slowing down.

A study by Arnek (2002) finds a 22-27 % gain in productivity shortly after the introduction of public tendering. There is however a tendency the last years of consolidation and fewer bidders, which may raise the prices and lower the quality in the future (CDU 2003, VV 2003a). The market and procurement division of Vägverket is therefore experimenting with splitting the tenders to encourage smaller firms to take part.

2.3 A Technical Innovation

The non-meeting 2+1 lane roads with cable barrier, semi-motorways or 13 m-roads, have been referred to as a breakthrough (product and technical) innovation. This positive assessment is related to the dramatic cut in fatal accidents on these roads.
continuously by VTI (e.g. VTI 2003). They save lives but are more difficult to operate and repair. Two plows are necessary going tandem, which obstructs the traffic and they have to go slower.

In Sweden a normal road with one lane in each direction is 9 meters. In the end of the 1990s many of these had been widened to 13 m, to allow a 3 m strip on each side as security and area for pedestrians, bicycles and broken-down cars. It was common knowledge and taught at driving schools that this shoulder should only in rare cases be used for ordinary, running traffic, for example when having to avoid obstacles or dangers in the main road.

With time however, the higher pace of traffic more and more forced the slower traffic to use the three-meter shoulder, to facilitate overtaking in the main lane. For truck drivers a contradiction occurred, since the reduced road support at the edge of the road if constructed before the middle of the 1970s (VTI 2004), would make them less suited for heavy vehicles. Still faster traffic more and more expected them to use this field more or less permanently, why the idea of the shoulder as safety margin was loosing ground (!) and some shoulders roads were literally worn down quicker than expected by heavy traffic.

To solve this, a first approach was to reduce the 3 m shoulder to only 1 m, thus making the main lane 5.5 m wide, enough for a car to pass without the slower vehicle having to use the 1 m shoulder. In general, however, the passing vehicle would cross the division line to the oncoming traffic, to keep a safety margin to the slower vehicle. To avoid this, the road was painted 2 + 1 alternating, so that there was a main right of way for one of the directions in the middle lane. Each couple of kilometers, the direction of the middle lane was altered, in an organized and well-marked way with signs and road line marking.

Still, drivers of the wrong direction often violated the middle lane. Torsten Berg, Vägverket, was one of the persons initiating that a fence was put on the middle line, to completely prevent accidents between meeting vehicles.

**Table 2.2** Along the 950 km of roads today equipped with 2 + 1 - design, the number of fatalities would statistically have attained 60, if no action had been undertaken. The actual number is however, with the innovation, only 9 fatalities (VTI 2004).

<table>
<thead>
<tr>
<th>Statistically expected number of fatalities since opened, if no barrier</th>
<th>60</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actual number of fatalities since equipped with barrier (June 2004, 950 km)</td>
<td>9</td>
</tr>
</tbody>
</table>

This result has been achieved at a relatively low cost. Raising the standard further into a motor road with fully separated lanes would statistically have marginally reduced the number of severely injured even further, but without reduction in fatalities and at a significantly higher cost.

The 2 + 1 roads with cable barrier are more expensive to clear from snow and de-ice than ordinary (1 + 1 or 2 + 2) roads and more difficult and dangerous to clear from snow and ice than freeways, with grass between the opposite lanes. Fortunately, for both plow drivers and all other drivers, the fence is flexible i.e. its posts will bend or detach from the ground if run into. This means that it is the wire, not the poles, along the fence that actually stops the vehicle. Accidents without injured or dead, but with
substantial damage on the vehicles and the fence, are fairly common. Common enough that the road administration is hesitant to repair holes in the fence unless there are a number of holes to be mended in the same repair loop (VV 2003a).

The work with repairing a hole is dangerous, particularly on the single lane side where the traffic will pass close to the works. On the dual lane side, the middle lane is usually blocked to create the area where the workers are. As traffic gets denser and faster, road workers demand the whole road to be blocked for traffic. This might be the background why Vägverket (VV 2003a, VVÄ 2004) were particularly interested in innovations in this field.

2.4 Radical or Just Incremental Technical Innovations?

Time will show if the following innovations are major or minor steps for humanity. Below we will account for some fields of innovation during the last decade as well as current research fronts.

2.4.1 Vägverket

An area of innovation in the 1990s has been information technology including geographical information systems (GIS) and global positioning (GPS). Before 1992, the road station manager kept an information network of taxi drivers and others who he could call for weather and road condition reports at their home location. The area was not larger than that he could personally keep track of all activities.

The increasing average area size and the decreasing number of staff demanded new information equipment, among other things for reporting and enabling action upon weather and road conditions. GIS and GPS have enabled better supervision, planning, documentation and follow-up, important achievements both for contractors and procurers, thanks to linking information through maps. Databases for safer calculations in the future have been created. Skanska Skövde-Falköping started with GPS on its plow.

Vägverket has invested in an own radio communication system. Mobile telephones were not sufficient since they were blocked in bad weather when all wanted to call at the same time.

Machines to reuse the gravel in the ditch were developed, making grass turf land on the truck but the gravel back on the road again. Vägverket Produktion won the first contract in 1992 thanks to this innovation, which dropped costs to 9,000 SEK/km. But next year another competitor offered 6,000 SEK/km, without using this innovation. Nobody knows how this price could be so low since the cost of the gravel itself is higher than that. Suspicions were that new gravel would never be added to the road, but not being able to prove it, Vägverket had to award the contract to the low bidder in question after having discussed the matter on the highest management level. (VV 2003a)

Nozzle feeder: Pressurized air was used to blow the hole in the road surface clean. Then the oil gravel was inserted. Nice, fast, little waste. The new contractors however turned their backs to this method and returned to manual methods. Was the nozzle feeder too expensive? One answer is that the nozzle feeder was not good enough. “The repairs do not last. Two men and a truck are unbeatable” (Skanska Billingsryd 2003).

Plow brackets: Independent operators were created so that they could serve any of the contractors. In 1992 Vägverket had many trucks with various plow brackets.
Slush plows: Vägverket assembled these until 1992 but no technical development since. Warm water-mixing came later.

“Finnish under-bite”: Vägverket forced the use of this innovation by including a performance-specified demand of 2-3 mm of ice plus mentioning a certain Finnish innovation in the specification as an example of a method to get rid of the ice.

Experiments with salt solutions. 54% of the salt is distributed in diluted form, to save volumes of salt (På Väg, 6/2003, p.6). Economy, environment and cars benefit from this.

Vägverket Produktion (VVP 2003b) mentioned the following examples of innovations, one as a positive example, one as a negative example.

A fairly recent innovation, saving millions, is a Norwegian plow, Scanasteel. Each full length blade consists of three shorter, hard and durable Sandvik steel blades kept together by rubber, vulcanized to the steel. This makes them follow the road surface more flexibly. Ice, snow and rain-mixed snow are better and quieter removed, without wobbling and with less friction. Each blade can be used for 7,000 km instead of 1,000 km. A side effect is that it also removes the road markings paint more than the traditional one-blade plows. Some of the profit from the methods must be used to cover extra costs of painting. This could be a reason to have the same contractor for snow clearance and road marking, an example of where a larger scope of delivery raises the innovation potential. As many as 390 out of 900 Vägverket Produktion units are now equipped with this Norwegian innovation. Vägverket Produktion saves 10,000 SEK per such plow per year.

Before 1992 each station, more or less, had a plow. Plows are nowadays less needed. There are too many. The ergonomic road plow was awarded the price as proposal of the year at one time but was too expensive to use. The innovation was not implemented.

2.4.2 Banverket

90 % of the research and development activity is bottom-up (BV 2003d). Examples of research projects in 2003 are geology mechanics, dimensioning of tunnels, environment issues, polluted soils, groundwater, transporting hazardous goods, noise, vibrations, the man-machine-interface, train drivers work environment, work conditions and suicidal risks.

Banverket’s technical specialists often work with the established Swedish technical universities such as KTH, Chalmers, Luleå, VTI, Uppsala University. International research projects where a Swedish research environment is involved are e.g. track stability (France), capacity for the track to carry a train at different speeds without vibrations and the contact between rail and wheel. There are some 10 projects with Chalmers regarding wheel wear, track forces and turnout functions. Turnouts are generally kept free from snow and ice by electric heat circuits, although ice and windblown snow may at occasions be removed manually by shoveling. Brushes have been tested.

Some research projects use image analysis, IR technology and accelerators. Image analysis is used in a system to photograph the power captor on the locomotive roof. When a defective device is detected which may tear down the catenaries, an alarm signal is generated. IR technology is used for detection of hot wheels. Acceleration measurement devices are used for detecting unircular wheels.
In the old days, a rail supervisor every 5 km checked the track before and after each passage of a train. Today, the normal procedure is still manual, although each inspector covers a larger area. Tomorrow’s technology may be inspection cars that feel along the track, at the same time filming it. The market drives such technology without research investments by the railway providers. Two companies in Europe are competing. (BV 2003d)

2.5 Innovation System Theory
Vägverket, Banverket and their contractors are concerned with the apparent lack of innovations in road and railroad maintenance and operations. They have expressed interest in studying the incentives for innovation for the involved parties, maybe all the way down to individual level. This suggests a more microeconomic approach than normally used in innovation economics and innovation system research.

Alderman (2001) implies that various (spatial) scales, from global to local, can be used for an innovation system, and also other types than spatial, e.g. sectoral. Which scale of the innovation system is most meaningful for our particular purpose?

Let us start at large distance, presuming a global innovation system. Is the road and rail administration and development global enough to make the global scale the most appropriate arena to study our industries’ incentives to innovate?

The suppliers are in many cases global corporations. But the principals for the networks are, almost all, national companies. Furthermore, they seem to remain national companies, usually owned by their government, also in the near future. Agreements across borders have indeed been reached on many technical issues. Nevertheless, it appears easier to see these agreements as cooperation between independent entities, than to see the differing national standards as deviations from a presumed unity.

Rejecting the global and European levels as appropriate, in favor of the national level, for the above reasons, the next step is to analyze if we should zoom in even further, to the regional level. Since 90 % of technical matters are handled on the national level, however, and since culture, history and language have resulted in a national system consisting of national technical specifications and practices, the regional level seems...
less appropriate in this case. The tender situation is regional. Innovations may occur
first time in a specific local area, then very quickly spread to the region (since the
principal representatives cover the whole region). Then quite soon it will probably also
spread to a national level.

Road and railroad investment are of long duration and technically complicated, which
slows down the globalization process of the innovation system. Accordingly, the
national viewpoint seems to be the most appropriate spatial zoom level for this study of
the innovation system for road and rail infrastructure. In addition we have the research
institutes and research funding which have a national character.

2.6 The Swedish Innovation System

The funding system for R&D in Sweden has been changed in later years. There were
previously five publicly funded main bodies financing postgraduate research and
development: Vägverket, Banverket, Nutek, BFR and KFB. BFR and KFB have
recently been reorganized by political decisions and replaced by the new agencies
Vinnova and Formas. Parts of Nutek still remain. The two new institutions are oriented
towards funding research on IT and newer technologies, at the cost of traditional
industry and infrastructure field such as road and railroad maintenance. This means that
research actors in the infrastructure have faced a more or less drastic structural change
in recent years. Most researchers have been referred to Banverket, the Swedish railroad
administration and Vägverket, the Swedish road administration, as the only means of
funding research in road and railroad related issues.

Banverket and Vägverket, have also, not the least because of the selective opportunities
offered to them by this new situation, started to question their previous financial
engagements. What useful results, for them, have been generated through the research
in the different research environments? There may be other more efficient research units
or research environments, from the point of view of Vägverket and Banverket, where a
higher lever of results as compared to inputs can be generated. (VV 2004a)

In the last years several government investigations have been performed to assess
whether the reorganization of the funding system has had an unintended technical
impact on research performance. Thus it is a matter of debate to what extent the funding
system for research in the infrastructure sector has itself had a negative impact on
technical innovation.

Vinnova define innovation systems as follows:

"Actors in research, industry and political and public organizations who in interaction
generate, exchange and use new technology and new knowledge to create sustainable
growth through new products, service and processes” (http://www.vinnova.se/main.

Let us in the following apply the Alderman (2001) and Maffin et al. (1997) ideas of a
value added system but boldly call it an innovation system. Identifying and stressing
each actor’s added value in the process should not be seen as an opposing approach, but
could be seen as a major contribution to innovation system theory. The added value or
their role in the system, is a precursor for a further, explanatory contribution to
innovation systems: each actor’s incentives to participate.

From these thoughts, a map of the innovation system at the national zoom level could
look as the Figure 2.5 below. The primary players, by Alderman exemplified by prime
contractors, principals, end users, suppliers and ‘project integrator’ (on our map:
‘principals’) are contained in rectangular boxes with solid line and their influences are marked with bold arrows. The secondary players (engineering scientists, financiers, regulators, insurers etc.) have no line around them and thin line arrows indicate their relatively smaller influence. The structural components, by Alderman exemplified by institutional framework, human resources, logistics, information systems and pre-existing state of technology and science base (on this map: ‘state-of-the-art’) are surrounding the system. Alderman’s four ‘drivers’; changing market requirements, technical improvements, new sources of competition and regulation/de-regulation and environmental issues; are summarized into just one: ‘market requirements’ on this map.

Figure 2.5 The Swedish system described with Maffin et al’s (1997) model for value added systems. Its two categories (primary and secondary players) have been developed by Alderman’s (2001) more modulated categorization: project integrator, producers, customers, end users, suppliers, financiers etc. A category, government/municipalities, has been added. The model has been verticalized to emphasize the (formal) positions of power.

2.7 Sectoral and Industry-Specific Zooming

In the map of the system above, we may feel intuitively that some of the actors have little influence, while other actors with more influence on technical progress, are not represented in a sufficiently detailed manner. To remedy this, let us bring back into our minds, that, although we have rejected further zooming in the spatial dimension, we can still continue the zooming into e.g. a specific sector (Marklund 1989, Malerba 2002), and, why not, into a specific industry or a specific activity inside that industry.
There is probably an advantage to magnify as much as possible, to find and see the incentives on micro and individual level. Still, the magnification must not exclude actors with major influence on the technical progress in our field of study. The most beneficial zoom level thus depends not only on our study object and our purpose, but also on the organizational and communication structures prevailing, why it can be difficult for a researcher to pick the right level successfully from the beginning.

The magnification level chosen for this study has developed into being the industry level for the railroad, and the activity (operations) level for the roads. Why? Banverket’s technical department, Järnvägssystem, is responsible for technical development of both Investments and Service of the rail network, in a way that makes it difficult to separate Service from Investments. Service cannot stand on its own legs and maintain an innovation system including technical progress, without Järnvägssystem.

In the road sector, however, technical development of methods and products to facilitate routine operations on the road could, to a larger extent at least, be possible without involving the departments responsible for the construction of the roads.

From a pure research point of view, there may perhaps also be an extra interest in applying two different zoom levels on the two industries. Enlarging a step (which we may have to do for the roads) can if necessary be done later. The choice of Railroads as the correct magnification was not done at the beginning of the study. It was decided when the service-people reported the opinion that the technical regulations managed by Järnvägssystem was perceived as obstacles for technical progress (Section 10.13.4)

The general national innovation system above is mapped to include all industrial activity in Sweden, but is also valid as a map of just the road innovation system or just the railroad innovation system. By double-arrow in the indicated direction we have emphasized the relations treated in this study.

Let us follow the incentives downwards in Figure 2.5. The first incentive interface is between the public and the government. Apart from unselfish incentives, we find the natural incentive in this interface to be the wish of politicians to be re-elected.

“The politicians have influence. Their demands with regard to alcolocks, environment and traffic safety open up for innovations. They required Vägverket to only use cars with maximum 8 liters / 100 km fuel consumption – all the way up to the top level managers. Despite initial protests, Volvo succeeded to develop a version of their S 80 with only 8 l consumption.” (VV 2003f)
The politicians’ influence on technical development in our industry will probably be general, image-related issues. Let us move on to the second incentive interface, the one between the government and the principals.

2.8 Government’s Incentives to the Principals

The government directives to the two principals are almost identical, except that ‘road transport system’ in the letter to Vägverket, is replaced by ‘track-bound traffic’ in the letter to Banverket. We let the objectives described in these two letters represent the governmental contribution to the incentives for innovation in these industries and delimit away all other documents and instructions from the government. Below is an extract of the Vägverket letter (Regeringen, 2004), which describes the main objectives to pursue the coming year. The overall responsibility is to ensure an economically efficient, sustainable transport provision for citizens and industry countrywide.

Both the two principals’ main objectives are subdivided as follows:

1. Accessibility
2. High transport quality
3. Safe traffic
4. Good environment
5. Positive regional development
6. Equal rights

The first objective is an accessible transport system, where the road transport system is developed to meet the basic needs of citizens and industry.

The second objective is that the road (railroad) transport system’s design and function should allow for a high transport quality for citizens and industry.

The third objective is safe traffic where the long-term goal must be that nobody is killed nor seriously injured as a result of traffic accidents. The design and function of the transport system must adapt to the requirements resulting from this objective.

The fourth objective is a good environment where the design and function of the system are adapted to demands for a good and healthy life environment for everybody, where natural and cultural environment is protected from damage. Good housekeeping with land, water, energy and other natural resources is to be promoted. The design of the system must contribute to the achievement of national goals of environmental quality.

The fifth objective is regional development, where the transport system promotes a balanced regional development by reducing the differences of opportunities of various parts of the country to develop, as well as reducing disadvantages of long transport distances.

The sixth objective is a transport system designed to meet transport demands of both women and men. Women and men must have equal rights and opportunities to influence the creation, design and management and their values must be attributed the same weight.

In addition to these overarching responsibilities Vägverket and Banverket are also responsible for the state of the roads and the tracks. They have own production units that, in competition with the private sector, can undertake most practical works necessary, in particular regarding routine maintenance.
When the responsibility for the technical development and Sweden’s competitiveness was added in 1996 it incurred some reorganization. Apart from building, maintaining and operating the state road (railroad) network as economically as possible, the principal should now also deal with work environment issues (safety of personnel) and the technical development and engineering related issues (VV 2003a). But when looking through the current directive (Regeringen 2004a) the importance of technical development and work environment issues is not particularly emphasized. Technologic development is not expressed as a goal in itself, nor is the working environment. Thus, although Vägverket is overarching responsible for everything, the direct responsibility for work environment lies with the contractors.

Fairclough (2002) identifies three important roles for the principal: regulator, sponsor and client. As regulator, it is responsible for the issue and enforcement of the specifications and norms regulating construction and transportation. As sponsor, they channel taxpayers’ money into investments and maintenance. As client they buy services from private companies performing most of the actual work.

The audit of the Swedish Parliament defines four roles (Riksdagens Revisorer 2000 p.9): Regulator, producer, principal for the networks and principal for the long-term functions and development of the sector in a wide sense.

The third incentive interface is between the principals and the contractors.

Figure 2.7 Focus of the study is the relation between principal and contractor (KTH 2004a, personal communication).

Chapter 3 will describe the history and present regarding organization, policy, incentives and general conditions for innovations in Vägverket. Chapter 4 will describe the same issues in Banverket. In Chapter 5 we make an international comparison, mainly by describing the French innovation systems for roads and railroads.
3 Vägverket – Swedish Road Administration

Vägverket divides its activities into three main categories (Vägverket 1990):

1. Investments - new roads or significant upgrades, i.e. to a higher standard than the initial one.
2. Maintenance - e.g. road surface realignment, i.e. upgrades that will technically last more than a year.
3. Operations - snow clearance, sanding and salting, ditching, drainage, gritting, patching, mending, plant and tree cutting, change and clean signs and traffic lights, bulb changing and urgent temporary repairs of holes in the road surface. These measures have no lasting effects beyond the running fiscal year.

Investments and maintenance are procured and executed on an object-by-object basis. This means that public tenders are organized around each individual road object, which was the case also before the contracting out reform of 1992. Objects are e.g. a road section, a bridge or a tunnel. The operations contracts are not object based, but regionally organized, covering an area of roads. The duration of the contracts are usually 3 years, with an optional 2-3 year extension.

Vägverket is organized in seven regional units administering all together 140 maintenance and operations areas.

Figure 3.1 Vägverket has organized their nationwide activity in seven regions, each containing several administrative areas of operations and maintenance.

Vägverket has an in-house production unit, Vägverket Produktion, The Swedish Road Administration, Construction & Maintenance. Its market share in operations and maintenance is today around 60 %. In this study, the term Vägverket normally refers to the authority only, not including its production unit. Vägverket Produktion is, unless otherwise commented, treated as one among the other contractors to Vägverket.

3.1 Organization of Technical Development

During the 1980s, expenses for operations and maintenance of the Swedish roads were increasing in relative terms. Vägverket executed and managed operations in-house with approx 250 road stations. Each station covered about 40 km of roads and was staffed with a manager, 2-3 assistants and 10-15 workers. The stations had their own trucks, plows, salt spreaders, road graders and excavators.

Steps towards more efficient road management were taken, but they were not successful. The purpose was not only to cut costs, but also to make Vägverket more uniform. Local road managers varied in their generosity and ambitions. When a year
approached its end, equipment may be bought to use budgeted funds, e.g. concrete pipes that were at a time bought suddenly in large volumes. The road worker trade unions wanted to keep all the 270 road stations. Vägverket tried to merge and close road stations, but local opinion was against and only few were closed at high goodwill cost for Vägverket.

There was creativity, but badly organized and without follow-up of the innovations. A special unit, DMk, 20-25 persons on national level, was dedicated to development of new equipment. Its members traveled around the country to sell their ideas to the road station managers, at the same time picking up ideas from the operative units.

“DMk had hundreds of drawings of plows from which nobody dared to diverge. They were fantastic drawings of fantastic machines, a dream for the machinery industry, which made good money from this activity. Ideas were often nicknamed after their inventors, e.g. Lilljanne, Storjanne” (VV 2003a).

Inventors were financially rewarded. Vägverket’s contracting unit, Vägverket Produktion, still maintains these practices to some extent, but the number of proposals has dropped significantly (VVP 2003a).

Another unit, DDa, with a national center and regional units in the seven regions, employed 45 persons dedicated to find efficient methods. In some cases each DDa unit specialized on one particular method. Both of these two units were closed 1992 and their staff was scattered to other units within Vägverket. A small unit of 1-3 people has still worked with machinery and technical development in Vägverket, but last person in this unit will soon retire.

There was a so-called machinery group in each county. This group was responsible for all machinery and the road station managers had to accept its decisions regarding service needs of machinery etc. The group kept track of how much each unit used, ratio of usage and such matters, and reported if equipment was not used enough and should be sold.

New contractors were invited into the business 1992, such as Peab, NCC and Skanska. Evidently Vägverket Produktion, being derived from a monopoly situation, had a head start before its private competitors. To reduce this effect, and promote technical development in general, Vägverket published handbooks containing all its used technology and methods. Everyone in the industry wanted its own copy of these books, and they were printed in six thousand copies. No update was ever printed since, which Vägverket takes as a sign of slow development and disinterest in innovations.

Vägverket also separated out machinery and machinery owners, to allow competitors to take advantage of them, including the latest most developed specialized equipment. There was a worry that the new contractors would otherwise use their more general and less specialized own but older equipment, letting the most recent, specialized road work equipment gather dust. There was discussion about whether Vägverket Produktion set the prices of the specialized machinery correctly. Individuals were worried about losing their jobs.

1 DMk, ‘Driftavdelningen, maskinsektionen, konstruktionskontoret’, i.e. operations department, machinery section, construction office.
2 DDa, ‘Driftavdelningens Driftektion, allmänna kontoret’, i.e. Operations Departement, Operations Section, general office.
3 Sweden was divided into and governed by 24 counties (län) and Vägverket had the same structure.
Whatever the reason, what everyone was afraid would happen did happen. The contractors refrained from using the latest machinery. Methods left behind 25 years ago were practiced again. Why?

3.1.1 Public Tendering and Contracting Out Reforms

International trends towards contracting out public services were influencing Sweden. Already in the 1970s and 1980s, investment contracts, in particular large, complicated ones, were offered as tenders to the private sector. But operations and maintenance were kept in-house until 1992. When investment as a whole declined in the beginning of the nineties, the Swedish government carried out a special study of the principal-contractor model (Hagström 1992). Results of this study were that the 24 organizational units (one for each county) were reduced to seven and 250 road stations were reduced to 140. Despite the dramatic organizational cuts, few protests were heard and a cost savings of 25% were decided overnight (VV 2003a).

Many received paid retirement and the age of retirement dropped down to 55. They were allowed to keep 80% of their previous salary. Much of it was financed by the state and the pension system. The second major result of the study was the parliamentary decision to introduce public tendering of operations in 1992. Today, what 10-15 people were previously doing, five people manage (VV 2003a, VST 2004b), with twice as large areas to supervise.

Investment and maintenance had objects for public tender already before 1992. Vägverket was accused for keeping the easy and non-risky projects for themselves, and open up only large, risky projects for competition. The less risky and thus more profitable operations contracts were kept 100% in-house. This criticism is however fully met by the 1992 reform, as all operations are now on tender. (KTH 2003c).

In the 1992 reform, Vägverket was divided into an authority and a production unit. Legally, Vägverket and Vägverket Produktion are until today not separated. This is remarkable since a separate juridical person would have a high symbolic value. Vägverket Produktion competes with the private sector, but still works under the auspices of a public enterprise structure. Finland entered the tendering process much later, in 1999, and chose a different solution. Their unit corresponding to Vägverket Produktion is separated from the authority and grouped with other state-owned companies. (VVP 2003b)

Due to complaints on the performance of private contractors, the government initiated a new study and froze the tendering policy in 1995. During that year, Vägverket Produktion received all contracts. Tendering was taken up again in 1996, after completion of the study. Since 1996 more or less all regions are subject to full competition.

The result of the tendering was overwhelming. Even in remote areas of Sweden, where there was only one possible contractor, this single contractor was so afraid to loose, that he pushed the price down. Since the costs have gone down, it would be expected that the road quality has suffered. But no research has confirmed this. The issue has been difficult for researchers to penetrate, due to lack of documentation, change of accounting system in 1992 and other factors. Rural areas claim that load carrying capacity has suffered on the small roads. This may however be more due to different prioritization of the roads, rather than the total cost saving, and should therefore perhaps not be attributed to the tendering reform.
Before 1992 it was not uncommon with extra-quality when Vägverket produced in-house, as opposed to when private contractors were engaged. If the specification said 70 cm thickness, 85-90 was used to be on the conservative side. The private contractors could however not afford such a behavior, why Vägverket Production may have received somewhat better reputation for quality. (NCC 2003b)

At some occasions prices in tenders have been so low that the principal wanted to disqualify the bidder. When the price offered could not even cover the raw material cost, the only explanation would be that the contractor was planning to do less than the contract demanded, speculating in being able to influence the controller negatively during the contract. (VV 2003a)

Other experiments and improvements of the tender documents were introduced in 2003. These experiments were called combinatory bidding. Bidders were allowed to propose other service combinations and other area covering than specified in the tender documents. One aim was to reduce prices by scale economies as adjacent areas were optimally combined by each bidder. A second advantage was that small local companies could now more easily submit bids for a small area or a specific task only. The principal is not satisfied with having only 2-4 bidders. As comparison Latvia has over 20 bidders (Aghinyan 2003).

3.1.2 Vägverket Performance Contract Model and RWIS (VVIS)

Ever since the start of the contracting out reform, a guiding philosophy has been that the principal should only be concerned with final performance, the results, not the methods used. The belief behind the performance contract⁴ (Zietlow et al 2002) philosophy is that innovations and technical development benefit from having as much freedom as possible. A Swedish interpretation for Vägverket is developed in a doctoral thesis by Ulf Olsson in 1993.

To work well, performance contracts should not contain any cost-influencing unknown factors at the point in time when the tender is to be submitted. The major problem with converting the operations and maintenance contracts into performance contracts has been the weather factor. Around 50 % of the contracted amount is often used by the contractor to clear snow and de-ice in the cold season. The contractors demanded not only access to weather information to be able to do their job, but also that the increased work caused by bad weather conditions should generate more payment.

VVIS, Vägverket’s weather information system, was a project initiated already in the end of the 1970s by Enator in Östersund. It consists of road displays to guide the traffic, sensors in the road at places prone to freezing, places that can however vary depending on e.g. cutting of trees. 650 sensors are placed on so called “reindeer horns” that measure air and road surface temperature. They send their report by phone line to a mainframe computer, which processes the data and create a forecast. It is a co-operation between SMHI, Swedish Meteorological and Hydrological Institute, and Vägverket. Vägverket submits the measured weather data and SMHI delivers the forecasts. A smart system, that enables correct action at the right moment. Concentrated, geographically limited action is made possible. This should reduce the long-term costs. Some cameras can zoom to see the road surface in more detail. This is complementary to the sensors in

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⁴ Performance contract in Swedish: Funktionskontrakt. The English word is not ideal, since performance can have several meanings. We are however reluctant to pioneer with a new English term, until having found it in English literature. Performance-specified is used in Zietlow et al (2002).
the road, which is useful for example to detect snow. There is a central unit in Borlänge with 2-3 people but each of the 7 regions has an office, to where the public can call. VVIS has influenced also the contracts regarding construction of roads.

Vägverket buys the service of the VVIS from Vägverket Produktion. All the contractors have access to the system for free. But it is difficult to know if they use it. Vägverket demands that the contractors follow a course how to handle the system. VVIS has replaced about 1,000 people who previously interpreted the winter conditions and the effect on the road. It is also a help to Vägverket to monitor performance of contractors, and to link payment with weather conditions and performance. VVIS costs Vägverket 25 million SEK a year to run. 10-11 million write-offs of investment and the yearly servicing. 3 million SEK are for those who work with it. Some millions are paid to SMHI and VTI, the Swedish National Road and Transport Research Institute, while operation of the system is paid and carried out by Vägverket. Automatic sensors react if there is a sensor failure. VVIS has received international recognition (road weather information systems, RWIS, is the English term for such systems). In particular Vägverket’s choice to have a national centralized database has been seen as an asset, compared to other countries having built up decentralized weather data, difficult to aggregate at a later stage (VV 2004g). SMHI can offer reports as detailed as every 12x12 km, telling whether that particular square of the country has received snow or is slippery. Of course there are now and then problems with practicalities such as snow measuring devices, plows affecting the devices and wind influence.

Vägverket wanted to be modern and had high ambitions in 1992. According to the weather statistics there are 35-60 days a year, depending on location in Sweden, when deicing is needed. Vägverket wanted the contracts on ice- and snow-clearing to be based on a price per such day. But the contractors refused and claimed that they would then sometimes have to go out without being paid, and other days they could stay home and still be paid, with such a system. In 1993-1994, Vägverket felt it had to revert to hourly payment again. In 2004, however, most regions, e.g. VMN (Mälardalen) and VST (Stockholm) have managed to push the weather-based payment through. It is now also the national strategy, except in the northernmost region where weather stations are some places too scattered, which makes the system unfair or too imprecise (VM 2004).

All except region north and west use weather-based payment models (VV 2004g).

Their argument is that even if the connection between the weather indicators and necessary action is not perfect, it is better than nothing and the same for everybody. The weather indicators regulate the pay, but the actual road conditions call for the necessary action. Contract fulfillment is to work when action is needed.

There are now 3 weather-related models used in operations:

1. Payment per slippery day, based on SMHI reports,
2. Payment per action
3. Payment per km cleared road (e.g. cleared within 6 h)

In some areas sand is paid per volume used, while salt is included in the fixed price and thus not paid by the principal but fully by the contractor. This has resulted in that sand was used as much as at all possible, though salt produces a clean and dry surface that would some times have been better for the friction of the road.

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5 In Swedish: Halkdygn
3.2 Market and Contractor Networks

Vägverket, the Swedish road administration, is not the principal for every road in Sweden. Of a total of about 430,000 km, 98,000 km, or 23% of the road network in Sweden, belongs to the state. 67% are private roads and 10% of all roads belong to municipalities (SCB, *Transport och kommunikationer*). All state-owned roads are regulated, administered and operated by Vägverket. The other roads are regulated and often financed, at least in part, by Vägverket, but with other principals for their administration and operation. We delimit this study to Vägverket only. We assume Vägverket to be the technical leader, which the others follow.

The annual expenditure for operations and maintenance of the state roads was around 6 billion SEK in 2003, with almost 3 billion concerning operations (Österberg 2003, p.13 and p.82, CDU 2003). An average area of a contract will cover about 700 km of roads and have a 20 million SEK turnover per year. But there are much smaller areas. Mälaröarna, an area close to Stockholm, costs Vägverket less than 4 million SEK per year.

A typical contract will be for three years with two or three years’ optional extension. 3 x 20 = 60 million SEK is a considerable amount to risk for a small company, which may explain the predominance of large, nationwide construction companies in the tenders. In the first tendered contract in Mälaröarna, Skanska, one of the major players, won the contract. But the second time the area was subject to bidding, one of its sub-contractors, a local construction company, won the area, which means it is now holding the current contract.

![Diagram](image)

*Figure 3.2 The Swedish market of operations and maintenance. Market shares are approximate*. The 140 areas have been colored depending on their current contractor (På Väg 2003)

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6 Approximate figures based on verbal communication at a reference group meeting (RGM 2003)
All the main competitors do not participate in each tender. Each ‘player’, if we use Alderman’s (2001) and Maffin et al’s (1997) somewhat relaxed vocabulary, has regions of interest where it is more competitive and it will submit bids only there. Vägverket Produktion, once being the monopolist, has branches in most places and will seldom refrain from submitting a competitive bid. It could even be argued, that Vägverket’s organization, Figure 3.1, is based on the same structure as Vägverket Produktion, which means that they have an advantageous position in the bidding.

The state-owned Vägverket Produktion has lost market shares from 100 % in 1992 to about 60 % today. It may look as if Sweden has been divided among the competitors in a predefined manner since the same contractor often runs connecting areas. Vägverket has at rare occasions, e.g. the district of Vara in Västergötland (VVP 2003b) helped a competitor to break into the most “solid Vägverket Produktion blocks” to increase competition. A juridical process is currently examining if a cartel is in place between the contractors regarding bitumen. In the case of operations and maintenance, however, the low general price level contradicts the theory of an organized cartel. The economic and practical advantage of already having an established operative unit in the neighborhood is an explanation.

According to a former employee at Skanska (Anon, personal communication June 2003) the profit levels in operation and maintenance were some years ago of little interest to the company. At the price level they could earn more money elsewhere and bids were only submitted if of interest for strategic reasons. Such a reason could be that the object could be used in the corporate marketing, as a reference object, rarely the case with an operations and maintenance contract.

Today, however, Skanska (2004) are interested in the business, as a result of Vägverket’s expressed interest to have more competition, which they hope will lead to a favorable assessment of new entrants’ bids. They want to be in when this market opportunity is developing.

We seem to have a game-like situation. Vägverket Produktion, which has not had any alternative business in the past to survive on, if they would loose an area, may submit a low bid, a bid “for survival”. The low price level and low rate of success for the private bidding companies continuously threatens to lead to less bidders, from an already too low number. This in turn probably makes the government hesitate to let Vägverket Produktion fly on its own wings. Without the bid from Vägverket Produktion, some areas could get no bidders, or Vägverket would have to award an area to a single bidder at a high price.

NCC, Skanska, Peab and Sveriges Byggindustrier (2000), the organization for private contractors, claim that Vägverket Produktion must be fully privatized. “Vägverket Produktion dumps the price to be sure of having something to do until retirement. Nobody now knows the result of Vägverket Produktion itself. The staff of Vägverket Produktion is “not acting as if they had to take the losses”. Their bids are unreasonably low compared with the number they employ” (NCC, Peab 2003-2004).

Vägverket Produktion, however, feels it has a disadvantage, not an advantage, in belonging to Vägverket. It has a legal obligation to act within the framework of Vägverket while, at the same time, it must compete in a fully deregulated market. Many decisions made by Vägverket Produktion are based on the directives of Vägverket and not the market situation. Disputes between Vägverket Produktion and Vägverket are decided by the General Director of Vägverket, without the possibility of taking the matter to court. (VVP 2003b)
There are grounds to assume that there is a political and economical wish to reduce the market share of Vägverket Produktion. At the same time, its existence on the market is a warranty for the government, to maintain control. Many other markets have been deregulated. The result has often been higher prices. If private consumers pay all or a significant share of this price rise (e.g. taxi, electricity, train operations), the price rise may not matter to the government. For the state roads however, the state would pay almost the whole bill.

Full privatization of Vägverket Produktion would probably raise market prices. The prices might rise because the criticism was correct, that its operations and maintenance division was subsidized by tax money pushing the tender prices down. Market price might however also rise because the lack of competition would allow all participating companies to add to their profits.

These profits would enable them to undertake more research and development, like in the old days. Whether they would use them for research and development, however, is not self-evident. A more secure route to canalize money to research and development might be to keep the current system, but pay extra for earmarked research and development projects. From the government’s point of view, in the pure interest of research and development, earmarked funding and keeping the current price control in the operations and maintenance may produce more innovations.

3.2.1 The Private Contractors

The new policy of opening up operations to public tendering in 1992 had impacts on the contractor side. Private construction companies were actively invited by Vägverket and also principally attracted to enter into this new business. The character of the operations business however differed in many aspects from the construction of roads, bridges and buildings, and thus demanded particular competence. It was necessary to recruit some key personnel from this business. They could be the ones previously having been occupied with the same activities in Vägverket, but it could also be the contractors. Adding to these labor key resources, they could then recruit new who would gradually learn the business.

Accordingly, it is not unfair to say that there was a recruitment problem aspect of the entry into the new business. The key personnel had to be convinced of their benefit of leaving the environment at Vägverket surrounded by many competent colleagues, to a situation of starting up from scratch and teaching new people of own force (NCC 2003b). It could even be argued that a kind of competence dilution took place, and it is not surprising if this implied a slow-down in the pace of technologic development for the following years.

Some years later however, it seems as these “isolated islands” have not only survived but developed positively. Many have become engines of development; keen and motivated staff feeling great involvement in their job. Compared to their previous tasks at Vägverket, they feel having influence, responsibility, independence and respect for their judgments. They feel a responsibility and professional pride of their service to the end users as the vehicle drivers and the pedestrians, in a much more direct way than when being one of the many in the state organization. (NCC 2003b)

“New ways to cooperate is nowadays more important than new types of blades and machinery” (NCC 2003b). Regarding research, NCC is not very active in maintenance and operations but in other fields e.g. self-compacting concrete. Cost reducing
innovations occur, such as developing casting templates that can be reused for another bridge. This favors both environment and the finances (NCC 2003b).

NCC’s perspective on the bidding process is as follows. NCC compares with its current competence and machinery when deciding whether to bid or not. 2-3 men with a pickup is a typical basic unit in e.g. NCC, and the presence of such a unit within reasonable distance matters for the decision whether to bid or not. A reasonable distance is within the same Swedish county, approximately 100 km. Additional machinery can be assumed to be available for hire locally. A region adjacent to an already established unit enables a lower bidding price. Tenders are only submitted when there is a fair chance to win. The nearby, existing contract does not have to be a state (Vägverket) contract. It may also be a municipality, since it is also principals for road operation. In major towns, the size of the contract does not necessarily mean that the units are enlarged. Instead more units are employed. In Södertälje, for example, five separate units are defending NCC’s flag.

A site manager is responsible for the team of 2-3 and above him the business manager. Under the business manager there may be several site managers and also project managers. All are responsible for their finances, but the formal responsibility for personnel is the business manager. Above the business manager is the region manager, the Sweden manager and above him the general manager of NCC.

There is no special unit in NCC dedicated to technical development. Instead employees from top to bottom meet to listen to each other’s ideas and latest news about technical development and other issues. It is based on the conception that the best ideas come from the people in the field.

The decision whether to bid lies with the business manager. To help him he may have some engineers for calculation and the site manager. Practically, he often uses old contracts as a template for the new. Risks and opportunities are evaluated. Experience sharing is important. A project leader may be assigned. Legal specialists will view the tenders and contracts before the business manager at NCC signs them. It happens that a bid is submitted for strategic reasons (i.e. at a loss in the short term). In these cases the bid must be signed one step higher, by the region manager. A strategic reason could be to break into a “compact Vägverket Produktion region”.

<table>
<thead>
<tr>
<th>Managing Director</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sweden manager</td>
</tr>
<tr>
<td>Region manager</td>
</tr>
<tr>
<td>Business manager</td>
</tr>
<tr>
<td>Site managers, project managers</td>
</tr>
<tr>
<td>Work leader</td>
</tr>
<tr>
<td>Basic unit : 2-3 operative men</td>
</tr>
</tbody>
</table>

**Figure 3.3 NCC organization**
3.3 Procurement Process

The Act of Public Procurement (presented in Section 7.5 below) and other related EU documents have been further developed internally. In 2003, Vägverket’s tender documents consisted of an administrative part, including the procurement regulations, and a technical part. The latter includes measurement and invoicing rules as well as verification and control procedures. The supplier must carry out most of the control and the client will only take a small sample to make sure the suppliers’ self-control is in order. The sample size is not and need not be mentioned (since in principle the client has the full right to control everything), but the penalty in case of unsatisfactory result must be mentioned in the call for tenders and in the resulting contract.

Once a year Vägverket distributes the plan of coming tenders, containing all maintenance of all the national roads. With on average a contract duration of 5 years (3+2), approximately 30 areas are out for tendering per year.

The procurement process starts in the spring, when contractors are invited to give their opinion on the future activities, based on the current and passed experiences. Ample criticism is taken and given. Vägverket (VVÅ 2003) describes the division of tasks with a procurement officer working with the formal and administrative parts of a tender, while the technical project leader, who is continuously in charge of the area in question, writes the technical part of the tender documents.

The work with the tender documents proceeds inside Vägverket and the resulting CD is distributed to the bidders during the winter. The bids are to be submitted by the tenderers 1-3 months later and the new contract will run from early autumn that year. If tenderers’ bids are close to one another, the project leader may collect additional opinions from the head office in Borlänge, other regions and colleagues before final decision is made.

Once the contract is in force, the technical project leader will usually follow it during the whole contract period. This is done by meeting the contractors about once a month and by random control that the contracted tasks are executed (Liljegren 2003).

An evaluation sheet of routine controls in an area is found in Section 3.5. A guideline is to have followed all roads in the area at least once in a full contract period (5 years). Penalties are generally not implied until the contractor has had a chance to correct an error. (VVÅ 2003)

The 3 billion SEK for operations and maintenance are a part of the about 14 billion SEK that are contracted out through public tendering each year. The national audit agency, RRV, has audited the procurement process (e.g. Riksrevisionsverket 1996) and noted remarkable deficiencies. The average increase of costs from the first long-term plan until finalized road construction amounted to 86% according to this report (Larsson & Lindvall 1997, ch 5). In 2000, SIKA, Swedish Institute for Communication Analysis, claims Vägverket has not systematically responded to criticism from Riksrevisionsverket.

Complaints have been issued regarding the time for submission of tenders being too short. Vägverket has not always respected the summer holiday of its contractors. But this is slowly getting better, according to Vägverket. Their local representatives however claimed recently (VVÅ 2004) that they receive the template from the head office months too late.
### 3.4 Tender Evaluation Model

The graphical presentation below is an evaluation model often used by Vägverket in the contracts of 2003 and 2004 (www.infra.kth.se/~stenbeck/ProRisk/, September 2004). Each bidder offers a price for the specified services. The 20,000 at the far right in Figure 3.4 represents this basic price.

The bidder has an environment certificate such as ISO 14001, or equivalent routines, to ensure traceability and continuous correction and improvement. This gives the bidder a 1% reduction. The box with 0.01 left of ECert in the graph above contains the reduction for an environment certificate, if any.

The bidder assigns more personnel to the contract than the minimum specified. 0.5% per person, max 1% together, is given if 1(2) persons of certain competence levels are employed 100% for the fulfillment of the particular project. The box with 0.01 left of Pers in the graph above contains the reduction for especially assigned personnel, if any.

The bidder has a quality certificate such as ISO 9001, or equivalent routines, to ensure quality, traceability and continuous correction and improvement. This gives the bidder a 1% reduction of the bid value before comparison with other bids. The box with 0.01 left of QCert in the graph above contains the reduction for quality certificate, if any.

The contractor is allowed to demand a prepayment from the principal at the beginning of the contract, but in that case the bid is penalized with an interest corresponding to an interest on the demanded prepayment. During 2003-2004, Vägverket tender conditions usually did not allow a higher prepayment demand than 10% of the total contract value. In the above model, a prepayment of 10% is assumed (0.1 to the left of Prepay). An interest rate expressed in the tender documents (4%, 0.04 in the model above) is added to the repo-interest rate (0.05 above). The repo interest rate is a measure of the current interest level set by the Swedish Central Bank. (0.04 + 0.05 = 9%)

**Figure 3.4** Vägverket’s tender evaluation model in 2003 (Roy 2004)
The basic price (20,000 in Figure 3.4) is subject to bonus or penalization before it is compared with other bids (follow the lines from right to left). Bonuses (above the straight line) can be achieved if the bidder meets criteria above minimum in certain specified areas. Penalizations (below the straight line) will apply if the bidder asks for a prepayment. Since the main principle is that the lowest bid wins the contract, bonuses are expressed as bid reductions and penalties as bid additions.

3.4.1 Risk Analysis and Simulation

The model can also be used for risk analysis. This is the normal application of the software, which has been used to produce the above graph (Roy 2004). A probability of failure (the character of the failure defined by the user, e.g. to meet the deadline) can be set for each activity, as well as an amount assumed to incur in case the risk would occur. The probability multiplied with the ‘cost-if-occur’ (weight x cost) is then the risk value for the action in question being delayed. Thus a weighted value, one value for each risk is achieved. Now the risks can be compared and prioritized.

By sorting the risks in order of this single value, a tool for risk reduction is achieved. If amounts and probabilities are correctly set, the first risk in the list is to be dealt with first. After the risk value has been reduced by some kind of action, a new risk probability and a new amount may apply. The character of the action to reduce the risk can be inserted, as well as the new risk amount and probability. The process is reiterated until the risks have been reduced to a satisfactory low level.

The overview of the risks may also result in a decision not to do anything about the risk but instead try to insure it externally. This is often rational for risks with low probability but high costs-if-occur.

![Figure 3.5 Planning and risk analysis tool. The blue flags indicate start and deadline for each activity. The amount in the left column is the risk value, the product of the probability of occurrence and the cost-if-occur.](image)

It should also be possible to add probability distributions to simulate the range of bid prices following a probability distribution.

3.5 Documentation Systems

In an area (VVÅ 2003) the following contract aspects were verified:
Levels of fulfillment
VVÅ uses three levels of fulfillment. Good, barely good and low. In general *good* means OK, *barely good* means OK after having been asked to act and *low* means not having acted within time despite having received the remark to do so.

No obstacles
*Hinderfrihet* refers to removal of objects stopping the traffic, e.g. cars after accidents and fallen trees after storms. A requirement could e.g. state that the contractor is forced to commence action within 2 hours and to have cleared the problem within another 2h. These time limits are stated in the function and standard description, the FSB. It is rare that any contractor does not fulfill this issue, since, in the rare case of a major obstacle being present at the inspection, the 2h rules allow him to react properly to the inspectors remark. Inspectors discuss if this issue of control should perhaps be removed from the routine controls, and instead only be a matter of special inspections, *riktade inspektioner*. Special inspections in the last year have e.g. concerned sinkholes and illumination.

Safety
*Trafiksäkerhet* refers to non-authorized advertisements hanging in road signs or placed within the road area, not removed in time according to the time limits in the FSB. Reporting non-authorized joining tracks and timber stacks are also in this category.

Side area
*Sidoområde* includes assuring free visibility: 4.5m above road surface to be free from branches and vegetation, and max 1.0 m high vegetation beside the road, until the wilderness fence or edge of the road area. To achieve this, the contractor uses mowers 2-3 times a year. A unit in Kalmar with specialized machinery provides the service and equipment to principals and contractors all over the country. The opposite of clearing and cutting could be the handling of rare species of plants. This is also a part of many contracts.

Barriers, *Vägskydd*. Operation and maintenance of noise walls, fences, rails, dazzling protection and curbstone.

Guidance, *Trafikledande*. Road edge posts, road signs, illumination, and traffic signals.

Rest areas, *Rastplatser*. Rest and recreation areas now and then along major roads, mainly motorways.

Road markings, *Vägmarkering*. Verification of the road markings with special equipment measuring retro-reflection. Only about 10 roads per year are tested, but still the results have been good. It seems the contractors take this issue seriously.

Winter operations, *Vintervåghållning*. The regulation in force in 2003 was Vinterdrift ’96. These controls are done when there is “weather” (which means weather like snow or ice calling for action). Also pedestrian roads and bus stops are verified. 90 % OK has been regarded as *good*. Discussions are now whether to raise the demand to 92%.

3.5.1 Penalization
The objective is that whatever the contract content and contract form, a continuous improvement of performance is the goal. But such a trend has yet not been noticed. Instead the error quotes seem to remain approximately the same. The south Swedish
The region has started to become stricter and is now more often issuing the financial penalties it is permitted to according to the contracts.

The main recourses when principals are dissatisfied and want to claim their rights in a contract are:

1. Financial penalty
2. Bring performance to contracted condition by whichever means, at the expense of the contractor
3. Discontinue the contract

The last recourse has never been used, as far as can be remembered (VV 2003b).

Transparency and objectivity are the key words in tendering and contract evaluation.

A common clause is that in case of deficient performance, the penalty is 1 % of that year’s total of that account with a minimum of 5,000 SEK. Road marking is an example of an account. If not fixed in one week, another 1 % (5,000 SEK) applies. This means not undertaking any action at all is the most economical solution. 52 weeks multiplied by 1 % only amounts to 52 %, while the saving is 100 %.

There are other mathematical examples of systematic deficiencies in Vägverket’s routines, making violation of the contracts to be the best business for the contractor. Vägverket tries to penalize them in the next tender process, if it is unhappy with the contractor’s performance in the previous period. It is questionable, however, if this will hold legally, if the previous contractor would again be the lowest in price by a significant margin.

3.6 Research and Development Program

Although the tendering and the following contract administration must be seen as the main way to influence the industry and its technical progress, the principal also has another tool. Researchers and innovators can send an application to Vägverket explaining their idea. To handle the large and expanding inflow of proposals, partly because the government’s recent restructure of public funding for research described elsewhere in this study, Vägverket has organized the RDD program:

Research ► Development ► Demonstration

19 preferred research domains have been identified, and a lump sum of money attributed to each of them. A new decision is taken every year. If there are many applications in the same domain, competition will be higher, and if there are few or no applications in a specific domain, Vägverket will make efforts to encourage applications in that domain. Thus it is not the application pressure that determines in what domains Vägverket will provide frame funding, at least not short term.

The total available for all the areas in 2004 are about 250 million, but out of these only 80 remain for distribution to new projects. The total of incoming applications amount to 840 million, divided on 617 proposals. Thus only 10 % of applied amount, or 10 % of the applications, will be funded (VV 2004a). For ideas that serve several purposes and

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7 If this has resulted in better quality, is however not yet fully evaluated, it seems (meeting 030910 in Stockholm).

8 In Swedish: FUD program (Forskning ► Utveckling ► Demonstration)
provide benefit to several domains, Vägverket will if necessary forward it to the other involved domains.

Each domain will evaluate and rank the proposals and propose a way to distribute the funds. Since each domain has its own amount to distribute, calibration with the other domains to achieve a common scale may not be absolutely necessary. The idea may after that advance to be assessed by a group consisting of Vägverket experts’ out in the regions. Each of them will make a first assessment on a scale 1 – 5 from not interesting at all up to very interesting.
4 Banverket – Swedish Railroad Administration

Banverket divides its activities into Investment, e.g. new and significant re-construction and Service, e.g. maintenance and operations. There are of course activities floating between the two. A third category between the two, corresponding to Vägverket’s Maintenance, would perhaps have helped to put focus on long-term maintenance, which now tend to be neglected. In practice, a division principle between investment and service has been the value. If e.g. a repair/replacement of a switch has cost less than 300,000 SEK, it has been classed as service. If more, it has been accounted as an investment. (BV 2004a). But other actions have other alues as division line between service and investment, e.g. 10,000 SEK (BV 2003a).

Non-specific railroad provisions like bridges, tunnels and groundwork have been procured from private firms since long. Routine maintenance and servicing of the tracks have been subject to public tendering since 1 July 2002. Banverket Production has 90-95 % of the contracts of service and slightly lower in investment. The service contracts are regionally organized, covering an area of tracks.

Most service contracts consist of winter and property operations. The contract has a fixed part of basic operations including actions under the division value, mentioned above. The contractor is usually paid extra for urgent repairs of the track. The needs and their urgency is inspected and determined by the contractor and usually the remedy action is also placed with the contractor who has the basic contract. Legally the additional orders can however be tendered out or left without action for financial reasons. Before starting remedy, the contract thus has to obtain a go ahead from the principal. The principal generally has no controllers to inspect the result. Region North is however in the process of establishing such an organization (BV 2004d).

The activities, both investment and service, are organized in 5 regions from north to south.

![Banverket organization of service and investment](image)

Figure 4.1 Banverket organization of service and investment

Each region contains about 3-4 track areas, staffed with about 10 employees each. They work with data registration and administration, propose a budget for the next year (there are three main parts of the budget: service, reinvestment i.e. major maintenance organized in projects, and new investment), verify invoices, meet suppliers and assist with procurement and tenders together with the regional level. A special material unit (Nässjö materialservice) handles public tendering and procurement of railroad strategic equipment.
4.1 Organization of Technical Development

In 1988, the State Railroads, SJ, were split into a train operation unit and a railroad provider. The train operation unit continued with the name SJ, and the railroad infrastructure provider became Banverket. The purpose was to rationalize the train operation part of the business by being able to allow different train operators to compete on a track provided by the state.

10 years later, 1 January 1998 next important step towards more efficiency and lower costs was introduced when Banverket was split into a principal unit and a production unit, as according to the principal-contractor model and philosophy. The production unit was named Banverket Produktion, while the principal, the body with government empowerment, is still called Banverket. A separate unit for planning and design, Banverket Projektering, was also separated out.

The years elapsed since have been a transition period, allowing competition to be introduced gradually while developing the forms of tendering, control and evaluation. First step was to define the tasks to be performed in order to formalize the interface and the relation between the principal and the agent, even if the contractor was always, until 2001, Banverket Produktion. The tasks were defined in tender documents, Basentreprendiare, in the autumn of 1998. The common base was further developed in each region, which lead to a diverging development. An overall evaluation was planned but never effected. Other aspects of the tender documents have been to describe expected performance and the technical state of the installations. Technical length of life for the installations could be up to 120 years (bridges), but generally around 10 years. There will always be uncertainties, although the aim is to eliminate them one by the other.

A new project started in the year 2000 to make Banverket 10 % more efficient. First results of the evaluation, in process when this is written, indicate that costs went up first, as the organization was developing the new routines, but that the costs now go down, and people are sent home, with a 10-30 % saving (BV 2003a). The tendering development process 2001-2004 will be a next evaluation project.

4.1.1 Today’s organization

Particular innovations will normally require the approval by the responsible expert for each field of activity in Järnvägssystem, the Technical Department. But strategy and policies also depend on the Strategic Department, and its subunit Research Policy and Planning, as well as the Infrastructure Management Department. Järnvägssystem, being the unit in Banverket with the technical responsibility, sets and follows up the technical solution; the system as well as its components. It supports R&D and procures technical development. It develops specific requirements when it not is possible to buy according to commercially established standards. Contractors should be able to take responsibility for development of methods for inspection and repair, but since they have historically been pure performers, at least Banverket Produktion, starting up this is yet a challenge (BV 2003c). General civil structures like bridges have of course always been procured externally.
An example in modern times is Banverket Produktion’s procurement of a tool to measure how a turnout works. Järnvägssystem is responsible for inspection standards, e.g. wear and tear and inspection intervals. There are many opinions and discussions, which leads to prioritization and development projects. Demands for exemption from approved standards are used as a method to test new technology and ideas. Järnvägssystem treats such demands daily. Banförvaltning, the coordinator of the management of the infrastructure, supervise the most common causes for interruption of the trains and provide this information to the technical department.

### 4.2 Market and Contractor Networks

Banverket, the Swedish railroad administration, is not the only principal for the railroad track network. The vast majority of rail in Sweden belongs to the state and is hence administered by Banverket. Other principals are:

- **A-train**, which owns the track to Arlanda airport but is leasing it (build-operate-transfer) to Arlandabanan AB for 47 years.
- **Öresundskonsortiet**, who owns the track to and on the Öresund Bridge between Malmö and Copenhagen.
- **Inlandsbanan** AB who owns the track from Mora to Gällivare.
- **SL**, the provider of metropolitan railway and bus services in Stockholm
- **SL’s** municipal counterparts in other cities like Göteborg.

It has been discussed how to increase the competition in the service and maintenance activities. Installation companies, now sub-suppliers to the contractors, could perhaps be interested if the contracts are split into smaller regions and smaller scope of service, such as polishing of the track only. Also the general construction contractors are interested depending on what services the contracts contain. Even the Swedish Road Administration’s production unit, Vägverket Produktion has shown interest. Cutting the market in more pieces is a strategy that has been used e.g. in the UK.

The market that is developing is that large international companies buy the small Swedish companies thus becoming large, companies with power to really be alternatives for Banverket. Another advantage except for bringing in competition, they may bring in international experience into the Swedish scene.

The total budget for service and maintenance in all Sweden is around 3 billion SEK (KTH 2004c). But objects may extend outside a region. It is assumed that it is more difficult to create a competitive market for rail operation than for roads, since e.g. the
machinery is more specialized. The principal-contractor model still young (1998) and contracting out even younger (2001), explains that Banverket Produktion has 90-95 % of the market.

The first contracts in competition were Inlandsbanan from Mora to Gällivare, the harbor tracks in Göteborg and the Öresund bridge. None of these three were originally Banverket tracks, which qualified them to be good trial areas for public tendering. After these three, Banverket continued by tendering some of its own tracks that were joining another principal’s tracks. Forsmo-Hoting and Hällnäs-Storuman are two railway sections in northern Sweden that join Inlandsbanan AB’s main track from Mora to Gällivare.

In 2002, six more areas were submitted for competitive bidding. Dalabanan-Sala, Haparandabanan, Kil-Torsby, Borås-Varberg, Hässleholm and Blekinge coastal tracks.

In 2003, the competitors were:

2. Carillion Rail Systems, British railroad company, who has bought SRS, Swedish Rail Systems, who runs Inlandsbanan, a route in the middle of the country from center to the north, a fairly long route with relatively little traffic, and Hamnbanan, tracks in the harbor of Göteborg. SRS’ head office is in Ystad in southern Sweden.
3. Belford Betty (BB) rail, a British company
4. NTS contractor division, half owned by Vossloh, who bought it from Corsefer, and half by Spitzer.
5. Öresundskonsortiet

Banverket has an overall approach to go from detailed specifications to performance specified contracts. A special issue is to make sure that this process does not set aside security. Accidents have at present put an end to privatization in the UK.

4.3 Procurement Process

As opposed to Vägverket, the procurements at Banverket do not follow an annual scheme. Tender development, bid evaluation and start of the contracts can be at any time of the year.

The contract may be more specified and detailed than it appears at first glance. Other, not enclosed regulations are often referred to in the tender documents. Not following these details results in contract violation, e.g. security level violation or efficiency violation. For instance greasing is a safety measure and must be done with regular intervals. The frequency of these services may be difficult to define in any other way than a number per time unit, or similar. Snow removal is easier. It can be defined in a more performance-related way.

Vägverket uses an evaluation method where non-monetary aspects of the bids are converted into a monetary value according to the fairly foolproof conversion method, described in Section 3.4. Banverket uses a multi-dimensional model, where the various aspects are assessed on a scale (1 to 5), multiplied by a weight (between 0 and 1) and
added to other parameters (the weights of all parameters must add up to 1.0). Also the price is converted to the scale 1 to 5, with a mathematical formula. The other parameters receive their assessment 1 to 5 by a human evaluator. Thus a number of subjective assessments are at the core of this method. Care is taken that these subjective assessments are as objective as possible in several ways. The assessor is an expert in the particular field. If the environmental aspect is to be assessed, e.g., the assessor will be an environmental expert. Often the name of the bidder and other parameters, like price, are hidden to the assessor, to prevent undue influence.

There is an internal discussion on regarding relative or absolute assessment scales. Should the best, e.g. environmental, offer always be assigned a 5, and the worst 1? Or, if the differences are small, is it OK to give all bidders the same note? In that case, some say, the environmental aspect will not get the weight as it was attributed beforehand. Others say, that if the differences are exaggerated (which may be the case if the whole scale 1 to 5 must be used, averaging 3.0), the environmental aspect received too much attention (KTH 2004c). There are many similar issues discussed regarding the calibration of the assessment scale. Another one is: must the criteria for each assessment step (1, 2, 3, 4 and 5) be established before the bids are opened? In the studied case what each step meant was established before each assessor started the evaluation.

Adding all weighted assessments together – will it then produce the best contractor long-term? The evaluation is for practical reasons restricted to what the bidder has put on a piece of paper and how convincingly the bidder has described the organization and its methods. In the studied case, the group was convinced that all the evaluated bidders also had the necessary competence.

After the contract has been signed, it is followed-up by meetings once a month. The contractor reports the past months and the plans for the near future. Invoices may be discussed and signed. At these meetings it is not excluded that the contractor suggests something different than specified, and may get approval for these proposals. This approval does not mean that Banverket legally takes over responsibility for this change. The contractor remains responsible.

4.4 Tender Evaluation Model

Figure 4.3 below is a graphical presentation of an evaluation model used in a contract 2003. It can be used to calculate comparison values of the bids, as well as to plan and run the tender evaluation process with its risks of delay.

Each parameter is assessed on a scale 1.0 to 5.0, with 5.0 being the best possible value. Even the price has been recalibrated into a scale 1.0 to 5.0. so that it can be weighted and added to the other parameters. The values to the left of each parameter is its weight in relation to its left hand neighbor. As an example @Total consists of Plan (24 %), ExpR (6 %) and SEK (70 %), totaling 100 %. Plan is subdivided further into ProjP (80 %) and EtabP (20 %). Incoming links to each node always sum up to 100 %.
4.5 Documentation Systems

The overall, measurable goal for Banverket is higher punctuality with security as condition and constraint. Banverket is, according to the statistics, responsible for 20% of the train delays. In particular the turnouts are often creating problems.

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9 The full application can be downloaded at http://www.infra.kth.se/~stenbeck/ProRisk/Banverket70-30.xml but requires the software ProRisk.
maintenance projects aiming at better punctuality thanks to improved technical installations are currently in progress at the moment in cooperation with the operators. Banverket stores data about objects and inspection observations in chronological and geographical databases. If these systems would have been used operationally, for example as a basis for the invoicing, they could have been a factor creating an incentive for performance and development. Unfortunately, they seem however to be used mainly for statistics.

Could lack of technical development have anything to do with the documentation systems? Are they designed to produce the right and relevant information? Can those who need the information find it? Since it would be easier to take advantage of already existing, documented knowledge and help its distribution than recreating new knowledge, some effort to understand Banverket’s documentation with regard to operations and maintenance has been spent within this study.

![Figure 4.4 Four main information systems in Banverket](image)

Starting with the most important events, derailments and train delays, these are documented by a system called Tför. The Tför events are further analyzed in Ofelia, where the delay reasons are identified to prevent their reoccurrence. Bessy is a register, where all deviations from specified state are filed. BIS is a geographical information system where each object (turnout, signal, line between turnouts, etc.) is stored together with the properties of the object (type, age, manufacturer etc.). BIS, being at the end of the chain of activities and without immediate operational importance for the urgent repair of a fault, may contain a delay of several months until changes are recorded in the system.

Tför and Ofelia being systems for urgent faults, Bessy can be described as the system for preventive maintenance. The Bessy remarks are in general generated by an inspector who follows each meter of the track from one end to the other. Once finished, he starts again from the beginning of another track until all tracks in the area have been inspected. The inspection interval for each track varies and depends on traffic and other factors.

### 4.5.1 Reflections on the Documentation Systems

Despite all these extensive documentation systems, the auditors of the Swedish Parliament, *Riksdagens Revisorer* (2000) criticized the follow-up of investments. Hansson & Lundh (2004) made several attempts to follow a project or object through the system, from planning to invoicing and the cost of its maintenance, without success.

Despite all these documentation systems, Banverket procurement officials rank “no possibility to document experiences” in second place among obstacles for technical development (Section 10.13.4). Preventive work is today often not undertaken. Annual and monthly remarks are left aside (BV 2004a), prioritized down by the principal, in favor of using all funds for actions requiring urgent repair (weekly or immediate).
An explanation might be lack of links between the systems, and lack of means and interest to make the data easily accessible in the daily operations. Uncompleted links between, and inaccessibility to, the documentation systems may remove the system overview, thus reducing the incentives for performance and innovations.

Another explanation may be the incentives in the terrain. The contractor usually employs the inspectors. The inspectors’ remarks create work for their colleagues. Even in tendered contracts, remarks are sometimes paid extra, why there is an economic incentive to report as many deviations as possible. This is beneficial for the security of the train passengers, but may be detrimental to the budget of Banverket. It is to some extent up to the inspector’s honesty and professionalism, whether a deviation is noted. Also, there is sometimes all to win and nothing to loose for the contractor to repair poorly and short-term, so that the fault will reoccur soon again and generate additional work and income. Long-term planning for service-free rail by an agent would be a threat to all his colleagues’ work places.

The same company sometimes acts as deviation inspector, repairing agent, and verifier after repair. This division of tasks, based on trust, may work well in a non-competitive situation, where neither the agents nor their employer have any economic incentive to deviate from honesty. This may well be the case in a state monopoly.

If the employer has achieved the contract under competition however, a fully self-controlled system for detection, repair and verification gets absurd. Honesty and working pride will be opposed to a profit-maximizing strategy of the employer. Faults must not be fixed until having the written order. Their repairs should ideally be just good enough to hold over the warranty period, not a day more. Innovations, increasing its life are of particularly low interest.

Banverket is gradually moving away from these negative incentives by letting more and more of the inspection remarks be included in the basic price. They compare the invoiced amounts with previous experiences of what the costs should be, to prevent the amounts being rounded off upwards to exceed the limit for extra payment.

4.6 Research and Development Program

Banverket’s R&D program has identified 12 important areas of development, structured into four main domains. These domains are related to the transport policy issued by the government and Banverket’s main tasks and strategic objectives:

- The development of the railway system in a society perspective
- Its competitiveness in a market perspective
- Its efficiency
- Its safety and environmental adaptation

Each area has identified its focus and limitations, purpose, knowledge base and potential. Banverket invites all R&D performers to send applications for projects. All R&D activities should in principle lie within the 12 areas.

Regarding international cooperation, EU’s Fifth and Sixth Framework Program, UIC, the international railway union and cooperation with National Science and Technology Council in the USA are particularly mentioned. Competitiveness and endurance are key words in the international priorities. Interoperability is also important, including international technical standardization. (www.banverket.se, accessed 22 October 2004)
5 International Experiences in Perspective

Cox & Love (1991) give Margaret Thatcher the credit for starting up public tendering. She used it for public transport in the beginning of the 1980s. In the United States the part of bus transport services that was tendered grew from approximately 0% in 1980 to 8% in 1990. In Colorado, legislators were more active and public tendering ratio achieved 20%. Cost savings averaged 30%.

Cox & Love list some reasons why a public monopoly was expected to be less expensive and more beneficial for the taxpayers than private operation.

- Absence of profit
- Absence of tax payments
- Scale economies
- Employees in the organization would be more service-minded, and oriented towards public interest, since they are not deterred by the profit motive

But empirics have crushed these theories and assumptions. Conversion of public transport to public monopolies has increased costs at extraordinary rates. Economies of scale turned out to be diseconomies of scale. Public transport riders complain over service quality. While public bus transport costs increased at 1.7% more than other inflation in the US as a whole, the San Diego competitively tendered bus service has increased 2.1% less than general inflation. Between 1979 and 1994, 30% has been saved. It was assumed public employees would be more virtuous than their counterparts in profit-driven companies. But all steer their performance towards rewards and away from penalties. Public servants are no different than anybody else.

Cox & Love explain the inefficient performance of public monopolies by the presence of negative incentives. In private households efforts will be made to purchase smart and get as much as possible with the money. If some money is not spent, it is even better. The same applies to some extent for individuals’ performances in a private company. In the public sector however, personal salaries are often linked to the budget and the number of staff a manager has to handle. Saving costs and cutting down on staff may hamper the manager’s status and salary package. Deficits are common and do not necessarily lead to the manager being replaced. The loss is passed on to others or to another year. Inefficiencies lead to need of more staff and a larger budget, which raises the possibility for career and salary.

The actor with an immediate and obvious interest of reducing this overspending is the taxpayer. But he is far from the specific activity concerned and can impossibly defend his interest, conclude Cox & Love. The public servants have a great deal of discretion to carry out their task, and the “good” manager, from a taxpayer’s point of view risk to be personally penalized as an effect of saving money and serving the public better. Pleased and happy staff is more important than pleasing the customer and the financier.

5.1 Brief History of Performance Contracts

Performance contracts\(^{10}\) for road maintenance started in British Columbia in Canada in 1988, but were still oriented towards procedures and materials to be used, rather than result. Shortly afterwards, Argentina contracted approximately 10,000 kilometers of its national roads accompanying result performance specifications with a penalty system

\(^{10}\) In Swedish: Funktionskontrakt.
applied depending on the time for rectifying deficiencies. In the mid 1990s, Montevideo contracted out the maintenance of its main arterial urban roads, 150 kilometers, after a pilot study of Uruguay. Five years later 50 % of the national roads in Uruguay were maintained under performance contracts. Several other countries in Latin America such as Brazil, Chile, and Colombia have started similar contracts and others such as Ecuador, Guatemala, and Peru are planning to follow. Most of the contracts include partial rehabilitation to bring roads to maintainable conditions.

Australia started its first performance contract in 1995 covering 459 kilometers of urban roads in Sydney (Frost & Lithgow, 1996). Since then several contracts have been implemented in New South Wales, Tasmania, and Southern and Western Australia. In 1998 New Zealand introduced performance contracting for the maintenance of 406 kilometers of national roads, and in 2002, 10 % of New Zealand’s national roads were maintained using the new contract scheme. In the United States, the State of Virginia pioneered a performance contract labeled an “Asset management and maintenance contract” for the maintenance of 402 kilometers of Interstate Highways in 1996. Four years later Washington D.C. implemented a similar contract covering 119 kilometers of federal roads (Federal Highway Administration, 1999). Both contracts are considered pilots. Several other states have started to contract out maintenance of parts of their road networks applying a mixture of performance specifications and unit prices (Zietlow et al 2002).

At a symposium in 2001 in Ottawa, Canada, George Seaden (2001) expressed different philosophies in a quite entertaining fashion:

There are different socio-economic beliefs, i.e., what drives the country. In Canada we are true believers in the free market that essentially the market knows best and presumably government knows least. There are other people, particularly in Europe, who actually believe that government knows best. When you look at state-led countries such as France, Germany or The Netherlands, there is a belief that the government, the guys up top or wherever they are, actually know what they are doing which is contrary to the American or Canadian belief where it is firmly believed that the government doesn't know what the hell they are doing.

Then there is a sort of social democratic compact in the Scandinavian countries where, in order for the government and people to actually act, the different parties -- labor, the people, the government, the industries -- get together in a much more harmonious way, and then action takes place.

In a Danish handbook on partnering (Busk 2003), the following areas are suggested to be subject to bonuses and incentives:

- Savings compared to designed solution
- Keeping the time schedule
- Safety in the work place

As an example of the first category, savings, Busk proposes the bonus to be related to the amount of the saving, e.g. 40 – 50 % to the principal, 10 – 15 % to the advisors and 40 – 50 % to the contractor (total: 100 %). Busk points out that the savings must be approved by the principal under consideration of the effects on aesthetics, function and use.

As an example of the second category, Busk proposes a 1-3 % bonus to be paid to a contractor delivering in full on or before the set time. Partial deliveries on or before time could also be awarded. Regarding the definition of full delivery, AB 92 regulation is to be applied. Busk proposes that 10 – 15 % of the time bonus is awarded the consultants, and the rest the contractor.
As an example of the third category, a bonus for safe and healthy work places, Busk proposes 0.5 – 2% of the contract value. Ideally, bonus is awarded on a daily basis for good safety measures such as education, foresight and help to colleagues in distress. The account is however penalized when accidents and incidents occur. The contractor is responsible that the bonus is forwarded to the staff working with the issues operationally.

In Germany, road workers with good ideas can be awarded. There is a system for deposit of improvement proposals. If the improvement involves machinery, the idea is forwarded to the machinery supplier, who may or may not realize it. If realizing it, it is usually at the private company’s own cost. Suppliers to the industry market themselves at exhibitions such as *Baumaschinenmesse* in Munich. (SBA 2003).

### 5.2 Organization of Technical Development – French Roads

Road maintenance and operations in France are under the Ministry of Equipment, Transport, Accommodation, Tourism and the Sea. The ministry has two groups in charge of road issues, the Road Administration, *Dr*\(^\text{11}\)*, and the Road Traffic Security Administration, *DSCR*\(^\text{12}\)*. Under these bodies are a second level consisting of *SETRA*\(^\text{13}\)* and the Central Laboratory of Bridges and Pavements, *LCPC*\(^\text{14}\)*, where LCPC is somewhat more academic and SETRA more practical.

*Figure 5.1 The French organization of road maintenance and operations*

Road operations are mandated by a ministry directive to the Regional Administrations of Equipment, *DDE*\(^\text{15}\)*. There is usually one DDE in each French county, *département*, with subdivisions in the major towns of the department.

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\(^\text{11}\) Direction des Routes  
\(^\text{12}\) Direction de Sécurité Circulation Routière  
\(^\text{13}\) Services d’Etudes Techniques des Routes et Autoroutes (SETRA)  
\(^\text{14}\) Laboratoire Centrale de Ponts et Chaussés  
\(^\text{15}\) Direction départementale de l’Equipement
Since 1996, the road service concept has been enlarged by information to the users transmitted by radio and large displays. The idea is that the user can then make an own decision regarding choice of transport and itinerary at a certain point in time. The information is thus complementary to the work on the road itself. It may also happen that e.g. trucks are not allowed at all on defined road segments for e.g. 8h, to allow staff to remove snow or take care of the trouble of water saturated roads when the permafrost lets go (LCPC 2004).

The state is principal and performer for the *RN, routes nationales*. The departments are principals for the *RD, routes départementales*. But the departments often buy the performances from state-owned DDE to maintain and operate their road network (Sveriges Tekniska Attachéer 1999).

Ponts et Chausses became DDE. It has a machinery park renting out the machinery. The state or the department buys the machinery, but not the repair and maintenance of them. There is no problem to attribute what costs should be carried by the state and what to be carried by the department. Different machinery for different roads, e.g. plow and salt spreader combined for the RN, while the RD equipment is smaller and more specialized for example snow plows mounted on tractors. The staff is state personnel, the department just sets the standard and the final requirement of the road status.

In France, road maintenance and operations are defined as being the necessary arrangements to make the road continuously useable. Government employees effect most routine operations under non-competition circumstances, which is a political decision. The cost was, as an example, in one case 4100 Euro/km/year. 1/3 is related to the winter. Each technical domain has own laboratories assigned for a certain area. Buying the services from DDE costs Savoie only 1/3 of what the neighbor, Haute-Savoie, is paying, who are doing it in-house (CG 2004). It can be questioned if the competition is fair and if the particular DDE units carries all appropriate costs (Sveriges Tekniska Attachéer 1999). Some places, DDE has no staff. 100 km of Savoie has this problem. Their neighbor Isere (Grenoble) have tried public tendering. In 80 % of the cases, they received no bidders, and in the remaining 20 % the bids were 5 times as expensive as before. The way it has always been done is to find and convince tractor owners such as farmers to help in winter, when farming is not an issue. They would never answer to a public tender.

Municipal roads may be taken by DDE if between two departmental roads, but otherwise the municipalities usually solve it with 1-2 machines and perhaps some private assistance.

DDE reports their consumption of materials and time. DDE uses a software, Corailles, showing time and material consumption. When ditching, special equipment may be bought. No further control of DDE. “They often put more people on the job than necessary and according to their offer. So it would be difficult to demand even more from them”. (CG73 2004)

There is, separate from the routine operations, also a plan of investments prepared by the subdivision. This is often publicly tendered. To determine if prices achieved are right, comparison is made with the in-house prices from the machinery unit, *Parc de l’investissement*.

An example of a research domain is permafrost. The permafrost attracts water from below, which makes the road float. Researchers in Autun, close to Strasbourg, are trying to solve this problem with sound waves. (CG73 2004)
5.2.1 Case Study: DDE Subdivision Aime

The organization in charge of operation and maintenance of the national roads is Direction Départementale de l'Equipement (DDE). Often it also has contracts with the departments to maintain their roads. Minor municipalities having for example only one, major road, the national or departmental road, contract DDE, but the major municipalities usually take care of their roads themselves with one or two trucks and staff.

DDE in Savoie is divided into 18 subdivisions. The subdivision of Aime (DDE 2004), employ 35 persons in the summer and 50 in the winter. Its road network covers 15 km of national roads and 110 km of departmental roads. They generally work in two shifts; 4 am – 12 pm or 1 pm – 9 pm. In emergency the first team has to start at midnight and the second team extend until midnight. Normal working hours are 35/week, but 42 is not unusual. 60 are the maximum allowed. Working 12-13.30 and 17-22 gives 20 % higher payment, 22-07 100 % additional payment.

A team is usually created around each piece of equipment, with a route to follow when snow starts to fall or when ice is reported. Preventive salting to deice, like in Sweden, is not allowed. Its main task is to undertake the routine operations like snow removal and grass slaying. This is a political decision. When the 35-hour-week was introduced, 14 new had to be recruited, but their employments are only for the winter.

All group managers as well as the main manager travel all roads each week. Observations with time, place and comment are noted in a book for each area, following the machinery. These notes may be useful if sued for not doing the job properly. In case of accidents, it may be important to be able to prove, what state the road was in at the time of the accident.

There are no edge posts along the French roads, but only one each kilometer, borne. (This could explain less interest for innovation in this field than in Sweden). Lines and signals are purchased from external companies. Occasional signs may, however, be put in place by the own staff.

Tenders are often covering several services during a three year period. For the resurfacing of the roads there is a planned program. Every 10-12 years the road surface is normally renewed. Extra money is applied for to undertake these measures, depending on what is planned for the year. In worst case the works are financed on credit. These maintenance works are often procured by public tendering. The specification is detailed and firm. The bidder must only fill in his price of the predefined services in the appropriate box of a form. The technical and contractual documents come from the head office of the department. Thus technical development is mainly top-down, from CETE and SETRA, but ideas of innovations may be forwarded directly from the companies doing the work to CETE and SETRA. The supplier has to report progress to the subdivision and CETE can also send staff to verify the services and their quality.

5.2.2 Winter operations

Winter operations (LCPC 2004) started up seriously in France in conjunction with the Winter Olympics in Grenoble 1968. It was made explicit from the top French political

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16 Filling in the price only can be argued to be an example of more "perfect competition" than in Sweden.
level, that during the games, all the roads had to be in proper order. The necessary machinery and staff to achieve it, were mobilized.

After the games, the nation wanted to keep the new standard, which was successfully achieved during the games, permanently and nationwide. Written regulation stating that the roads should be free from snow and ice, all over France, was developed. But reality caught up when the bill of this standard of service was to be paid.

It was realized that both better technology and slightly reduced service had to be employed to reduce costs. The roads were classified in three main categories:

1. Permanent 24h snow and ice removal. Snow and ice are allowed only during and in close conjunction with the snowfall on these roads, around the clock.
2. 06-20 snow and ice removal. Between 20 (- 24 in some cases) and 06 (- 10 in some cases) the road users must accept that the snow and ice may not be removed.
3. Other roads. Roads are serviced without stated time limit.

Figure 5.2 Four winter service levels have been established in Savoie (CG73 2004)

Since 1997 research has been focused on work with plows and salt, salt solutions, mixes of sand and salt. The methods have been developed with fairly little international influence.

The European Committee for Standardization (CEN) has appointed a Technical Committee, 337, to create a European standard for road operations and maintenance.

In the Technical Committee 337, the work is organized in 4 groups:
- Working Group 1, lead by Dr Unckel from Germany, dealing with winter operations.
- Working Group 2, lead by France, dealing with the non-winter operations.
Working Group 3, lead by Mr Gileta from Italy, dealing with the interface truck-tool (since the specialized operations equipment is often mounted on standard trucks).

Working Group 4, lead by Switzerland, dealing with materials of cleaning the roads

Group 1 has worked since 1985 on normalizing salting equipment, and they are now working on meteorological sensors in the road surface and other places. Standardization, homologation, is well seen in France. By creating monopolies for the suppliers, at least the first years, until a competitor copies or improves technology further, the idea is that low prices will follow thanks to scale economies in the production.

The machines are sometimes permanently mounted on a vehicle used only for that purpose, but more often the machinery is detachable so that the truck can be used for other equipment. Renault and other French industries have so far competed to deliver the trucks.

Also the yellow/orange color of the machinery and the working staff is in the process of normalization. There are over 100 different shades in use – some of them are claimed not to be visible enough. (LCPC 2004)

5.2.3 Research

Continuous research is done since 20 years to find models to predict the state of the road surface. LCPC, Center of Snow Studies17 as well as the French weather forecasting service18 participate in this. Efforts are also made to make sensors and devices to measure the distribution of the salt, and to develop surfaces with little noise still retaining acceptable friction, qualities that appear to be contradictory in many cases. Center of Technical Studies, CETE19, are part of SETRA. There is also CETU, specialized on tunnels. There is also research on how to clean roads that have been subject to leakage of hydrocarbons, like petroleum products. Existing products tend to leave behind a glossy surface, which must not happen.

No matter how good an innovation might be, the law and regulations will make it impossible for the users, like the DDE, to adapt it, unless it has passed the process in the right way (LCPC 2004). The innovator has to contact SETRA/CETE, to let them validate the innovation. Then, if validated favorably, the innovation is tested on the road before approval. The costs of testing and evaluation are shared 50-50 between SETRA (i.e. the French state) and the company.

The special road works where the innovations are tested are named innovative road works, chantiers innovants. Competitors and public are not refrained from seeing the innovation in these spots, but neither CETE nor the company is allowed to disclose any further information until the product has been approved or disapproved. Once approved however, chances are good that the users will adapt it quickly. Not only because a government body with high credibility has approved it, but also because laws may be altered to favor the new technology embodied by the recently approved innovation.

The law must not, of course, state a particular manufacturer, but only the higher demands on performance parameters, that the innovation has enabled. Parameters could

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17 Centre d’études de la neige, Grenoble
18 Meteo France
19 Centre d’études techniques
be for example point of gravity and size of grains. In the most fortunate case, for the innovative company, the new product is the only one meeting these new requirements, at least for some years, which creates a privileged position for some years to pay back the costs of the invested research.

The testing institute can be seen as a special expertise working on behalf of the users (LCPC 2004). This solves the problem that the user may turn down new innovations just because they are new and not fully tested, and because they themselves do not have the resources to test themselves.

5.2.4 Comparing Road R&D in France and Sweden – Reflection

An advantage of non-competitive road operations is that there is no strong economic incentive to do less than has been demanded. Professional pride to do a good job is probably less in opposition with management’s strive for profit, than in the case of the contract having been won after a competitive process. Cracks and potholes are supposed never to occur in the French network. Preventive and early curative maintenance is planned towards this target. Absence of economic incentives to wait with a repair may have lead to more preventive maintenance in France than in Sweden. If so, the market to mend and fix major cracks and holes would be smaller in France than in Sweden, explaining the absence of such machinery in both production and research.

In a fixed price contract like in Sweden, after contract has been signed, there is automatically an economic interest for the contractor to do as little as possible. This force is stronger the more the contractor has had to push his price downwards to get the contract in the tendering process. Only conscience and honor of the involved will act opposite this interest, if not supported by enforced penalties. A generation shift among road workers and road worker management in the Swedish road sector and a harsher economic climate in general will accentuate the problem for honor and consciousness to win against the economic forces.

The French innovation system is in many ways in line with the philosophy of the patent system, that a certain protected period is necessary to create incentives for innovation. On the other hand it contradicts, at first glance, the spirit of equal competition embodied by the Act on Public Procurement and the benefits of open competition creating a higher technical level long term (Jacobs 1969).

Maybe the benefits of protection could be combined with the benefits of competition by allowing a reasonable protection period of e.g. 5 years, after which the innovation meets the open market.

If we see the Swedish pre-1992 in-house innovation system as a 100 % government subsidy solution, and opposed to this we see the present Swedish innovation system, governed by the EU Act of Public Procurement as the other extreme, perhaps a compromise similar to the French system with approximately 5 years protection could be the ultimate solution for the future.

5.3 Organization of Technical Development - French Railways

In Atlas of the World's Railroads, Brian Hollingsworth (1980) describes the development of the French railroad with healthy British irony. The network was developed slower than the English due to the smaller population compared to the geographic distances. But “Gaullic logic made sure that, once started, it was better
planned, larger in scope and that problem solutions and properties of the railroad had to be French” (free translation).

The railroad law of 1842 declared that the French state without exceptions should own all major lines, just as it owned the roads. The law of 1842 prescribed a network of seven main lines originating from Paris plus two other lines across the country. One was Bordeaux – Toulouse – Marseilles and the other was Dijon – Mulhouse – Strasbourg/Basle. The state ownership included the right to decide which lines to be built and to supervise all activities. Private companies could however be invited for cooperation on a tenancy basis. As soon as having been built by the state, every line was to be submitted for tendering and the company that offered to pay the highest rent during the shortest period (max 99 years) was to be awarded the concession contract.

From 1879 onwards the main network was completed with smaller feeder lines, so that almost all towns with more than 1500 inhabitants had a railroad connection. The traffic was run by private companies, but with the special deal that the state guaranteed the dividends, in exchange of having quite a high portion, 2/3, of any surplus that might arise. Some lines were however run by the state itself, generally because the private company once in charge had failed. 1930 onwards many of these small lines had to be cut down, as road traffic was developing. The total length was cut down from almost 70,000 km to today’s 40,000 km of state owned railroad. The old private companies ran into economic difficulties one after the other, and this led to the nationalization of all railroads in 1938 and the forming of SNCF, Société Nationale des Chemins de Fer Français. This decision was made by a socialist government, but with little protests, in particular if compared with the corresponding action by British Rail in the UK 10 years later.

Thanks to the state sovereignty expressed by the law of 1842, much of the railroads were built in a similar manner. In the 1840s, the engineer Josef Locke influenced the constructions. He tolerated steeper slopes (1:125 - 0,8%) than his master and teacher George Stephenson (1:250 - 0,4%). Stephenson’s solution was to accept short distances with cable operation to master a steep slope. Locke avoided tunnels. Both engineers didn’t hesitate to move large volumes of earth to avoid sharp curves. Locke’s tracks were slightly cheaper to build, but somewhat at the expense of the heavy and rapid traffic, which, in particular during the steam engine era, had some problem to master the steep slopes. A speed of 100 to 120 km/h was nevertheless generally possible on the main lines.

The state financing of the railroads had dramatic effects in some hilly areas, such as the Central Massive. Despite traffic volumes that would never support to pay back the investment, impressive viaducts were built across gorges and tunnels through hills. But the course of more and more spectacular works finally had to be abandoned. The railroad Le Puy – Lalevade d’Ardeche was given up before it had been completed, leaving a 3 km tunnel (St Cirques) behind that has never been used.

Some of the main lines’ companies (Paris-Orléans and Bordeaux-Toulouse-Narbonne) started electrification already before 1938. They then established a 1500 V DC (direct current) system in the southwest of the country, and this was used after the Second World War also for the main line Paris-Lyon-Marseille. The SNCF engineers had however before it was completed developed a new, less expensive system with 25 kV 50Hz AC (alternative current), which has been used since 1950 for the railroads in the north and east and remaining ones in west and south. But it has not been considered being worth the trouble to convert the DC lines to AC. Instead, repairs and minor extensions of the DC network is done with the DC technology. The problems where the
two different tensions meet are solved with special locomotives that can run on both systems. Most of the locomotives are however capable to run only on one system.

Electrification and more advanced signal systems enabled a major increase in traffic intensity. The slopes are now allowed up to 1:30, 3,3 %. Still, the TGV (*Trains Grandes Vitesses*, high speed trains) were constructed to enable even more and faster traffic, with the first line being Paris-Lyon. It was built on a completely new track for 275 km/h, and at this speed not only horizontal forces had to be planned for by large radius curves, but also the vertical forces.

Unsurprisingly, the French signal system was given a different logic from the English and German. There was one signal for stop due to standstill or approaching train or other object, implying a definite recommendation to stop, but another to signal another train on the line moving in the same direction, which could be interpreted as allowing the second train to advance with care. This difference has enabled the signal system to become less complicated than the German and English more rigorous ones. Security has instead been assured by warning systems and registration of the train driver’s actions. The system e.g. draws a map automatically for each trip, where can be checked that the driver has not only followed all regulations, but also in due time before the apparatus alerted his intention to do so. All violations against the rules and bad habits can in this way be discovered and corrected before an accident can occur.

5.3.1 Who placed the order?

Even if released from the infrastructure investment, the yearly results of operation have a higher deficit than other European railroads. In its favor should however be noted ticket price reductions to certain social groups and other measures that should perhaps have been paid by social authorities, are carried by SNCF. (Hollingsworth 1981)

The French railways were financed as an indefinite loan into the future already before, but the additional costs of establishing the TGV in the beginning of the 1990s started a debate. TGV was extended from Lyon further to Marseille without anyone caring about the price. The costs ended up 4 times as expensive as Paris-Lyon. Then, following a three-week-strike in 1995, an enormous debt appeared. Suddenly it became commonly known how badly SNCF was managed. (SNCF Lyon 2004)

Who placed the order? The state blamed SNCF. SNCF blamed the state. Whichever, taxpayers and future generations are the final debtors. The state had not handled its role as principal, and government decided something had to be done. New management of SNCF was established with conciliatory conditions. The debt is unreachable and need not be paid back. But maintenance nor train operations must no more run at deficit and new investments must be fully financed.

SNCF activity historically consists of three main services:

1. Operating and maintaining the track
2. Locomotives, wagons and other rolling material
3. The transportation of goods and passengers

Overall objective of the activities could be expressed as keeping the trains circulating safely and on time. But the organization has during most of its history focused on technical aspects. Not until 1995, as Mr Bergougnoux was nominated president of SNCF, the *customer* was introduced as a factor in the business. Until then they were just *users* of the provided technical equipment.
But unfortunately this revelation was too much for the organization. The workers went on strike and Bergougnoux had to resign already in November 1995. Le Floch Prigeant, private industrialist, who changed the whole board, replaced him. But it didn’t help. Already after 6 months he was charged for having been involved in an Elf-Aquitaine scandal, and was imprisoned. Next president was Louis Gallois, installed in office 1996, previously president and general manager of Aerospatiale. Despite the fate of his unfortunate predecessors, he continued the client focus and went even further. Not only did he organize all activity around the clients and their needs. He also shocked the organization by recruiting some business administrators, ENAs, *Ecole Nationale d’Administration*, breaking the dynasty of engineers for all high positions. (SNCF Lyon 2004)

The government also undertook another measure of security against unexpected financial surprises. RFF, *Réseau Ferré de France* was created in 1997, assigned to optimize the specific amount to be spent on rail infrastructure each year. The amount, approximately 3 billion Euro, is set to cover infrastructure maintenance and if any is leftover, it may be used for improvements and construction.

RFF is a purely administrative body of no more than 200 persons, with the only mission being to represent the financial interests of the owner, the state. They cannot undertake any technical operations themselves. SNCF still has monopoly to produce all services regarding tracks and property. RFF orders ”assurance of the train traffic” from SNCF. SNCF is also the only train operator, except for a few cargo transporters, such as the German BASF, which are in this case hiring the track from RFF. RFF makes the decisions regarding any further investments in new TGV lines and have 15 persons placed in Lyon (SNCF Lyon 2004).

### 5.3.2 The New SNCF

Gallois reorganized SNCF based on client characteristics:

1. **Major lines**, *Grandes Lignes*, including high speed, *Trains Grandes Vitesses*, and other trains intended for more than 2h travel including night trains. (The night trains are however gradually being suspended at the moment.)

2. **Regional express lines**, *Trains Express Regionaux*, to 60 % carrying commuters, e.g. between Lyon and Grenoble. Paris region however not included, see below.

3. **Ile de France**, i.e. Paris metropolitan area including the suburbs. Since 500 million out of SNCF’s 800 million passengers each year are in Paris, it is reasonable that they form a special category.

4. **Rail cargo**.

5. **Railway stations**. Since clients of small and large stations are different, a market study has identified 140 large stations as of interest to modernize and commercialize.

6. **Infrastructure**. Track operations and maintenance is, as in line with European conventions, called *Infra*. It includes the rail and its foundation (*voie*), structures like bridges and tunnels (*ouvrage d’art*), overhead line (*catenaire*), earth banking (*ouvrage de terre*), signals and other electric installations and buildings (*batiments*).
SNCF employs 180,000 men and women. Out of these, Infra employs 60,000 today. The workweek was cut from 39 to 35 h without salary and wage drop in year 2000, which was a political decision to create more jobs in the French economy. The law meant 10 % less work per employed, and should thus have a theoretical effect of 10 % more jobs. Only 4% however, 25,000 work places in SNCF, was compensated by recruitment. The remaining 6% were not filled, but compensated by productivity increase.

In the U.K., as has been referred to earlier in this study; a process to bring all infrastructure maintenance in Britain in-house under the name Network Rail is in progress. When completed, by the end of summer 2004, Network Rail expects to have 30,000 employees. In Germany, Deutsche Bahn has only 14,000. But there private companies are presumably doing the work (SNCF Lyon 2004). Jacques Couvert, head of Infra, has declared: Infra will continue to trust its own workers, despite being as many as 60,000. Swedish Banverket has 6400 employees (www.banverket.se, 17 August 2004), thus a per inhabitant ratio half way between France and the UK. 

In SNCF, a typical regional and local organization might look as Figure 5.3. Teams of 6-8 persons, agents, specialize either on maintenance of the track, the overhead catenary line power supply or the signals. In the sector of St Jean de Maurienne three such groups, brigades, take care of the track maintenance. The manager of the three group leaders is the sector manager, DPx. Above the DPx level we find the Operational Unit

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**Figure 5.3 SNCF operations and maintenance organization**

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20 60,000 / 60,000,000 in France. 6,400 / 9,000,000 in Sweden. 30,000 / 70,000,000 in UK
Manager, DUO, and the manager of the establishment, DET, which now means a personnel responsibility for 250 – 300 people. The DPx, DUO and DET positions are regarded as some of the toughest positions in SNCF, since they have the direct contacts both with staff and clients. There is a well-defined career structure. A technical secondary high school diploma, bac, e.g. metallurgic diploma, in rare cases enables you to advance to a DPx position. Normally DPx positions require a master (maîtrise = bac+2) diploma. For DUO and higher positions, bac+5 will usually be necessary. Supervisors can grade the work performed in four levels: insufficient (red), barely acceptable (yellow), minor faults only (blue) and perfect (green). These remarks do not influence the salary short term. But in the long run, many greens will of course be helpful to advance within the organization, which normally leads to a salary increase.

Technique and security are noted separately. Technique is e.g. the personal skill while changing a rail. Security refers to the worker’s own safety, anything from wearing the regulated clothes to making the crucial call to the power distributor to switch off the current before starting work on an overhead line. Even when working on the track, the current must be switched off.

The own staff is not undertaking all works. Complementary, private sector is appealed, e.g. to cut vegetation along the line and to remove snow from the switches which is often a manual work. Private contractors can do all except security issues. Personnel reductions have led to a gradual privatization of railway maintenance in this way.

5.3.3 The Strict Economic Management of RFF and SNCF

Even if SNCF does not have to pay its enormous debt, the troubles are not over. The demand for break-even is a major challenge, since not even the routine operations have, it seems, covered its costs. RFF cannot put SNCF under competition, but it can “starve” SNCF to spend no more than the RFF amount. In this way government and taxpayers can maintain control of the costs.

SNCF and RFF make a contract, convention de gestion RFF-SNCF, each year. 100 % of by SNCF required maintenance is always accepted. In addition to this there is some money for investment, but SNCF must prepare their arguments well. Regeneration of a 30 km track is an example of a considerable investment. A project is created. SNCF must state and motivate the claimed costs.

A somewhat simpler investment case, such as a signals investment may look as follows:

1. A simple A4 presentation
2. Project phase when the study is deepened with precise costs and benefits
3. RFF may bargain
4. Realization

The same procedure is used inside SNCF when lower levels ask for financing of their routine operations as well as their improvement projects.

Operational managers are asked to reduce costs each year, despite demands of maintaining the same standard, or better, as before. In SNCF Maurienne (2004) the objective of budget reduction next year is set to -8%, all to be gained in the calendar year of 2004.

How can 8% be saved, practically? What about all the fixed costs such as employed state personnel and equipment? The equipment is collected in a separate body, from where the users hire the equipment. In this way the operational units are given
incentives to use the equipment only to the extent needed. The personnel are handled in a similar way. The operational units hire the SNCF personnel from the regional level. In these calculations, a railroader costs the same all over France. The operational units, the sectors e.g., plan and create projects, which places a demand of materials and personnel. If there is 8% less to spend, they must plan and create projects that amount only up to this new budget constraint. Leftover personnel are returned to the region at the disposal of other sectors in the region.

But if the equipment is already invested and the personnel employed by SNCF on unlimited contracts, which practically means for their lifetime, where is the bill finally paid? Is there really a saving at the bottom line? The neighboring sectors will probably have a cost reduction objective as well. They would then hardly need the leftover personnel but rather tend to have staff left over too.

SNCF Maurienne (2004) responds that leftover staff is no longer the sector’s problem. Until now the yearly reductions have been solved at regional level by natural quitting. Personnel quitting because of age or moving on to other jobs are often not replaced. In the last 7 years, staff has been reduced by approximately 15%.

But 8% in just one year is significantly more than 15% in 7 years. SNCF might have a personnel surplus problem ahead that it did not have before, unless it coincides with almost as many going into retirement. To clarify this, interviews with regional human resources management would be needed. Savings in overall costs have dropped more than the personnel drop, maybe 20 – 25%. Who has paid this saving is another topic beyond the scope of this study.

5.3.4 Strategy for Innovation

The French innovation system for railways has for long been a system inside SNCF. In 2000, however, the road research institute LCPC became involved in rail research through an agreement between SNCF and the state, which in 2003 was turned into a direct contract between LCPC and SNCF, according to the SNCF magazine Rail & Recherche (2004)

France holds 82 international patents per 1 million inhabitants, while the US holds 10121. Often ideas have been uttered, but when asked to write it down, nothing was sent. SNCF Lyon (2004) has heard that German Rail operator DB would be much better on innovation. Whether this is true or not, there is a strong wish in SNCF to improve on innovations the coming years, and a strategy and organization is in place.

SNCF has assigned an administrative person on national level, who is responsible for registering and forwarding innovations coming from the regions. The innovations may be forwarded to the research and development group, the technical experts in charge of the regulating documents, the legislation department, etc.

In each region, a person has been assigned to take care of all ideas in a region in a systematic manner and forward them to the national level. Any railroader is welcome with new innovative ideas. Unfortunately this is not yet a fulltime task (SNCF Lyon 2004), despite the 10,000 railroaders of the region.

As history can tell, the trade unions have powerfully succeeded to resist many changes. The railway trade unions were earlier in good company with its counterparts at other
state companies like e.g. Renault and Air France. But at Renault, the workers have now been “brought to sense”. How? There is no commonly shared explanation. Maybe the global competition is, finally, making its voice heard. Maybe it is thanks to managerial effort by one or more top managers.

The national level, mainly placed in Paris, handle general management, finance and research etc. Of interest for our subject, infrastructure-related innovations are:

1. The technical experts, part of the Infra division.
2. The R&D department, serving all business areas.

In SNCF nothing is left to chance, but every procedure regulated in detail (SNCF 2004). All railroad workers are supposed to closely follow the strict procedures developed by the technical experts on the national level, référentiels. Many of these regulations, particularly if they regulate safety issues, are part of the French legislation.

A particular person is often responsible for the directive regulating the procedure, but there are other members of the same group as well as the group leader that can take over if the particular person is missing or leaves the company. The responsibility includes not only updating the document, but also to decide on individual cases when the regulation can be set aside. Such a decision is generally based on an applicant’s submission of a file explaining the reason and grounds for the call for a bypass.

The bypasses may also be part of experiments and technologic progress. When cadmium was prohibited as material in the overhead line, for environmental reasons, tests with new materials are tested in a smaller area first before being introduced in the countrywide regulation.

**SNCF Research & Development department**

The R&D department (SNCF 2004) is responsible for all technical issues including the methods, except the organization of the maintenance. The R&D department consists of 250 full-time-employed researchers, and about 220 ongoing research projects. In addition to the 250 are 30 to 40 doctoral students employed in partnerships with universities and other research institutions. They are financed by SNCF for three years and have to achieve their doctoral degree in this time. This means they normally have to have a master and a DEA (diplome d’études approfondies) before. They are normally placed at SNCF and will often spend about 80 % of their time there. Only 20, or in rare cases up to 50, percent will be spent at their university of origin. Thus a railroad-specific scientific milieu at the university of origin is not an absolute must.

At SNCF the track is seen as a subsystem of the rail transport system, beside the rolling material. There is an interaction and an interface between the rail and the train as well as between the catenary and the train.

Research is organized in projects always financed by some activity division of SNCF where the results are to be implemented or harvested. Together with this internal client, the research department develops a program of projects. This program is brought to the general director of SNCF for comparison with other priorities of SNCF and, if favorable, for final approval. Innovations and research ideas may emerge in the research department or on the user side. If in the research department, which is the most common, selling the idea to a user within the organization will be part of the process.

Is there any lack of ideas? No, but there may be a lack of really good ideas, quickly lucrative ones. Since SNCF suffers from a constant lack of money RFF’s strict financial policy limits the research.
Also the research project development procedure is formalized and rigorous (SNCF 2004). There is a multiannual scheme, but each year the following is a general structure for meetings between Infra and the R&D department:

1. Ideas of research projects are presented and discussed
2. R&D presents the costs to Infra (who will present it to RFF)
3. Infra (and RFF) has prioritized their requests and places their command
4. Results of all ongoing research projects are evaluated, discussed and decided on whether to pursue further or discontinue.

What about the ideas presented at the first meeting? How are they generated? This procedure is internal in the R&D and Infra respectively, and somewhat less formalized. But there will usually be a series of internal meetings preceding the meeting with the other party to make an internal prioritization of the ideas.

Only 0,1 %\(^2\) of the total SNCF budget is spent on the research within the R&D department. This also covers work of technical experts and managers on the user side paid by the projects after they have been approved, but not project preparation and other overhead costs like benchmarking and policy decisions linked to the role of being the principal. Maybe about 5-10 people in Infra and 50 outside Infra but engineering for Infra are involved.

The production quality committee meets once a month to analyze train traffic and occurred faults.

5.3.5 Engines of Innovation and Incentives to Innovation

The high-speed trains have been engines of innovation. They have challenged the established competence and demanded regulatory and technical changes. France, Italy, Austria, Spain, Belgium and Portugal have agreed on a common 25kV / 50Hz system for their high-speed-trains. The 50Hz means some commercially available equipment can be used without too much alteration. Sweden, Germany and Switzerland have 15kV / 16,67Hz, for their high-speed as well as their other trains. The low frequency means that basically no electrical equipment for the commercial market can be used but all need to be special.

The differences between the countries, or EU’s wish to harmonize, whichever, have in itself been a reason for innovation. The modern practical solution to the harmonization has been to build locomotives that can operate on two, three or four tensions. The historical solution has been to switch locomotives at the border crossings, where the rail yard can be powered with any of the tensions of the two countries – however not at the same time. In Modane, border-crossing Italy/France, the trains coming from France on 1,5 kV DC roll into an non-powered section of the rail yard and then the current is switched to the Italian 3 kV DC manually. The high-speed trains have all three voltages. They only switch the driver at the border (SNCF Maurienne 2004).

EU is now in the process of introducing a European standard for the signals, ERMTS. This will not be a problem for new investments in high-speed-train technology. But for the old states, dual signal systems will probably be cheaper than changing the trains.

\(^{2}\) 22,45 million euros / 22 176 million euros = 0,1 % in 2002.
UIC, Union Internationale de Chemin de fer, is the European body in charge of these system changes.

Another reason for innovation is the weather. Wind, heat and flooding have had influence on the development of the regulation. Computers and electronics, more and more present out in the terrain, are particularly sensitive to humidity and temperature.

Environment, e.g. the trains’ emission of noise, is an axis for innovation. Rail & Recherche (2004) reports on an innovation reducing noise when the trains brake.

In the neighboring region east of Lyon, Chambery, Fauve Piot, equipment establishment director, DET equipement, for Savoy, has set a number of innovations that he expects each of his unit managers, DUO to deliver, with the help of their staff, during the calendar year of 2004. Good ideas can be awarded with up to approximately 2,000 Euro, although 300 Euro being a more ordinary amount. In Maurienne, the number of innovations has been set to 6, which is twice or more the number of the preceding years. But at this moment, June 2004, it is expected that the target will be reached.

SNCF (2004) has also conducted a prize competition. All engineering units in SNCF were invited to participate, as individuals or as groups. Submission should first be to their supervisor, who would make a first assessment and add his or her comment, before transmitting it to the competition coordinator.

Three categories of competition were set:

- Innovations for the future. Idea mailbox, for innovations that will require some further development before being possible to exploit.
- Technical innovations immediately exploitable. Improvement of existing methods and current development, which carries an innovation.
- Production methods (studies of processes, methods, organization) leading to faster, less expensive, better quality, better reliability.

The ideas could emerge from technology, methods or management. They could be created in-house or come from customers. Particular originality, large technical leaps forward and outstanding teamwork were awarded by a special prize. Criteria such as significant improvement of the current, feasibility, originality, productivity, gains in the result, its planning or its maintenance and applicability to other domains were used to evaluate the proposals. The response was 80 submitted proposals. Out of these 23 were considered of interest to pursue and were therefore gratified.

5.3.6 Character of Innovations

The operative staff is not authorized to alter the regulations. Thus the character of innovations, e.g. for a track group, would typically be new tools and machines to facilitate the work such as screw tightening levers, lift assists and removal of snow from switches (SNCF Maurienne 2004). These may concern improvement of the working conditions, which is applauded by the trade union, and at the same time economizing, which lies in line with SNCF’s interest.
On the national level, main domains of research are along three major axes:

1. Knowledge about physical phenomena, e.g. rail / wheel interaction

2. Develop methods, in particular supervision and repair

3. Survey for radical changes of global dimension

**Knowledge about physical phenomena, e.g. rail / wheel interaction.**

Research is conducted in how the rail behaves and wears depending on the traffic, weight of rails and rolling material, train speed, environmental conditions, etc. The following could be seen as part of this domain: wheel irregularity detection by accelerometers.

![Figure 5.4](image)

**Figure 5.4** Sensors in the rail enable SNCF to detect irregularities of each individual wheel at an early stage without regular inspections. (Rail & Recherche 2003, 2004). Photo: SNCF/CAV & SNCF/DRT.

**Develop methods, in particular supervision and repair**

In particular high-speed lines create tough conditions for the SNCF maintenance teams. SNCF researcher Vincent Delcourt is responsible for image processing. Rails, ballast and overhead power line are areas where there are hopes to improve inspection efficiency by 50 % with image processing techniques (Jacques Couvert, director of SNCF Infrastructure). Techniques involve pattern matching, neural networks, geometric model finder (GMF) and automatic comparison of images of with potential hazardous scenarios. But a problem is still to handle all the data these techniques deliver. This is a matter of organization, not technology (Emmanuel Rivas, SNCF Paris Region Department). SNCF is also sponsoring PhD student Samuel Hocevar, *École Nationale des Télécommunications* in a project aimed at creating manageable 3D scenarios by using video film taken from the front of the train (*Rail&Recherche* 1-3/2004).

**Smart trains to kill weeds** is a video assisted detection system where chemicals are distributed at 60 km/h on the rail and the ballast. The amount of green in the image as indicating presence of weeds, the system is designed to reduce the quantity of herbicide and save money and environment. SNCF’s seven weed-killing trains are to be equipped with the system within 3 years (*Rail & Recherche*, 2003).
Remote surveillance, *telesurveillance*, deals with connecting switches, signals etc. to a central control board where their function can be continually verified on-line. The remote surveillance is most functional for errors that have already occurred without yet having been remedied but less useful for routine maintenance intended to stop faults before they occur. It gives the repair team some notice before the train arrives, and might thereby avoid train halt and immediate delay minutes starting to count. (*Politique de maintenance des installations fixes, Direction de l’équipement et de l’Aménagement, SNCF*).

The remote surveillance could also enable a rational planning for the repair team in order to correct several faults close to each other along a route. So far it has not suppressed any work places, since SNCF prefer using both the established manual routines and the automatic supervision, instead of choosing one or the other. By the redundancy the service to the customer is enhanced by higher safety and less delay minutes in a way that neither safety officers nor the trade union can object to. (*SNCF Lyon 2004*).

In the domain of remote surveillance we also find experiments with *shuntage*, creating a short-circuit by the contact between rail and wheel, in order to be able to detect the presence of a train anywhere on the line (*Rail & Recherche, 2004*).

Following remote surveillance, developmental efforts are conducted in how to operate the signals remotely and maybe even remedy minor faults at a distance. Remote operation of trains, even under fairly complicated conditions such as two locomotives for a 750 meter long freight train, has been proved to be possible in complete safety (*Rail & Recherche 4-6/2004*).

The first switches and signals that can be remotely operated have taken 10 years to realize, but now 20 are in operation. An objective is to have 100 or 150 in operation in 5 years. In 1960 started the electrification of the first switches, in 1975 remote surveillance and in 2005, thus, remote operation (*SNCF 2004*).

**Survey for more radical changes, of global dimension**

*Poste Mistral* a system for voice reconnaissance, e.g. to enable the train drivers to communicate with the signals by their own voice (*SNCF 2004*).

Turning the problem upside down: an overhead line mounted along the locomotive, with an accumulating battery, that is charged whenever the locomotive passes a powered pylon! This idea was awarded at the 6th World Congress on railway research September 2003 in Edinburgh (*Rail & Recherche, 2004*).

### 5.3.7 Financing of Research

Louis Gallois, president of SNCF, writes that the company has decided to play the European card 100 % and take full advantage of the possibilities provided by the EU (*Gallois 2002, p.3*). Research is mainly financed by three external sources, except by SNCF itself:

1. **Prédit, Programme pour la recherche, le développement et l’innovation dans les transports terrestres.** 305 millions Euro budget. 30 % of this is for research. Prédit is for issues of French national interest.

2. **UIC, Union Internationale de Chemin de fer,** the International Union of Railways, finances research of general interest.
3. FP6, (6° PCRD in French), Sixth Framework for Research and Development, has a budget of 17,500 million Euro which is 3.9% of the overall EU budget. 2,120 million are assigned for sustainable development, 610 million of these are for surface transport and 30% of the 610 are for rail transport.

The 30% of 610 million in FP6 is an immense increase since the 30% were only 11% previously. Industrialists express some concern whether the EU will really be able to handle all the “networks of excellence” in a non-bureaucratic way. Siemens favors new products, use of new technologies and massive investment in the infrastructure rather than establishing a “virtual center of technical innovation” in Brussels, which will not solve the current problems. Effective action in the areas of interoperability, intermodality, safety and environment is needed (Rail & Recherche, 2003).

The abundance of European money may enable groups of researchers around topics, which employed only one researcher previously. Findings must be shared and universities must get more involved than they have been previously. On 15 March 2003 EU took a first step to opening up the rail market for freight to competition (Rail & Recherche, 2003).

Some EU projects are:

ERTMS, the European Rail Traffic Management Service consists of ETCS, a train command-control system and GSM-R, the railway communication system. (Rail&Recherche, 1-3/2004)

SNCF, DB (German) and FS (Italian) are having discussions regarding a common platform for high-speed train. Ideally the trains should be able to cross the borders with a minimum of adjustments. (Rail&Recherche, 1-3/2004)

Figure 5.5 Locomotive change at the French/Italian border. Photo:SNCF/CAV.

5.3.8 Ideas from France Worth Importing to Sweden

It might be argued, whether effective competition is possible in a situation where only one company has the competence to do the job. Railroading contains many non-standard, technical issues that may only be possible to learn by experience. Small technical errors easily lead to disasters, if trains collide or derail. A question is, whether Banverket has not overlooked the issue of multiplying the competence, before starting
the competitive bidding processes. Although this education period may be limited in time, it must not be overlooked. UK had to revert the process, perhaps because of neglecting the technical complexity and its implications on the privatization process.23

If Banverket is rushing ahead too fast and the process ends in the same way as in the UK, France will not be as behind in the privatization process as it seems at present. France has made the very first prerequisite for privatization by creating Réseau Ferré de France, RFF. When doing this, they are 10 years behind Sweden, if seeing the RFF creation as corresponding to the Banverket creation in 1988. In 2001 the first private competitor was awarded a contract in Sweden, a measure yet to come, if ever, for France.

Still, France’s method to achieve most value for money is of interest and seems effective. A fixed amount is allocated creating a budget constraint, within which SNCF lets own ideas compete with each other (Section 5.3.3). Competent parties have to convince each others which measure is the next to be prioritized. Such collaboration will hardly happen when different private firms compete with each other. In many ways the French budget constraint method combines the benefit of monopoly with the benefit of competition.

A second interesting feature of the French system, also worth importing to Sweden, is the awareness of the importance of innovations, revealed by a reward structure for innovators and the establishment of an organization to take care of innovations and evaluate proposals (Section 5.3.4).

A third lesson learnt from France, is the idea of a prize contest (Section 5.3.5). A fourth lesson is the active call for innovations expressed by the inclusion of a certain number of innovations to be expected by each operative unit (Section 5.3.5).

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23 That the accidents would be related to rushing into privatization, neglecting the technical complexity and multiplication of competences, is a hypothesis only. The reasons for the accidents in the UK are not part of this study.
6 Theories of Technical Change

As an introduction to this chapter, we will shortly brief the role of technical development in society’s production function, and a few reflections on incentives. After this macro approach we will zoom in towards micro and more endogenous aspects of growth and technical development, as presented in particular by Joseph Schumpeter’s innovator descriptions and Wilfred Salter’s theory on mechanisms and speed of technical development. Finally, we will connect with chapter 2 (innovation systems) by presenting the spillover theory advocated by many researchers of innovation systems, and its contradiction with incentives to innovation. That discussion and comparison with the empiric results of this particular study is continued in the final, 9th, Conclusion and Proposals chapter.

Angus Maddison (1982) divides history into six epochs, their definitions selected and adapted for the purpose of analyzing the driving and constraining factors for economic growth. He assumes the reader being familiar with the general production function,

\[ P = F(L,N,C,t,e,d) \]

i.e. production being a result of labor (L), natural resources (N) and capital (C), which he extends further by technical progress (t), education (e) and division of labor (d).

According to Evensen (2004, personal communication), Michael Porter (1990) stressed the importance of incentives as a condition for growth, however with the somewhat sad and cynical conclusion that fear of loss seemed to be a stronger incentive for action than hope of gain. Karl Popper (1959) was also positive to ideas, but stressed the importance of doing something with the ideas. Ideas should be tested, systematically and continuously to lead society on.

6.1 Schumpeter’s Entrepreneur

Joseph Schumpeter is a forerunner of modern innovation theory in economics. He stressed the role of technical progress. He completely rejected the natural resources constraints advocated by earlier economic thinkers. He stressed the dynamic character of technical progress and its interactive nature with surrounding factors. If the economy had a circular static flow, shocks of innovation carrying society to a higher state interrupted it.

To Schumpeter (1961, p.116), capital did not have the central role in the process, but the entrepreneur. “Capital is nothing but the lever by which the entrepreneur subjects to his control the concrete goods which he needs”. Schumpeter describes it as a process starting with an innovation of breakthrough character, which, if successful, will be followed by incremental innovations and imitators.

Maddison (1982) opposes the idea of the unique entrepreneur, and means Schumpeter himself is contradictory, since Schumpeter mentions that innovation can be institutionalized in large firms. “If the entrepreneur is disenfronced in Schumpeter’s schema, then we must fall back on capital as the vehicle for technical change”. Maddison also finds it odd that Schumpeter does not discuss patents, R&D and

\[ I may have used other letters than the source \]

\[ A further discussion in the Swedish language on Schumpeter can be found on http://www.infra.kth.se/~stenbeck/Memos/030509_schumpeter.htm \]
invention, these being one step ahead of the entrepreneurial act. If this omission is deliberate, Schumpeter may want to stress that innovation normally occurs within the frontier of potentially exploitable knowledge.

Schumpeter (1961) mentions three capacities required by the entrepreneur.

1. Capacity to see beyond the established routines
2. Power to seek cooperation and do something with the new insights
3. Power to survive the resistance of the surrounding

The resistance first appears in the groups threatened by the innovation, then in the problems to establish the necessary cooperation with others and finally when the consumers are to be convinced. Thus, these challenges require a special form of leadership.

The special form of leadership capacity of the true innovator only unveils where the new opportunities happen. It is not contained in the basic function of the leader to create nor find new opportunities, because they are accumulated in surplus among humans. Many have ideas, but it must also be done something with them. The innovative leader is more characterized by will and authority, than by remarkable ideas.

Other literature differs invention from innovation. The inventor creates the technical solution, but the innovator makes sure it reaches a market. Without realization, the invention is worthless. The realization requires another type of leadership, and it is this type of leadership that characterizes the innovator (Dahmén 1983, Swedberg 1994). This does however not exclude that the inventor and the innovator could be the same person, just as the innovator and the financier could be the same person.

The entrepreneur leads society onto new tracks and into new domains. He also becomes a leader for the competitors trying to follow, but this is an unintentional side effect, since they may cause reduction of his profit in the future.

It lies in the nature of the case, that the new discoveries may be difficult for the contemporary to understand. Often a small group of specialists, maybe without personal motives to understand, are the only ones. The entrepreneur may for this reason not be encouraged by the surrounding world. What are then the incentives for the entrepreneur?

Rational behavior can exist even when a rational motive is missing. Much of what people do, seems to depend on a feeling of duty to society, a wish to please others with a vague hope about a social or economic reward.

Schumpeter writes that the entrepreneur is not driven by money, that the results or the reward from the innovation will bring the means to fulfill other desires. Experience tells that typical entrepreneurs withdraw when their powers cease, not when a particular need has been fulfilled. They do not even take the leisure necessary to consume what they have gained on the innovation. The financial result is secondary, except perhaps as a measure of the success.26

Finally, not to be forgotten, is the joy of creating something and get things done, get an outlet for energy and entrepreneurship. The innovator searches difficulties, changes to create change and loves to take risks. (Dahmén 1983, Swedberg 1994)

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26 It can be argued, against Schumpeter, that money as a measure of success is an important point. Money is becoming more and more accepted as an objective indicator of who is a valuable person.
Schumpeter (1950) identifies five threats to the entrepreneur and thereby on the capitalistic mechanisms:

1. Bureaucratization of management and decision-making in large corporations
2. The progressive tax systems
3. Trade unions
4. Socialist ideas
5. Anti-capitalistic movements

Schumpeter’s followers have developed his general thoughts in a more technocratic direction. Two new ideas have appeared in this literature. The first one is to regard technical progress as being embodied in the capital factor, and the second one is education as a form of human capital embodied in the labor factor.

The first of these ideas was brought forward most distinctly by Salter (1966). He sees capital as an accumulation of technical progress. He makes a distinction between ‘best-practice’ – productivity and average productivity, to explain existence of a span of different technologies, from new to old technology, within an industry. This helps to map the process of technical change and the competitive, economic and technical dynamics involved. The similarity to Schumpeter’s leader-follower theory is not far away.

The second idea is from Schultz (1961). He treats education as a part of the labor force, stressing the existence of a span of varying competence. Schumpeter seems to have treated labor as homogenous. Maddison (1982) finds that although education seems to be a factor to explain difference in earnings and productivity, it has proved not to be self-evident. Other factors like intelligence, social origin etc. may be more significant. It seems that shortage of educated people has never been a constraining factor in advanced capitalist countries.

Denison (1967) used statistical analysis of data to identify each factor’s particular influence. None of the opposite views of the economic historians seem to be possible to rule out completely. Even the theories of absolute limits to development, as they were forwarded by Malthus (1798) and others, cannot be ruled out with certainty. This debate is central in the literature on sustainable development.

### 6.2 The Role of Demand

Schmookler (1966) makes an attempt to relate inventive activity and innovation to economic growth. According to his theories, development of new products and processes are induced by demand, i.e. an endogenous mechanism. Scientific knowledge is exogenous and more or less autonomous and just permissive as regards to what products appear. If scientific knowledge is limited in a certain direction, a functionally equivalent solution will be developed in another technical direction.

Schmookler agrees that long-term economic growth is the result of the growth of technical knowledge. The direction of the growth is however induced by demand, and the size and pace of the growth is determined by the rate of investment. Schmookler also claims that there are no diminishing returns to inventive effort. This would imply that if you spend twice on technical progress, you receive twice as much progress.

Based on Rosenberg’s (1976) examples of constraints to technologic growth that money cannot solve, such as the size of the pool of technical skills available, Maddison takes
the example of the different situation for a leading country and the follower countries. The follower countries, that do not have to break new ground, could reach productivity advances as a linear function of capital, but maybe not the leading country.

If so, individual countries should remain in lead position only for short periods until caught up and passed by followers. Still, this is not the case. Netherlands was ahead 1700-1785, UK 1785-1890 and USA from 1890 until today (1982\textsuperscript{27}). Maddison attributed this to the world wars being beneficial to the USA, and that other European countries would catch up. When arriving at the technical frontier, Maddison, however, expects their growth rates to fall equal to the US level.

6.3 The Interaction between Science and Innovations

Jewkes, Sawers and Stillerman (1958) argue that the innovations of the nineteenth century depended on scientific research to a larger extent than often assumed. This does not necessarily imply a one-way linear model from science to innovation, but strong reciprocal interaction between the two. In the twentieth century, technology has developed more in the private R&D laboratories than at universities. There seem to be insufficient communication between the universities and the private sector (Freeman & Soethe 2000, p.197) in the twentieth century, which leads to a suspicion that the full and optimal possible pace of development is not utilized.

In the nineteenth century inventor and entrepreneurship were heroic actions with named persons becoming famous. In the twentieth century inventions and innovations seem more to be resulting from collective work in large organizations. A philosophy regarding funding for technologic development, which was successful under the Second World War to produce atomic bombs etc, is that by feeding the roots, the fruits will fall down by itself on society. This approach justifies governmental support to the universities and support to fundamental research. It is sometimes called the linear or the technology push model. It may work sometimes, but not always. A third traditional belief is the network model, assuming that people meeting often and regularly will create new ideas. This idea is common in the academic world as well as in the public sector. (Seaden 2001).

Much literature and debate on innovation are based on the innovation process being in the hand of the contractors, and the challenge and the science is for these contractors (and research institutions) to guess and forecast future market development and demand. Efficient organization and communication are identified as important to make this guessing and forecasting successful (Westling 2001). Large innovations may be supply driven and small may be demand driven (KTH 2004b). Although initiatives to innovation can be made both by the demand side and the supply side, experience of recent times is that the major part - some researchers say 75 % or more - have resulted from the demand side (Westling 2001).

History supports demand-side driven technology development by competition. Spain, France and Britain organized a contest. Who could construct a device to get the longitudinal position at sea with certain accuracy? 30 years and 4 prototypes later John Harrison, UK, succeeded.

In the 1980s, a competition to refurbish lifts in multi-family buildings led to total cost cut by almost half (52%) and with little disruption to residents (few days instead of

\textsuperscript{27} Maddison published his book in 1982.
several weeks). This was achieved through a complete prefabricated lift shaft put into place by a crane.

In energy reduction, 30-50 % reduction was achieved as results of competition. “Traffic Lights with LED” was a competition built on the idea that 90 % power saving should be within reach, initiated at a seminar in Amsterdam in April 2000.

Technology procurement for apartment buildings was carried out in 1996-1998 in Sweden (Westling 2000). Objective was to reduce building and operative costs. Tenders were evaluated in respect of economy 40 %, housing quality 20 %, indoor environment 20 % and resource management and eco-cycle adaptation, each 10 %.

250 wanted to participate, 10 were chosen. But few innovative solutions came up that met the goal. The following reasons and lessons for the future were listed: The time set aside for the task was too short, the task was too complex, a large upcoming market could not be promised, future financing conditions were uncertain, the buyers were not sufficiently involved from the beginning, tender requirements were too detailed, where to erect the prototype was too vague and the construction sector does not take life cycle total cost into account. But it could of course also be a trend break, indicating that technology procurement by competition is not as effective as the competition organizers had hoped, and as it may have been in history.

As an example of historical successful contests could be mentioned the great steam engine locomotive contest at Rainhill, UK, in 1829, where George Stephenson's "Rocket" beat John Ericson's "Novelty" (http://home.swipnet.se/sm0pry/steameng.html, 2004-09-29).

Banverket (BV 2004d) commonly uses a type of technology procurement, where the market is asked to find a solution to a particular problem. There is always more ideas of research and development coming from the market and within the organization than there are funds.

6.4 The Natural Rate of Technical Development

In his book *Productivity and Technical Change*, Wilfred Salter (1966) provides technical development a pure economical definition. Technical development is equivalent to increased productivity, i.e. products and processes enabling us to produce the same output with less input. In *Modern Theories of Economic Growth*, Hywel Jones (1975) adds new products to the definition to allow for qualitative aspects of technical progress.

Salter comments that productivity, for a clever businessman, is not a goal in itself, but merely one way of reducing production costs. Capital costs may be equally or more important than labor productivity. Salter may want to stress that technical change is slowed down by capital costs, compared with what the rate of technical change would have been otherwise.

Salter continues his theory regarding the factors determining the rate of technical change. To replace an old technology, the cost per unit produced with the new technology must be lower. Furthermore, the average cost per unit when using the new technology, $A_{new}$, must be lower than the marginal cost of all the already existing factories, $MC_{old}$. This since the invested capital cost in the old technology is already installed in place and will not disappear, even if dismantled, while the new technology’s lower unit cost cannot be realized without engaging the investment connected to the new technology.
Figure 6.1 Technical development (Salter 1966) consists of discrete jumps determined by the difference in production cost per unit between the latest technology (n-1) and earlier technologies (n-2, n-3, ...). N-5 had to give way when technology n-1 entered the market.

If the investment is considerable compared to the variable costs, new technologies will often not be competitive until the old technology ceases to function (Salter) or when its maintenance costs become uneconomic. The investment in place, usually, the technology cannot be altered any more, and the production cost will vary directly depending on the factor prices (Salter 1966, p.75) and the learning curve.

The average technology level on the market would then trail behind latest available technology with approximately half the technical life span. If we consider a road maintenance machinery market demanding only for four machines, bought 2004, 2003, 2002 and 2001 respectively, with a technical life length of four years, the average age of all machines on the market will be 4/2 = 2 years. The natural rate of technology propagation then corresponds to two years. With this in mind, the average age of machinery in civil engineering would be approximately five years, if the average life length is 10 years. It is nothing wrong in using old equipment until it falls apart. It is not a sign that something is wrong with the technical development, but rather the normal case. With this in mind, it appears as if the age of machinery in the road sector is not unreasonably high, even if some old trucks from the 70s may still be driving around. Sooner or later they will fall apart and be replaced by new machinery.

6.4.1 The Financial Comparison
Assuming the new technology in existence and being a concrete option, the entrepreneurs and financial risk takers’ decisions are merely financial. They depend on the outcome of the following function, which determines the value of the new technology:

\[
P = F(L, C)
\]

where

- \(P\) is production,
- \(L\) is labor (man-hours),
- \(C\) is capital costs
To make the function operable, P, L and C must be expressed in the same unit, e.g. US$/year.

(6.2) In its simplest form, assuming an interest rate, r = 0,
C is calculated as C = I/t
where
I is the investment and t is the technical life time of the equipment.

If t is expressed in years, and I is the total investment needed during the time t (but with its main part being an initial investment at t = 0 28), the units of formula 6.2 become consistent with 6.1.

To keep in consideration is that technical obsolescence may place a definite limit on the life of capital equipment, causing t to be lower and raising the annual cost of the new technology and thus lowering the speed of technical change. On the other hand, obsolescence of the old technology may be the reason why the decision situation has appeared, which has an increasing effect on the rate of technical change. These two contradictory impacts of obsolescence should result in a net effect being positive for the rate of technical change. This however is the author’s assumption and its mathematical proof is beyond the scope of this study. Salter avoids the problem by treating the risk of obsolescence and all other risk factors to be included in I.

6.4.2 The Interest (and/or Profit Margin)

For the capitalist to be able to compare old technology (without investment) with new technology (inclusive investment) all the future costs and revenue needs to be discounted back to t = 0, or some other way to make all figures the same unit. This is why Salter adds r to the production function, P = F(L,C,I,r). But any non-zero interest rate leads us having to decide on a depreciation formula.

The theoretically ideal depreciation method would bring the allowance each year to reflect the reduction in the present value of the expected gross earnings (Amer, 1925, Lutz & Lutz 1951). As an approximate for this function we have a straight-line declining balance (I/t above, but adding r to it) or annuity methods that assign amortization and interest so that the sum is equal over the lifetime of the investment. Salter favors the annuity method.

Another approach, however, is to choose the straight-line assumption, easiest the totally straight one where r = 0. A reason for this is as follows. As a general scientific rule, we should never choose a complicated assumption, if a simpler is equally, or more, probable. Firstly, we are talking about real interest rate, not nominal interest rate, which makes r = 0 more probable than to assume a nominal interest rate of 0. And even if this assumption would be wrong, the error between r = 0 and the actual interest rates each year, will be positive 29 and very small, compared to other risks such as still unveiled technologies or changes in demand for the product produced. Before including r into the formula, we should have included these other, much more important risks.

28 Salter does not mention any part of I to be any other year than at the start. Recalculating Salter’s I into yearly depreciation has the advantage of enabling other yearly costs to be added or subtracted.

29 Positive, since if actual interest rate > 0 but model interest rate = 0, the difference will inevitably be positive.
Future yet unveiled technologies and changes in customer preferences will probably have a quite large negative impact on our calculus\textsuperscript{30}, while the interest rate error most probably generates a small positive one\textsuperscript{31}. Until those negative risks are included, we thus improve the formula by keeping a small, deliberate positive error factor in it, achieved through the $r = 0$ assumption.

### 6.4.3 Best-Practice Productivity

However, whether we keep Salter’s annuity assumption or change to the $r = 0$ assumption, may not matter for Salter’s further reasoning, as he introduces mathematics and dynamics. The following is in brief how he explains how new technology gradually replaces less efficient technology.

**The Iso-Product and Relative Price Tangential Point**

Salter assumes that at each point in time there are a range of possible techniques employing different mixes of labor and capital bringing the same output, which can be shown as an iso-product curve in a diagram. The curve represents society’s technical opportunities at a certain point in time, to produce a given output. Which mix of $L$ and $C$ is optimal depends on the price of labor as compared to capital. The optimum point can be solved graphically by introducing a straight line into the diagram, with a slope reflecting the relative price between labor and capital. Where an iso-product (technical opportunities) curve tangents the straight line, is an optimal mix point, given the current technical opportunities and the current prices of labor and capital.

It may be commented that labor should also include salaries, not only wages. The capital cost will still be $I/t$. We thus relax a condition, which could be seen as a higher scientific level, without loosing anything.

The $n$ and $n+1$ in the diagram means that $n$ is a certain year; $n+1$ is one period (or one technology) later etc.

---

\textsuperscript{30} Assuming that future changes reduce the reason to change now with more than some few percent.

\textsuperscript{31} Assuming interest rates between 0 and some few percent.
6.4.4 Shifts in the Curves

The shift of n towards origin with time, is a graphical way to display technical development. This shift can be "symmetric" or biased towards the L or the C axes.

New technologies improving the efficiency of C at no or negligible cost, such as an improved lubrication oil for a machine used in "our" production, will create a new iso-product-curve representing a new mix where less of one factor can be used despite all other factors remaining constant, giving the same output as before. This corresponds to an asymmetric curve shift favoring the use of capital, i.e. moving the iso-product curve more to the left than downward.

Relative factor prices may also change, resulting in a new slope of the straight line. Technical change thus has two components, one related to the superiority of the new technology, causing a shift inwards of the isoproduct curve and the other to changes in relative factor prices, causing a different slope of the straight line and moving the optimal point along a curve. (Salter)

By consecutive time series data inserted graphically in this way, the best-practice speed of technical change propagation would be possible to calculate. The micro-economic mechanism triggering technical change would be that when the distance between best-practice and least efficient technique in use has grown enough \((AC_{\text{new}} < MC_{\text{old}})\), it will be rational for the capitalist to invest in new technology. If this new technology is the best-practice, actual (average) labor productivity would, based on this analysis, trail behind best-practice by approximately half the actual lifetime of the equipment (approximately n-2 in Figure 6.1, without this delay necessarily hampering the best-practice technical development (n in Figure 6.1).

6.4.5 Components Shaping Best-Practice Productivity Movements

In mathematical terms, all proportional rate of change, Salter expresses the biasing factors as follows:

\[
L = T - \pi D + \pi \sigma \left(\frac{g}{w}\right)
\]

\[
C = T + (1-\pi)D + \sigma(1-\pi) \left(\frac{w}{g}\right)
\]

The first term, T, is the size of the shift inwards, the (symmetric) technical advance period-to-period. Second term, D, is the degree to which this shift is not equally distributed on the capital and labor productivity but biased towards one or the other. Positive D means bias towards labor, a negative D means bias towards capital. \(\pi\) is the share of capital cost in total cost. Economies of scale can be included as a factor as well\(^32\), but it complicates the matter without changing the discussion.

Third term, \(\sigma \left(\frac{g}{w}\right)\), describes the shape of the curve by an elasticity of substitution, \(\sigma\), between labor \((w = \text{wage})\) and capital \((g=\text{capital cost, I/t})\).

The relative factor prices, \(g/w\), \(g\) the price of capital, \(w\) the price of labor, influence the tangential point both by the straight line and the shape of the curved line. Salter recognizes that all these four factors are mixed and difficult to separate. This, he diplomatically expresses, would be a rational explanation for that other researchers\(^33\) with more macro-economic view have not attempted to separate T into components and the complication that capital and labor might be subject to different rates of productivity.

\(^{32}\) \(L = T + S - \pi D - \pi V + \pi \sigma \left(\frac{g}{w}\right), S = \text{general scale effect, V = scale bias effect.}\)

\(^{33}\) Salter is here probably referring to Harrods, R.F and Hicks.
change. Salter’s motivation to do so is that to explain the microeconomic mechanisms, it is necessary to separate out what is exogenous, from an individual company’s point of view, without being so from a macroeconomic view.

6.4.6 Can Wage Rises Stop Technical Development?
Salter discusses whether a rise in wages may result in an equal proportionate increase in the prices of capital goods, so that no substitution of labor to capital goods will occur (Shove 1933). His argument is that maybe short-term but not long-term, since the capital goods in a world of continuous technical progress continuously demand less and less labor to be produced. Their price would fall if wages were constant, and rise less than the wages in any case. Therefore a constant substitution from labor to capital is to be expected.

6.4.7 The Exponential Effect on Capital
The initial investment, I, may consist of capital goods, themselves subject to technical change.

Assume the following example, not available when Salter wrote his book. When investing in computers, the following will happen: after one year the equal machine performance can be purchased at a much lower price. The more rapid the expected price fall, the less incentive to invest in the new technology now. This should, in itself, slow technical development.

This gives us the paradox that too rapid technologic advance may have a counteracting effect on the purchase and implementation of new technology.

A rescue out of this paradox could be to simplify and analyze a net technical speed. Gross technical speed – the counteracting effect above = net technical propagation speed. Back to square one. But the above serves to show that it is an aware simplification and not that we have forgotten the slowing effect of technical change expectancy.

6.4.8 The Mechanization Jump
Another factor, Salter argues, would be that when mechanical power replaces human power, much more spectacular innovations and significant moves within an iso-curve or to another iso-curve may result, than later, when the machinery is replaced by other machinery. This may explain a diminishing rate of labor’s productivity change (Salter, p.25, Table 2) and a slow down of technical development after a period of intense mechanization. Salter mentions the mechanization jump as a factor that partly explains his empirics being contradicting his theory. But we mention it while it could be part of the reason for the feeling in Vägverket that no technical development has occurred in the 1990s. In the late 1980s, much of the mechanization, being a concrete and conspicuous form of technical development, may have been completed. In the 1990s technical development may have consisted more of replacing machines with machines or improving efficiency of already existing machines, which is, of course, less conspicuous than replacing manual methods with the first machine.
Salter supports his theoretical reasoning with statistics, which are however in some ways contradictory, in particular with regard to the approach of this study, the incentives.

6.4.9 No Incentives in Salter’s Theory
Salter’s surprising finding is, that during the time period that he has studied, first half of the 20th century, owners of industry with high productivity increase, generally make less profit, than owners of industry with slow technologic development. Instead the industries with higher rate of technical change generates more employment and more output. For society, a larger volume, a larger amount of GDP being channeled to the innovative sectors, compensates the loss in profit per unit. This is however little consolation to the actual innovator, who will probably find it reasonable that a part of the profit to society lands in the own wallet.

It seems as most of the gain from the high productivity increase is forwarded to the customers. This would then, in a sense, lower the incentives for the particular industry to engage in technologic development. Salter argues that the data fit into his theoretical model, e.g. explaining it as consistent with perfect competition. But more precisely why and how technologic development sustains in these high productivity sectors is puzzling from the innovator’s incentives point of view.

A first explanation might be that the loss per unit is somewhat compensated by volume, not only for society but also for the innovator.

A second, possible explanation is that Schumpeter was right. The profit is not determining for the “true” innovators. The honor and feeling of having contributed to societal growth is enough.

A third explanation could be that the factor linking technical development, growth and individual incentives, is still missing in the model.

A fourth might be that the value rise of the shares needs to be added to the profit variable in the statistics, to show the innovators’ real profits.

A fifth could be that the salary to the innovator and business owner needs to be added to the profit variable in the statistics to show the innovators’ real profits. Often a business owner can choose freely what to show as profit and what to take out as salary.

A sixth would be that Salter’s findings support necessity as being the only mother of innovation.

6.4.10 Applying Salter’s Theory on Our Experiments
Let us leave Salter’s empirics and return to his theory. Would, a subsidy for an innovative investment lead to a sustainable increased rate of technical progress? This would initially accelerate the replacement of old machines and methods by financing new machinery. Practically, we lower the entry barrier until a new machine is bought as a result of the $AC_{new} < MC_{old}$ mechanism described by Salter.
A new factory, with a technology n, must offer a lower price to enter the market, which, in Salter’s model, requires a lower unit production cost. (In our case: the new machine/method enables the bidder to reduce the price and win the tender). The new lower price makes the least efficient technology (n-4) unprofitable, leading to scrapped or reduced production with this machine/method. The newest factory will fill the output gap corresponding to the obsolete capacity, which was just withdrawn from the market. In our case: The new machinery/method should result in machinery/method somewhere else being scrapped.

The newest factory will also produce the additional output coming from raised total demand, an effect of the aggregate demand curve (increased demand when price becomes lower). In our case: Additional output due to a sloping aggregate demand curve will probably not occur, since Vägverket / Banverket may not increase demand even if services become cheaper. Their demand curve is probably more or less vertical.

Productivity will have risen after these operations. Conclusion 1: If the subsidy is added until a technologic jump occurs, it is probable that it will have the desired effect: to raise the technical level of the industry.

Since the jump was created artificially (by funds from outside), it is not to be expected that even better technology can be purchased in the following years, if the machine manufacturer maintains the price of the first unit. It is not excluded however, that the machine manufacturer, having had a first paying client, having paid for development and such once-only costs, could sell to the ‘followers’ the machines at a lower price.
In the good times, maybe equipment was scrapped long before it was used up. It could be an explanation that the 1990s was a relatively difficult time, creating a transition period with little new investment.

Salter argues that low wages lead to a lower rate of investment replacement (since the reason to invest in machinery is then lower, my clarification). The average technology would then trail further behind best-practice (newest) technology. The 44% reduction of staff in road operations the last decade must somewhat have pushed wages downwards. Following this, it would be theoretically expected that machinery investments have slowed down in this transition period.

6.5 No Incentives in Spillover Theory

Spillover effects are often considered to be beneficial for the performance of an innovations system by regional innovation system researchers. When using the perspective of the individual innovator, however, this assumption is not self-evident. On the contrary, the higher the risk of followers copying the innovator, inherit in a system characterized by high spillover effects, the lower the incentives to be the very first, to be the innovator oneself. Being second in the race, just copying the pioneer, will cut corners and often be more profitable. A well-known example of this strategy is the Apple - IBM battle in the beginning of the 1990s. Macintosh’s user-friendly operative system was an innovation, but Windows followed with small alterations and competed it out. It seems reasonable to assume that the more an industry is subject to spillover effects, the more advantageous will be the “being second” – strategy.

As actors of the system gradually realize this, there may be fewer and fewer “number ones”. The problem now is that without number ones, there will be no number twos, no spillover effects and no technical progress. This is one of the most frequent answers to...
one of our research question (why no innovations?) given by our respondents in the empirics chapter, presented later in this study.

Are incentives an innovation to innovation system theory? Is it because incentives were never considered, or is it because they were omitted as irrelevant, on scientific grounds? Edquist, in Fischer & Fröhlich (2001), touches the issue in his third policy implication (p.52), but the following text, and all the other of his seven policy implications, stresses the opposite. The eight policy recommendations see “lock-in” of competence as the main problem, not at all reflecting on that, from an innovator’s incentives’ viewpoint, some “lock-in” (secrecy) may be a precondition for engaging in innovative activity.

Archibugi, in Fischer & Fröhlich (2001), is on the same track, since he explains low innovation in Europe by it not being open enough, to the world and between European countries (p.74). His conclusion, that greater efforts towards generation and transmission of knowledge is beneficial to the innovation rate, is provided without commenting the contradicting impact that ease of transmission might have on the incentives for idea generation.

Lagendijk, in Fischer & Fröhlich (2001), continues on the same track, indicated in the title of his paper, Knowledge Creation and Spillovers, although he ends with a question mark regarding these assumptions (p.100, second paragraph). His empirics seem not have supported the theory of the region being a meaningful analysis framework, implied by the spillover theory, and propose focusing on competences. Maybe his empirics would fit if focusing on incentives instead.

Karlsson & Manduchi, in Fischer & Fröhlich (2001) are along the same line as Lagendijk, stressing “substantial disagreement” (p.100, line 6) whether knowledge is geographically bounded or not. In their proposals for further research, it seems however that they are not prepared to question whether spillovers are at all beneficial for innovation. Instead they propose that knowledge networks replace geographical regions as explanatory factor for innovation capacity.

Fischer et al, in Fischer & Fröhlich (2001), are using a regional viewpoint in their study. Despite this initial focus, with an inherit assumption of knowledge spillover effects, they conclude (p.142, 3rd paragraph) that “increasing returns appear to result largely from between-firm knowledge diffusion rather than knowledge spillover effects”. They are thus negating the spillover hypothesis (maybe without realizing it) in favor of closer cooperation between firms, which is in line with the incentives hypothesis of our study.
7 Technology Procurement Strategies

Let’s assume we are the government and we have been given a budget, an amount to allocate, for technical growth promotion.

Ideally now, this amount is used as catalytically as possible. What they want is a lever effect: as much technologic development as possible with as little money as possible.

Let us consider different ways to spend the money, and discuss advantages and disadvantages depending on the degree of privatization. At one end of the range of possibilities we consider a monopoly with a distinctly earmarked amount for technologic development, similar to the Swedish organization for operations and maintenance before 1992. At the other end of possibilities we put perfect competition with as few directives at all, hoping that the market will lead society and all actors involved to the optimal long-term level of R&D. Neither earmarking of money nor directives from the state will then be used, similar to the situation in operations the last 5 years.

Between them we place all methods trying to combine the advantages of the two extremes. We can never be sure about the long-term effects (according to the philosopher David Hume in the 18th century), but we have to do something which means we have to assume something. Suspicion is that technical development has diminished since steps were taken from monopoly towards competition. At the same time however, costs have apparently fallen by 20-40 % as a benefit of the reform. Our aim is now to find a way to remove the obstacles to technical development, while trying to keep the benefit of a reduced general price level.

We will now list seven alternatives for a principal to manage the network and promote technical progress. We have ordered them on a scale from 100 % state monopoly to as little involvement by the principal as possible.

1. State governed monopoly
2. R&D as separate tender
3. R&D tendering plus an operations contract
4. Variant execution (side bids)
5. Soft variable
6. Performance specified procurement
7. Perfect competition

We will now analyze their advantages and disadvantages.

7.1.1 State Governed Monopoly

In this scenario, all the R&D is done in-house. A part of the principal, or another state monopoly, receives an amount dedicated to research and development. The politicians will usually not be competent (and will hopefully realize that) to tell exactly what R&D to do with the amount. However, by assigning an earmarked amount, they once and for silence the voices claiming that “there is no money for R&D”. Of course the financiers have reason to demand a report on the result of the spending.

An advantage of this strategy is that it maximizes the probability that R&D will take place. This is its major advantage, since we make the assumption that R&D is positive for society in general and for the road sector in particular. Another advantage is that the
allocation process is relatively easy. No time need be wasted on presenting ideas that are later turned down. The amount is received without effort and all hours can be spent on carrying out the actual R&D.

Another advantage is that public pressure on evaluating staff will be low. Since there is no tender, no evaluation staff needs to be employed. Thus a societal risk of turmoil is avoided. No large companies will feel like losers. Individuals may attempt to be selected for the research, and those unsuccessful may feel like losers. But since this is on individual level, protests will be small. Reality will with time automatically evaluate the innovations. Some will bear fruit, some will not. But this will be a much less dramatic evaluation than the one in conjunction with tendering. The gradual evaluation will be less transparent, less public and take place under less competitive circumstances, which reduces the risk of turmoil and saves costs to hire expensive staff dedicated to evaluation.

The main disadvantage is that there is no market mechanism making sure that the money is spent in the way, which is most profitable for society. The absence of competition will, according to market theory advocates, most probably lead to an inefficient use of the amount. Innovations that are fun to develop, but with little benefit to the sector, may be produced. Also, the financer cannot compare with other uses of the same amount, in order to see how much was researched and how much was spent for administration and other less productive means. Experiences from promotion of regional innovation systems have resulted in administrative costs consuming more or less the whole amount without any long-term result at all (Lars-Olof Persson 2003).

7.1.2 R&D as Separate Tender

This alternative is similar to alternative 1, except that the allocated amount is open for anybody who wants to compete. Since the amount is fixed, the tender will be of purely qualitative nature. The bidder who can offer the most R&D will win the tender. Since prices are all equal (common denominator), the ‘lowest bid’ principle is inapplicable, and the more general ‘most economically advantageous’ (Act on Public Procurement, §1:22) would be the only possible approach.

In this alternative the principal must be aware of the risk that bidders offer more than they will eventually deliver, thus making profit at the principal’s expense. This would also ruin the fairness and the profits, to the principal, from the tendering procedure. Continuous reporting, revision and follow up are therefore key components of qualitative tendering as well as well-defined procedures and penalty systems for deviations. If the contractor tries to deliver less than was offered in its tender, the penalty must exceed the profit of such a shortcut.

On the other hand, it is not excluded that extra money could be budgeted and paid for accidental extra quality. In this case the remuneration should be lower than the contractor’s profit of delivering the extra quality. Else the result could be that the contractor will deliberately deliver something not ordered to compensate for losses in the basic contract, which would not be fair to the basic contract tender competitors.

The procurer must also be aware of the pressure on the revising staff. Procedures to reduce subjectivism should be established, e.g. by using several independent controllers. The contractors need to be protected from over-pedantic controllers. The public and the competitors need to be protected from under-pedantic ones. The temptations to bridge the gap with bribes or looking the other way need to be removed, if the system is to
receive respect. Special skills are needed to construct procurement and controlling systems that are robust and fair also when negative statements need to be delivered.

**Advantages** compared to alternative 1 are that the tendering of the amount makes the procedure more open and subject to public supervision, which could be seen as a democratic merit. It will not be too difficult to formulate the tender documentation, if kept short and simple. Such a description opens up for varied types of innovations, which according to market theory, gives the bidders more opportunities to find the optimal innovations for society.

Many will argue that the main **disadvantage** of this alternative is that it assumes R&D to have its own value, irrespective of its ends and object. This is unfortunate and may lead to sponsoring of innovations without any practical value or profitability. In the interviews of this study, contractors were faced with questions why they did not buy or hire certain innovative machinery, such as the nozzle feeder, from Vägverket. A common response was that an almost equal or better result could often be achieved by manual methods, such as “a truck, a man and a spade” (Skanska Billingsryd 2003). Adding the costs and trouble of finding the specialized machinery made the balance tip over to using the own standardized equipment.

It should also be kept in mind, that new methods may often be connected to new products. New machinery is mainly a concern for the machinery developers, a step upwards in the value added chain, not the operations and maintenance industry itself. Our industry makes its money on using the machines and will normally not spend time and money on developing them.

Practical **disadvantages**, in particular if a short and simple description was chosen in the tender documentation, arise when the principal will have to evaluate different innovations against each other. The Act on Public Procurement (1:22) states that the qualitative features to which weight will be attached should be mentioned in the tender document, preferably in the order of significance to the procurer. But since the main benefit of alternative 2 is to stimulate flow of previously **unknown** ideas, enabled by keeping a short, simple and open tender document, the qualitative features to which weight will be attached cannot be mentioned in the tender documents. Legal specialists will have to judge if this contradiction may make alternative 2 impossible to use.

If tenders offer the same innovation, quantities can be compared. But if they offer different innovations, maybe one offers an organizational innovation and another a process innovation, which is probable if the tender document was unspecific, it will require high technical and economic competence to evaluate the two against each other. Even if postponing the problem by a short open description in the tender, the evaluation problem cannot remain unsolved. A procedure to quantify them all into a comparable unit seems inevitable. If the common denominator ideas presented above hold and are legally approved, the disadvantages of this method are surmountable. Then, alternative 2 is a viable option.

A disadvantage, which reduces the effect of the strategy, is that the winning bidder will have difficulty to experiment and use his innovations if having no operations contract. This disadvantage is taken care of in the next alternative.

A practical example of this alternative is an innovation contest. Separating the contest and the realization of the proposals can solve some of the difficulties addressed above. The best proposal is awarded the first prize, a predetermined amount, which is the pay for the idea as such. By paying this price to the winner, it can be argued that the idea from now on belongs to the principal for further use without any additional sharing of benefits.
7.1.3 R&D Project as Part of an Operations Contract

This alternative simply connects the previous alternative to a specific operations contract. The tender will contain two items. The first item is a standard operations contract, i.e. the operations and maintenance of a certain region for a certain time. The second item would be R&D according to alternative 2, a description of an R&D project.

The bid for the second item, the R&D part, may have a positive, a negative or a zero cost. A positive cost is the addition Vägverket has to pay to carry out the proposed R&D. But it is also not excluded, that the bidder offers a price reduction on the first item, in exchange of being allowed to do it a different way than specified.

The advantage compared to 2 is that the winner will have an arena where the innovation can be tested. The disadvantage is that the best R&D project may not win, since it is the total of item 1 and 2 that is compared with the other bids.

7.1.4 Variants (side bids)

The Act on Public Procurement (§1:23b) expresses that if bidders are not allowed to offer variants to the specification, this should be specifically stated in the tender. This can be seen as an encouragement that, unless special reasons apply, variant execution should be evaluated. Unfortunately common practice by Vägverket and Banverket has long been to more or less explicitly forbid side bids. In this way they have discouraged much of technical development. Vägverket project groups (VV 2004d) dealing with the issue of side bids have come to the same conclusion, Section 10.13.1 (in Swedish only). Side bids should be allowed and evaluated, unless there are particular reasons not to.

Deviating from the specification as such, should not improve the chances for winning the contract. In exchange for changing the specification, there must be a benefit for the principal. If the side bid enables lower production costs, the bidder must share his profit by offering a discount or promising that the method will result in some other benefit. Other benefits could be extra quality in some aspect of the specification, which may reduce maintenance long term. It could also be improvement of transport comfort, testing a promising innovation or entering a new technical or scientific track for the industry.

All variant execution bids must bring benefits superior to the specification and/or a price reduction. If not, the side bid need not be evaluated.

A disadvantage with the side bid solution is that the bidders have to be innovative and creative while being under time pressure. They may fill up the time until last tender submission date with calculating the main bid. The main bid exactly as according to the specification will probably be given priority, and surplus time may be used to try to find ways to cut this price instead of developing and expressing side bids. Furthermore, the side bid option will hardly open up for anything but marginal, incremental improvements.

But the main disadvantage is that the best side bid will probably land on the “wrong hand”. The value compared with other bids is the main bid + the benefits of the side bid. If the value of the side bid is only few percent of the main bid, the side bid will seldom matter. If the lowest main bid is e.g. 20 million SEK and the second lowest 22 million SEK, the benefit from a side bid of the second bidder must exceed 2 million SEK. If the first bidder does not bother to submit a side bid, and the second bidder submits a side
bid bringing 1.9 million SEK, the first bidder will still win the contract, and the idea cannot be realized.

It can of course be realized if the principal buys the main bid from the first, and the side bid separately from the second bidder. But it may be more tempting for the principal to simply take the idea, call it his own and realize it with the first bidder. The mere risk of this drastically reduces the incentives to submit side bids. The second bidder seeing the competitor and the principal realizing “his” idea will only happen once. After that the second bidder will never ever submit a side bid again, and the principal has crushed a source of innovation. Even the other bidders may see the pattern, and also draw the conclusion not to submit side bids.

Attributing a higher weight to the side bid could to some extent reduce the risk that it will not be decisive. But in that case the second advantage mentioned below will be eliminated.

A first advantage with the side bid method is that it is nothing new. The industry is accustomed to, and the individuals keen to, create side bids. A second advantage is that if attributed a correct weighting in relation to the main bid (the same denominator), the side bids will probably have a quite high rate of success, i.e. bring the principal a benefit, perhaps already in the current contract period.

### 7.1.5 Soft Parameter Attribution

What a soft parameter is, is explained elsewhere in this report, e.g. Section 7.2 below. For technologic development there are no evident certificates that could be used as basis for soft parameter value attribution. A possibility would be to rank the innovations and give the winner, a predefined percentage of reduction to the main operations bid. Second and third offers could also receive reductions and maybe everybody taking part in the contest for technical development could be rewarded a basic reduction.

The disadvantage of soft parameters is that full consensus regarding their correct weight in relation to the price will never be reached. The evaluation will always contain a subjective, nontransparent part, which means that the decision-makers must have a high integrity. The risk is high that the losers will feel unfairly evaluated.

The advantage of soft parameters is that it is a way to introduce innovation, creativity and other factors than price into the bidding. Many consider a price-only principle detrimental to innovation and creativity. Compared to the side bid method above, soft parameters make it possible to attribute any weight to any parameter, which may result in a higher weight to spur to innovation than side bids above.

With time, the soft variables may influence the market so much, that all bidders fulfill them. It may then be time to make them into minimum requirements instead. Let us for example consider innovative proposals a minimum requirement some time in the future. Within the public tendering framework, innovations could be commanded by requiring each bidder to deliver at least one proposal for technical development. The tender documents could simply state that bids meeting the specifications without an additional proposal, criticism or other contribution to long-term development will be disqualified. This would be a distinct signal to the market that Vägverket awards contracts only to companies showing ability and wish to contribute to the future.

A disadvantage with such an aggressive approach is, that it could deter some companies from participation. If one out of only two potential bidders in a small remote
area is deterred, the remaining one will be awarded the contract no matter his price, which could be an expensive exercise for Vägverket.

Another disadvantage with the minimum requirement approach is that the quality and value of the proposal may not matter. Simple proposals and advanced ones will have the same importance and suffice to qualify the bidder. This disadvantage can of course be reduced by not only requiring any innovation, but also attribute the innovation with a fair value that can reduce the main bid amount.

An advantage with having innovation as a minimum demand is that a strong incentive for side bidding and proposals are created. It is hard to imagine a stronger incentive for technical innovation.

7.1.6 Performance-Specified Procurement

Performance specified requirements instead of technically detailed specifications have been proposed as a way to promote R&D since at least 15 years. The idea is that more degrees of freedom are necessary to unveil the spirit of innovation.

A performance specified description would rarely be perfect the first time. “Snow-free” roads were once mentioned as a performance-specified requirement without specifying how this was to be obtained. The contractor achieved the result by using salt only, which may have saved costs for machinery, but with high negative impacts on environment, ground water, bridges and the vehicles trafficking the road. In this case the next version of the performance-specified description will contain something about “without raised, preferably lower, negative impact on environment” or similar wording. The documents must be in continuous development, in any case, but in particular when using performance specified tendering. Thus an organization of experience-based learning is a relevant demand both in the principal’s organization and in the organization of the contractor.

One measure to promote quality innovations could be extra money for “benefits to society”. Delivering a road in better condition than contracted could be paid extra money for. Public information about a company-internal innovation could be paid extra money for by the buyer. When pricing these extra services, however, care must be taken, that deliberate supply of extra-quality is not done to make up for a price dump on the main contract. The marginal revenue of delivering extra-quality as compared to specified one must not exceed the marginal cost.

A disadvantage with the performance specified contracts is that the previous, precise commands are difficult to reformulate into performance requirements. Some may never be fully possible to rewrite into specified performances without losing some detail. The evenness of a dirt road may be well described and easily verified in a performance contract. But the total volume of gravel in the road may be necessary to define with waybills, invoices or other documents verifying that the required volumes were really deposited on the road.

Loopholes and imperfections in the performance specifications take long to eliminate. Vägverket’s feeling is that despite 10 years of experience, there are still loopholes in the performance contracts, and there is a feeling that the problems rather grow than

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34 The term performance-specified is not ideal, since performance can have several meanings. Since we however found it in the sources referred to in Section 5.1, and are reluctant to pioneer with a new term, we use it in this report as the English translation of the Swedish funktionsentreprenad (funktionskontrakt).
diminish. This gives fuel to the critics of them and threatens the whole strategy towards performance specified contracts.

Another disadvantage is that experience may be trapped within the organization of the contractor, instead of being spread to the buyer and the whole industry. These issues thus have to be dealt with separately if this strategy is chosen.

An advantage with the performance contracts is that it gives the contractors an appreciated freedom. It should also facilitate innovation and creativity within the contracts, without asking for the principal’s expressed permission.

Perhaps performance-specified contracts with detailed specifications in particular parts can harvest the advantages without having the disadvantages. Maybe they are most useful for efficiency innovations, since the idea is that the contractor finds new and better ways within the existing contract without having to contact the principal, but that for innovations of the specification itself, other stimulation measures need be added.

7.1.7 Perfect Competition

This alternative is based on the market philosophy. By deregulation, leaving the actors in the sector as uninfluenced as possible in their technical choices, market mechanisms will guide R&D to the optimal long-term level. According to Jacobs (1969) competition is more beneficial for innovations than the collaborations and scale economies made possible by monopolies. If so, part of the strategy to promote innovations could be to maintain the competition. Private monopoly should be no more tolerated than a public monopoly (Cox & Love 1991).

Karlsson and Redtzer (Banverket 2000) discuss some primary prerequisites for adapting Banverket to purchasing in competition, such as neutrality between bidders, competence of evaluating staff, systems and routines for description of installations, methods and follow-up of development.

Cox & Love (1991) lists the following activities to foster a competitive market: full disclosure of information to promote a wide participation, limited contract duration (normally no more than 5 years including renewals), limited size and scope of the tender to allow also small companies to participate, firm prices: no price negotiations after contract has been signed and no unnecessary regulation that may disfavor new entrants to the market.

Advantages are that innovations with benefit potential will be developed and those with a poor expectance value will not be developed or dropped after a while. The professionals themselves will carry out the evaluation. They only need to convince themselves. The costs will be fully integrated with the on-going operations, and with time, the benefits of the R&D will penetrate to the taxpayers through lower prices thanks to competition and the new technology. Experiences from the road sector so far indicate low R&D level with this strategy, which is an empirical indicator that it should be abandoned.

The strategy followed by Vägverket at present, lies close to this alternative. There may be four reasons for not abandoning this alternative:

1. There is secret R&D going on within the companies with good profit prospects.
2. Perfect competition needs more time to establish itself.
3. The low level of R&D that we are seeing is actually the optimal for society. We must not make R&D an objective in itself.
4. Little involvement saves administration costs for the principal.

**Disadvantages** arise if the companies cannot act long term, but have to dump the price to a level allowing no R&D, to win the contracts and survive in the short term. Technical development demands much technical competence. In an imperfect market world, this may be to ask for too much. It may then be that society will earn more long term, if they instead offer themselves to carry a part of the risk.

### 7.2 Soft Parameters

Soft parameters are other factors than the price to be taken into account when awarding a contract. For example quality systems, environmental certification schemes, organization, number of employees, qualification of individuals involved and number of fixed establishments in the region have been factors that matter in the tender evaluation. Tenders have contained soft parameters up to 30 % of the value of the contract, but the share has decreased and is now down to only 3.5 %. In investment the tendency is the opposite. Soft parameters have risen in importance to 40 % in some cases.

Many contractors are pleased with low soft parameter content (Vägverket 2000, pp 71-74). The main reason given is that they have bad experience and no confidence in the weighting system and the way Vägverket uses it.

Other contractors (Vägverket 2000, pp 71-74, NCC 2003a) favor them. Region southeast uses a model with extra points for bidders who offer more than what has been asked for, for instance regarding technologic development. Soft parameters are good and they should be altered with time. When all bidders meanwhile have quality-certified their internal systems, this factor need no more being a soft parameter. Instead it can become a prerequisite for participating in the tender. Soft parameters are ideally used for making the principal traffic policy goals operational. The 97 % price influence in many tenders today is much too high and more a result of evaluators and Vägverket’s legal department’s uneasiness with dealing with more complicated factors than attributed to the public interest (NCC 2003a).

Examples of soft parameters with environmental implications that have been used:

1. Contractors’ use of vehicles with more or less polluting properties.
2. Distance to the asphalt works was another attempt. But a problem with this parameter was that the asphalt works could be moved, at the cost of longer transport of the gravel and other ingredients to make it.

The quality system as a soft parameter was easily contoured. By demanding access to the other bidders tenders, the quality systems of the first developer could be copied.

Some contractors call for the old principle of disregarding the highest and lowest price. Choosing the second lowest would create a buffer useable to promote development.

Another model for soft parameter evaluation could be for example 70/30 for price/quality weighting. Price is recalculated into a point scale e.g. by giving the best price 70 points and the lowest 0 points, with a straight line between for intermediate prices. Then quality gives 0 to 10, environment 0 to 10 and personnel 0 to 10.

In Finland the soft parameters are treated and evaluated before the tenders with prices are opened. On Wednesday they are opened and Thursday the points are published. Friday the prices of the operations are opened and the authority can now not change the soft parameter weighting, to fit its wishes. (VVP 2003b)
7.3 Multicriteria Analysis

A search for common methods in Sweden (KTH 2004c) and in France (SNCF 2004) to evaluate and add multiple aspects generated the following method (hence referred to as the general method).

Multiple quality aspects are assessed (e.g. on a scale 1 to 5). Each assessment is multiplied by a predefined weight factor.

\[ \Sigma (\text{weight} \times \text{assessment}) \]

The values are then summed into a total for each bid, which determines its overall comparison value versus other bids.

We found the main disadvantage with the general method to be that the terms that are added will not have the same unit. The rules are clear, enabling fair competition, but there is no warranty that the chosen solution is the optimum for society. The weights attributed to each factor have to be defined before the bids are submitted and the result of the total operation will thus deviate from societal optimum weights. In particular if “innovation” would be added to the “weight x assessment logic”, it would be difficult to fix the correct weight for this parameter, since the value of an innovation will vary very much from case to case, depending on the particular innovation.

To reduce subjectivity and raise quality several assessors with different backgrounds usually form a jury. The credibility of the jury is warranted by its members’ qualifications. For a bridge contest, like the Svinesund bridge between Norway and Sweden, architectural specialists as well as engineers were represented in the jury (KTH 2004c). The Banverket tender evaluation model, presented in Section 4.4, is based on the weighted individual assessment logic.

The unit problem is solved in the Vägverket model, but only practically. Vägverket has selected only one parameter to be “continuous”, the price. The natural unit of measurement of the common denominator then becomes the currency in which the bid prices were stated. Quality aspects can only have a few discrete values, 0, 0.5 or 1 for environment, quality and fulltime employed competences, which is multiplied by a fixed price, \[ \Sigma (0 \text{ or } 1 \times \text{constant}) \]. The total of the operation is then added or reduced from the bid price, as explained in Figure 3.4. The interpretation of the certificates into discrete values however suffer from the same deficiencies regarding deviation from societal optimum as the general method. If adding “innovation” as a quality parameter, fixing its price beforehand, to be multiplied by 0 or 1, it may not at all reflect the principal’s benefit of the proposal.

For this reason we continued to search other methods, but were not successful and had to develop an own solution, presented below.

7.4 Common Denominator

Comparing different innovations with each other is more problematic than comparing prices of a defined service or product. In the latter case, the definition makes sure that the bidders offer the same product. Usually the currency of the offer is also defined in the tender conditions. In this way there is a common denominator for the bids, so that the prices can be compared. When evaluating innovations, as well as strategies of creating technical change, the common denominator, in economic literature called numeraire (Fournier, S. 2004, personal communication), becomes a problem. Probably this is one of the main reasons why technical change and tendering have not found each
other. Addressing the problem of the common denominator and identifying a useful numeraire will hopefully become a main merit, an innovation of its own, of this study.

An approach, which would solve a part of the problem, would be to use price as a common denominator. All bidders have the full amount to spend, and they simply list what the principal will get for the amount allocated. But a problem for the principal arises if bidders offer different services in different quantities, all being useful to the principal. To avoid this, the specification of what the principal needs, prioritized, with quantities, will be necessary.

But if we want technologic development, this cannot be listed. It is our wish that the last pennies of the amount will be spent on R&D and unless the bidders offer the same service in different quantities, we need another evaluation model for this part of the bid.

Fortunately, a first idea of a common denominator for innovations of different nature emerged in early discussions. It does not exclude, and should of course not prevent us from brainstorming, other ideas of common denominators.

In an early interview Hallberg & Fredriksson (VVP 2003b) mentioned the potential long-term profit of an innovation. They had not seen this aspect of innovations commented in previous studies. They mentioned the innovations at the end of the innovations chapter above as examples of profitable and less profitable innovations.

In practice, calculating long-term profit will be difficult. In addition, each bidder will have an interest to overvalue the future benefits and the competitors to undervalue and question them. The evaluators will be under pressure, and the demands of professionalism and integrity high. This is a disadvantage of the long-term profit as common denominator.

Some problems:

1. How will the evaluators find the real profit? The future will give the answer, but by then it is too late to redo the process.
2. How will the evaluators convince the bidders, the public and the politicians, that their calculation is right and fair? Otherwise the method, even if being right and fair, will not be long-lived.
3. How to compensate for false calculations? No system is fool-proof, in particular not one like the quantifying of qualitative innovations. It is a matter of time before the first difficulty occurs.
4. Can bidders be punished if their innovation was overvalued? Ideally the evaluation method should be self-corrective.
5. Is there a way to make all actors have the same interest? This common interest should be that the calculated long-term profit will be reasonably correct already at tender evaluation stage.
6. The goal is that all bidders should reasonably agree when seeing the result of the tender.
7. At least one aspect may need to be specified: how many years long-term is considered to be and whether the depreciation is to be considered linear.

As much as possible about how the tenders will be evaluated against each other should be mentioned in the tender documents. This is both in accordance with the Act of Public Procurement and in the interest of the points above. To ease the job for the evaluators, and improve the quality of their work, the bidders should be asked to enclose their own
calculation of the expected benefit. This may help the evaluators not to forget economical aspects of the innovation long term.

7.5 Act of Public Procurement

The Act (SFS 1992:1528) on Public Procurement (LoU 2004) is an EU directive regulating all public spending. Vägverket refers to Chapter 1,2 and 6 as applicable for them, and Banverket uses Chapter 1,2 and 4. Vägverket regards its operations and maintenance services as being in the 27. Other services category of Section B of the Annex to the law. None of the two principals make use of the rules linked to category 14. Property management, including cleaning and routine maintenance in Section A, in which case the procedures for the tendering process would have been more rigorous, demanding e.g. open procedure with prior advertising, more often than today. (VV 2003b)

Without knowing all political details behind the emergence of The Act of Public Procurement (APP), it seems reasonable to assume it being based on several, good intentions. One would be to warrant equal and fair competition for governmental contracts and limit the possibilities for corruption. Another intention would be to benefit from low, market, prices and thus assuring the most value of taxpayers’ money.

APP’s precondition is that the purchaser knows what he wants and is able to describe it in an unambiguous manner. It is well adapted for standard, commercial goods. It contains openings applicable also for less defined matters, such as engineering and integrated engineering services, urban planning and landscape architectural services, related scientific and technical consulting services and services concerning technical tests (e.g. APP, Annex, item 12) and design contests (APP, Chapter 6, §18).

It also comments the issue of variants, but without defining it (APP, Ch.1, §23b). Variants are indirectly encouraged, since APP requires the tender documents to state specifically if variants are not accepted. However, the bidder might be severely restricted to submit variants, since they have to fulfill all specified minimum requirements (APP, Ch.1, §23b).

In practice it will often be difficult for the purchasers to state what are the minimum demands and what are not before knowing the proposed variants. If reducing the risk of legal appeals is the main concern, requiring more or less all items mentioned in the specification to be minimum requirements, must be the safest way. This solves practical aspects like the numeraire problem addressed in Section 7.4, but evidently also limits the long-term technical development. Thus the strategy of no legal appeals may indirectly be one of the obstacles to technical development. On the other hand, it is of course preferable, if the contradictions between “justice” and technical development could be eliminated.

Even if the purchaser would succeed to define some areas of freedom and receive side bids, the practical methods to compare qualitative aspects are not clearly stated in the APP. The lack of such information could be interpreted differently. Probably the price-focused approach, which is the easiest and stressed in many parts of the Act, in general should be applied also for these services. This would support a common practice being that bids for these services are compared by price (per hour or total development cost), despite the ideal having been that the actual, qualitative result of the development had been taken into account.
7.5.1 What is a Variant (Side Bid)?

The most correct method to find out the answer to what a variant is, after having failed to do it in the actual APP text, as explained above, would have been a study of background to and practices around APP. This is a doctoral study in itself, which we hope somebody else, probably a law student, will undertake some day. It must however be taken into account that even if conducting such a study, there is no warranty that a single answer will be found, nor any answer at all.

After not having found the answer in the APP itself, as explained in the previous Section 7.5, for solving our immediate, operational, needs in this study, we have had to invent an own definition. Our definition may have become less innovation-friendly, too defensive, than some innovators would have preferred. Still, it may be more innovation-friendly than the principal can live up to and more innovation-friendly than its current practice.

Our definition of *variants*:

Variants must fulfill the same function to the end user, with no (relevant) disadvantages, and at least one advantage\(^{35}\). The advantage might be a lower price, a better quality or additional services\(^{36}\).

By allowing a single relevant disadvantage to disqualify the side bid we constrain the field of possible innovations. Still it seems to be the only operable and legally sound solution. Otherwise two best prices, depending on which advantage is most valued occurs, with an ever-ongoing discussion to follow the decision. In a legal dispute, ambiguity will act in favor of the principal’s decision.

In case of equality, however, it seems reasonable that the *main bid* wins. The *one advantage* requirement is based on the idea that changes are not always to the better. On the contrary, new methods will usually carry teething problems not thought of, and the current method will usually have benefits not thought of. One should not change a winning team, a solution that has proved to work. In case of doubt it is reasonable to assume that keeping the established routines can be expected to be the most economic decision.

This does not apply, if a weighting system allowing comparison of different aspects were presented already in the tender documents. In the case of innovations, however, the weighting of yet unknown benefits, will hardly appear in the tender documents.

The above definition of variants is of course not the answer to all remaining queries related to these matters. But it serves as a starting point, from which notions such as function and advantage can be discussed and specified further. Unfortunately the unknown character of innovations makes them difficult to discuss and specify beforehand. This science, including further specification of the *long-term profit* already addressed in Section 7.4, must probably develop in a trial and error manner.

\(^{35}\) Analogous with the definition of *Pareto* optimum in economic literature.

\(^{36}\) Analogous with Jones’ three categories of technical development in Figure 2.3.
8 Empirical Studies and Findings

It was expected that the reform would give incentives to innovation. Vägverket is however disappointed with the technical development since the reform was introduced (VV 2003a).

This study has searched the obstacles for technical development by four different methods:

1. Interviews
2. Experiments
3. Survey
4. Participatory observation

Representatives of the four nationwide contractors have been interviewed, as well as local, regional and national representatives of the principal. The interviews have all been slightly different and adapted to the particular respondents experience with the common trait to first identify the obstacles to innovations and then discuss ways to improve the innovative climate.

The survey was an intermediate result of a 2-day seminar discussing obstacles to technical development. The procurement offices of all the Banverket five regions were the main target group, but some experts from the regions and the Banverket head office also participated.

Participatory observations refers to participation in the bidding process on the bidders’ side as well as taking part in developing the tender documents and discuss evaluation with bidders as an observer mainly on the principal side.

8.1 Interviews

The following obstacles to technical development were mentioned mainly in interviews with the contractors of Vägverket, but the ideas for improvement of the innovative climate, which is the idea of presenting them, might be useful also for Banverket. A response is provided as a comment to each claimed obstacle to technical development. (Issues specific to Banverket are referred separately in Section 8.1.1).

1. Contracted areas are too small
2. Contract periods are too short
3. Vägverket acts like seven different organizations, one for each region
4. Only price counts
5. Principal does not listen
6. Ideas are stolen
7. Contracts are, still, too specified
8. Why no partnering?
9. Principal’s staff are not up to date
10. Principal does not value proper performance
11. Homemade\textsuperscript{37}, discriminating rules

12. Overfocus on process

1. Contracted areas are too small for scale economies to arise, which by volume can pay back specialized machinery (VV 2003, VVP 2003b)

As a response, Vägverket combined adjacent areas to make them larger, but it did not help (VV 2003a). To raise competition, Vägverket has recently tried the opposite strategy. By cutting into subunits the objective is to enable minor local firms to bid. In its last experiment, combinatorial bidding in 2004, the suppliers could pick individual subunits and combine them, as they prefer. A special software was developed to help the tender evaluators to compare the bids in an optimal way, which otherwise seem impossible, when the bidders are bidding on different object combinations. Some small savings were reached (VM 2004). It is evidently too early to evaluate the result on technical development of this recent experiment.

2. Contract periods are too short to allow pay back time of investments and experiments with new machinery and methods (VV 2003, VVP 2003b).

During the 1990s, Vägverket has prolonged the contract periods and enlarged the contract areas. Vägverket has experimented with different contract periods from 1 to 5 years. A typical contract period is now 3-5 years with an optional extension for another period of 1-3 years, totaling 5-7 years before the area is subject to a new public tendering. No noticeable effect on the intensity of technologic development undertaken by the contractor has been recorded by these alterations. (VV 2003a)

3. Vägverket acts like seven different organizations, one for each region, with differing philosophies and guidelines. This disrupts the scale economies necessary for technical development (VVP 2003b).

Large contractors consider seven different Vägverket regions, each with their own procurement practices and rules, to be a problem. The same rules everywhere would create economies of scale. Some contracts demand road edge poles to be cleaned all the way down to the ground. Manual methods with soap, a brush and a buckle of water is the most economic solution in this case. If only the top half with the reflective label needs to be clean, machinery could be developed and used.

Some of the seven regions have changed the rules. How does Vägverket enforce the rules? If a dirty pole is observed, the contractor is notified and if no result appears penalized. In the 1970s the rule was that three poles must be observable at all times in dark. If there are 60 meters between the poles, this means 4x60 meters of free sight. Different regions however enforce the rules differently. In the countryside they seem to be harder, while metropolitan regions tend to be more flexible. Seven regions having more unified rules are demanded (VVP 2003b).

However, in this study it will be difficult to amplify the voice of those who are not participating in the tenders. Maybe it would be in the interest of the nation that they participate, to increase competition and employ and engage also small companies in small places. Vägverket having non-uniform rules may favor them. The smaller and

\textsuperscript{37} Here, the expression is used for rules added or altered during the game to favor a particular player.
more particular the tender, the more chance they will have, as compared to the large companies. Also, there will always be some local factors that must be taken into account. Both Vägverket and Banverket have solved the incompatible interests by issuing a standard template document from the head office, which the regions should use as a base. There are compulsory parts that must be in the tenders as well as voluntary parts. The tendency is towards more and more standardization.

4. Only price counts (Skanska 2003, NCC 2003a, Peab 2004ab, VVP 2003b)

Most contractors express regret that there is no money for anything extra than doing just what the contract states. The contractors (NCC 2003a) have to choose the cheapest sub-supplier, with the oldest equipment and technology, to win the tender. Technical development as side offer or soft variable in tenders has been suggested, but few proposals came (VV 2003a). Vägverket Stockholm (VST 2003a) mentioned oilgraveling of all gravel roads as an example of a useless proposal. Awards have been granted with R&D as critical part of the winning tender. One example is the on-line information system showing where all snow plows are working at the moment, which would give the public a forecast on when the plow will arrive at their road. This caused no positive vibrations, not even with the awarded contractor (VVP 2003b). NCC (2003ab) wants Vägverket to try again. They would welcome specific clauses promoting innovations in the contracts. In fact, they have been waiting for this for long. Secrecy and patents are not a problem since patents are rare in this industry. NCC (2003a) would like a higher proportion of soft parameters. They should amount to at least 30%. Since all bidders now have the quality and environment certificates, they can become minimum demands. Instead new challenges should be added.

Other contractors have however expressed other opinions. They are happy with the reduction of the soft parameters to only 3%, primarily because they do not trust in the principal’s evaluation system. To them, the principal’s decisions on the soft parameter evaluation have appeared arbitrary, so they cannot learn from them.

NCC (2003b) and Peab (2004a) underline that many innovations occur during a running contract but not while working out the tender. Peab provides the example of a special brush for cleaning the inside of the Tingstad tunnel, developed from a worn out car wash brush mounted on tractor.

5. Principal does not listen (NCC 2004, VVP 2004, Peab 2004a, BVP 2003b)

NCC (2004), Vägverket Produktion (VVP 2004), Peab (2004a) and Banverket Produktion (BVP 2003b) have tried side bids, but the principal has not been interested or has required extremely short payback times. The innovative ideas are either discouraged or at the earliest to be used in the next tender submission. The use of consultants may further reduce the willingness by the principal to take risks.

The road contractors, including Vägverket Produktion, have participated in 10 different discussion groups, organized by Vägverket. The name of the project was “better product quality”. Securing the tender documents (reduce the ambiguity) was the objective, which is in the interest of both parties (VVP 2003b). Among other things, side bid rules

38 This is according to Salter, Figure 6.1, nothing abnormal.
and principles have been discussed, and a result (in Swedish) are the guidelines found in
10.13.1. Side bids are variants or additional services not originally specified, usually
originating from the suppliers. They may be proposals to deliver a better road condition,
or a request to be allowed to use a more efficient method, than the one specified. There
have also been discussions in the project about listing all possible risks and discuss the
responsibilities at an early stage, in particular if new methods and technology is to be
used (VVP 2003b). In development the contractors want to share the risks with
Vägverket.

6. Ideas are stolen

Another reason for little innovation has been that it is impossible to regain the costs due
to non-serial production and the ease of imitation39 (Skanska 1997). The principle of all
documents being open to the public in Sweden combined with cultural factors such as
no tradition of keeping secrets has in some cases implied that tender procedures have
been discontinued. Shortly after, the tender has been reissued, now with the innovative
proposal as part of the documents so that any bidder can use it (Malm 2004).

The majority of the interviewed (VVP 2003c, VVP 2004, Peab 2004a, BV 2003a) have
experienced how the principal has turned down an idea just to use it in other contracts
shortly afterwards. Within two years the principal has put it in tender documents for
everybody to bid.

The general principle in Sweden is that all aspects of all bids are public once the tender
has been awarded. This may help technical development to spread within the industry,
but will reduce the incentives to be the very first, the creative pioneer. When quality
systems like ISO 9000 entered the scene, the competitors soon copied the quality
system developed by the pioneer.

If the public and the competitors can demand a copy of all side bids and innovations
after the tender has been awarded, this will reduce incentives to deliver innovations a
lot.

At the beginning of the public procurement era, the bidders seldom asked for secrecy of
their bids. Today, however, this is the case more and more often. Each individual bidder
has an interest to see the other bids, but no interest in the own bid being made public.
This will in particular be the case for innovations. In the experiment referred to later in
this study (8.2.1), all bidders requested all aspects of their bids to remain secret.
Demanding secrecy is, however, not a guarantee that the secrecy will be respected or
accepted. A legal procedure will decide the matter if a competitor appeals against the
secrecy.

This leads to that the incentives for innovation in side bids are somewhat linked to if the
secrecy will hold legally. A bid may also be public in part and secret in other parts.
Then the issue is if the secrecy of the innovation part of a bid will hold legally. This has
not, as far as this study knows, been tested. A legal case touching the issue and giving
some guidance is provided in 10.13.3.

39 Ease of imitation, no secrecy, etc. are in this study treated as synonyms to the academic term spillovers.

Performance-specified procurement, i.e. a larger and longer scope of delivery, with more responsibility for the contractor, has been a controversial issue for long. In 1993, Lyrén and Sandgren, as cited by Nylén (2000), found that 14 of 16 questioned contractors favored the contractor’s over-all responsibility, while none of 14 architects and only 1 of 19 technical consultants agreed this form of contracting rendered the best results. An issue of interest is to find out the reason for this discrepancy. Are the architects and technical consultants just defending their own interest, to remain “head” of the project? Or are they right, when they imply that the contractors do not have the competence or the true will? Nylén did not provide any explanation of the result of the survey.

It might be speculated that the consultants do not trust the contractors. It could also be that they are worried to loose their current income from the principal. Performance-specified procurement has proven to bring both better and cheaper results according to Vägverket’s own investigations.

Still the principal has often had difficulty to keep its hands off and let the contractors do it their way. It has told the contractor that they will not get any further contracts if they insist on doing it different from the traditional way. Even when the contractor was awarded the contract because of their new technology, the principal prohibited them to use it. Instead they demand the contractor to take the responsibility for the principal’s way to do it, according to a contractor.

More freedom through performance-specified requirements is necessary to open up for new methods to reach the same result. Trade marking of e.g. bitumen-mixes occurs. But Vägverket often specifies precisely, instead of specifying the performance of the surface. The performance of the mixture is an automatic way to protect without having to disclose the recipe.

A problem with the performance specified tenders are that the contractors reduce all action, whose result cannot be measured, to a minimum. It is for example easy to measure holes in a dirt road, but it is hard to determine the total thickness of the gravel. Since new gravel is expensive, the contractor removes the top layer of the road without replacing it. Thus the performance-specified demand of evenness is fulfilled and the cost of new gravel is saved at the cost of the principal in the long run.

Vägverket is aware that payment per time unit and volume of raw materials subsidizes certain activities and thus do not give optimal incentives to be efficient. The strategy has been to move towards performance specified requirements, so that the contractor takes the responsibility and have no particular economic benefit of one method or the other. But protests among the contractors have pushed Vägverket back to payments in hours and volumes in some regions.

Vägverket finds that the performance specified contracts have proved difficult to formulate. Instead of less and less to be forgotten, it seems more and more needs to be added and further specified. For example drainage is difficult to see and prove. It takes 20 years before anything happens. They now turn back to buy these types of contract items as specified services (in this case a number of km of ditching). Performance-specified requirements mean that an agreement, about how to control and measure, so that an invoicing basis can be reached. This has also been difficult in practice.

These examples should however be seen as minor deviations from the performance-specified procurement approach, which is still the overall strategy in the operations and maintenance contracts.
Another obstacle, and a reason that Vägverket’s objectives have not been reached, is that the contractors often still have an economic interest in large volumes of raw materials and labor, as long as they are paid extra for these. Contractors are happy to dig a certain number of cubic meters, but nobody knows if they were actually needed (VV 2003a).

The warm-sanding innovation is an example of an incentives’ conflict. With the conventional method, dry sand, one truck could be enough to blow away most of the sand which had just been spread on the road. New labor and new sand needs to be distributed, creating new income for the contractor. This action is still in many cases, paid per hour, cubic meters or km. (In some cases salt is part of the performance-specified contract while sand is not, leading to extensive use of sand and salt applied only as a last resort). By using a warm mix of sand and water, the sand grabs into the road surface in a way resembling a sand paper. The sand sticks to the road and large volumes, some claim 90 % of previous sand volumes, can be saved. The innovation reduces environment impact and saves money for the principal. But if the contractor is paid per volume, sand and work hours, the innovation reduces his income. So there is no incentive for the contractor to use this invention.

Vägverket has used performance-specified procurement since at least 10 years, and thus has experience with it. Some regions use it, while most try combinations of performance-specified and detail. If no detail, a main problem has been the contractors always finding “loopholes”. And although the contracting entity tries to close these holes, the contractors take advantage of new ones. Contrary to as one would expect, the number of holes seem to grow. Still, the overall approach is to continue with performance-specified procurement as much as possible (VV 2003-2004).

8. Why no partnering? (NCC 2003a, VVP 2003c)

An interesting partnering project was conducted around Särna, Dalarna. The contractors were invited for a bus trip along the road to be tendered. Vägverket commented on its objectives while driving, calling it a wish list. How many of these wishes can you deliver for 12 million? The trip was also documented on a video, which was distributed as part of the tender documents. The advantage was that once the contract signed, the project became a true cooperation between the principal and the contractor. When there were unused vehicles at the nearby road station, these were used. In some cases additional orders were placed, but the spirit of being antagonists, as often otherwise, was not there. Why no more such contracts? NCC (2003a). Maybe part of the answer is that Vägverket is advancing carefully. A performance contract of the E4 270 km motorway through Småland and Östergötland was recently awarded, valid for 8 years which is a year longer than the 5-7 years normal for maintenance and operations. Vägverket pays a bonus if the rutting (track depth) is shallower than specified and a penalty if it is deeper. The bonus is less than the penalty. Thus from the financier’s point of view, the bonus is good value for money (VVP 2003c). Penalties reduce his costs for the maintenance immediately.

9. Principal’s staff is not up to date

During 1992-1994 tables and rules from the time before public tendering were used and not questioned. Since 1994 just a small group of people, when taking into account the impact of its work being the rule and regulation makers, follows the research. They are
reluctant to changes. The industry is fully occupied with following the rules and has given up engaging in influencing the rule makers. (Skanska, Peab, NCC, VVP 2003b)

Vägverket competences are changing, both practically and literally. Both Banverket and Vägverket often use technical consultants for inspection and technical discussions (KTH 2003c). According to contractors, the tender documents do not develop with the times. Few new people are recruited and the tender demands requiring several years of experience excludes young personnel also on the contractor side. The principal and its consultants are too unwilling to make room for new ideas, new methods and new technology. They stick to the old texts and technology that they are familiar with, to avoid risks for failures during their few years left to retirement. In the contract phase, the consultants focus on finding errors. Many contractors say that they would welcome a more constructive representative. The only way to come round this problem is to have a good contact with the Vägverket consultants, so that new technology is specified from the beginning. As an example, ‘Flexstabil’, a flexible foundation for the edge posts, has been included in the specification on some occasions.

Other contractors however see the age as an asset. The well-experienced representatives of the principal have the ability and confidence to look further ahead than the letter of the specification. They look at the function and the practical aspects and are able to deviate from purposeless regulations in the contracts. The young project leaders tend to cling to the rules, which may be because they are not as experienced and secure.

If the representative of Vägverket is known to be a particularly meticulous person, the probability of complaints will be higher and thus the price is raised a percent or two to take care of these. On the other hand, if a project leader can be chosen that well matches the principal’s representative’s personality, the price can be trimmed since disputes will be less likely. (NCC 2003a,b, Peab 2004, VVP 2004)

10. Principal does not value proper performance

Related to performance-specified procurement is the verification of result. Contractors have claimed that the principal does not inspect them often enough (Vägverket 2000), which has made it difficult for them to fulfill some formal requirements in the next tender. More severe however, this may hamper technologic development, since it is a sign that the principal does not care about the performance, which is the natural driving factor for innovations. The least active contractor makes most money. Since money makes the world go around, this could be the reason why R&D does not go around very much in this business. The procurement officers spoken to in this study all would welcome more distinct guidelines regarding control from the head office.

Vägverket has equipment and procedures to objectively verify both input and output in the operations and maintenance field. But the control is rare, unsystematic and subjective. While the French principal inspects each km of its road network every week (DDE 2004), the Swedish principal may not do it even once a year (VVÄ 2003).

Defining the result and measure it is possible. The surface can be inspected ocularly and with instruments. The layers below the surface can be checked with drilling tests.

It is better to let the costs be attributed to the right project by issuing the penalty, than that penalty is being passed on, formally or informally, to the next tender. (BVP 2004b)

Vägverket is starting to respond to these demands from the contractors and its own observers in the field. A study, Genomlysning Grundpaket Drift, is underway (VV 2004e).
11. Homemade\textsuperscript{40}, discriminating rules

The weighting of the different parameters has not been clear in the tender documents. Tender protocols are published without explanation. Rules are added and changed along the evaluation procedures (VVP 2003b). An example is when the result of the evaluation of the Vara district was explained:

“Since one firm has received so many contracts in this region, it was time for another firm to be awarded, since they were so close in price this time. We will maintain the competitive situation in this way.”

Vägverket’s legal department agrees that it is illegal, but in principle nothing is done about it (VVP 2003b).

The legal outcome of this case is complicated by many factors. It might be argued that a client is allowed to discriminate himself as he pleases (which is the case as long as Vägverket Produktion belongs to Vägverket). However, from a strict concern regarding innovations point of view, the negative feelings resulting in Vägverket Produktion by this discrimination may have emotional effects and hamper its interest to help the principal with innovations. This will then be a severe setback to the industry’s overall development since Vägverket Produktion has 60% of the market.

12. Overfocus on process

One of the main innovations in the 1990s has been the ProData system. It consists of GPS receivers in each vehicle with a logging function so that it can be seen exactly where the vehicle has been and at what time. A pocket PC is used for the operator to input the activity: sanding, salting, plain transport of the vehicle or waiting. This system has been introduced in 1,000 vehicles. It is an impressive system, but may create more data than can be processed.

Normally the documentation is available when the driver comes home and empties his pocket PC to the main system. One principal representative was interested in having online reporting and Vägverket Produktion offered this to improve the chances to get the contract. They set aside a specific computer where the data was displayed in real time. But nobody turned out to be interested in this feature, says Vägverket Produktion, except Vägverket.

The other party, Vägverket, claims the public has expressed interest in where the plow is in real time both often and clearly: "Lots of snow here. Where is the plow?"

When inspecting, the principal found the system was not working, which nobody had noticed until then. Vägverket Produktion was penalized 300,000 SEK. Vägverket Produktion is dissatisfied not only because of the penalties, but also because the demanded feature was less useful and now only serves to satisfy the particular principal representative. They see it as an overfocus on process instead of result, which is against the idea of performance-specified procurement.

It could be argued, however, that even if the public would not use it as expected, the contractor offered the service and it attracted the principal’s interest. The service became a key determinant for the awarding of the contract, and must now be respected.

\textsuperscript{40} Here, the expression is used for rules added or altered during the game to favor a particular player.
Another example of controversy is the “Finnish underbite”\textsuperscript{41}, a Finnish invention that according to Vägverket removes the ice from the roads better than anything else. After 1992 the contractors ceased to use it. Vägverket claims the result suffered and has therefore forced this method into the contracts, within the limits of the regulation. The contractors claim that the method is no better than other methods but now use it, as they get more paid if they do.

Clearing the real merits of this invention might be a future research approach, not only to find the truth about this particular innovation, but also as a way to reveal the more general communication problems between the parties.

8.1.1 Banverket

A reassembly of the diverging tender documents into a common one to accumulate the experience, into a national template, rikslikare, is in its final process waiting to be published. Experiments and deviation from this general document will be allowed for development reasons. (BV 2003a)

A procurement problem is that Banverket is often stuck with a particular supplier. A system has been selected once and it is difficult to service and update it with standardized components. A typical such supplier is Bombardier. Banverket procurement staff wants to sit together with the supplier to find ways to bring the cost down, instead of doing it through tendering. They feel they have no alternative short term to the present supplier. (BV 2003a)

There are similar monopoly situations with Banverket Produktion in many cases. Now aware of these future problems, contracts are made so that drawings and descriptions of components must be delivered to Banverket, to enable them to buy them from other suppliers. For existing contracts Banverket has had to buy the technical documents describing the installations, before being able to organize a tender in order to create alternative suppliers. But the market is developing towards standardized components, which may reduce the need of such specific information in the future. (BV 2003a)

Performance-specified contracts have been tested in Kolbäck, Sweden, where the requirements have been expressed in terms such as punctuality of trains, load carrying capacity of the track bed, maximum allowed speed and reliability of operation. The specialized machinery necessary for track maintenance and operations is assumed to be an obstacle to public tendering. But measures have been taken to limit this effect. Banverket Produktion has a pool of machines that it is obliged to rent to any contractor, at equal conditions. The machinery unit is located in Norrköping, separated from the rest of Banverket Produktion. Inlandsbanan AB has an own pool of engines at the disposal of its contractor. A problem has been disputes about who is covering maintenance and repair of the machinery. There have also been disputes about large repairs, if these are included in the operation of the track. Banverket has issued a 10,000 SEK\textsuperscript{42} rule: if repair costs exceed 10,000, Banverket pays the costs beyond 10,000 SEK with extra funds. (BV 2003a)

Contract types that promote own initiatives for development of production methods are needed. A wide and general maintenance contract for a line from A to B might be one way to go. An experiment with a performance-specified contract, relative freedom

\textsuperscript{41} In Swedish: “Finska underbettet”

\textsuperscript{42} As an example. The exact amount may be higher or lower depending on several factors.
regarding methods for maintenance from a point on the railway line to another, is carried out in Tierp, 50 km north of Uppsala, Sweden. The region and the contractor have access to Banverket Technical Department’s documents and take on own responsibility within that framework. A problem has been to measure start and finish of the contract. The regions are running a development project regarding how to describe; what is possible and what is appropriate. Pure execution contracts give few incentives, why a wider responsibility is desirable. (BV 2004d)

Another interesting project is around Västerås, Sweden. As contractor in the area Banverket Produktion has developed a specification document declaring what could be included in a contractor’s commitment. According to Banverket Produktion (BVP 2004e) this information is essential; still it has been missing in the tender documents of many areas already contracted out.

8.2 Experiments (Vägverket)

Initially, the scope of this research project was to map theory and practice of innovation and innovative activities in the 1990s and to propose action that could lead to more innovation. To widen the view, comparisons with other industries and/or other countries were also proposed. A reasonable way to get hold of the data for such a study would have been to collect theory and experience from science and the industry through interviews, books and papers. After only a few months, it was however decided to make an experimental implementation of the action plan as part of the project. The more we add of real world, the more risk of quality deficiencies in the proposed action. It was agreed to take this risk as a way to shorten the distance to a truly innovative climate in operations and maintenance.

Three kinds of experiments have been discussed.

1. Encouraging bidders to propose side bids, alternative methods and innovations, that produce the same result, or better, from the user’s point of view, as the specified solution in the tender documents.

2. Organizing a contest specifically addressing the innovation issue.

3. Further development and fulfillment of performance-specified procurement.

Experiment 1 has been carried out and is reported in Section 8.2.1. It could be repeated, both for scientific reasons and as an education exercise. Following experiments may however be biased by the first year’s result, hopefully in a positive direction for technical development. If, however, this bias results in a negative trend regarding the number of approved side bids, the side bid method should not be continued.

The idea of an innovation contest where anybody could take part popped up at a Vägverket internal meeting in September 2003 (VV 2003c). A first meeting to prepare for it has been held in April 2004. Its realization now depend on a budget and a project leader to be assigned, and is on hold until the next internal budget cycle in Vägverket.

Experiment 3, fulfillment of performance-specified procurement has been developed within Vägverket prior and parallel to this study, e.g. the project Genomlysning Grundpaket Drift and establishment of sampling systems to verify contract fulfillment (VV 2004e).
8.2.1 Experiment 1 (Vägverket)

It was decided to start with the first alternative, which is hence called Experiment 1 or The side bid experiment. Experiment 1 has so far only been conducted as a pilot study, which was realized by Vägverket in 2004.

Background

Developing the tender documents is, since a long time, a continuous process in Vägverket. Price is most important (in 2004: 97%) in the tenders, but other factors are and have previously been taken into account to warrant quality and long-term development. Minimum requirements and soft parameters are the most used tools to convert into a common denominator\textsuperscript{43} and introduce other factors than price before the bids are compared.

Interviewed contractors claimed, that the principal’s tender documents and its following evaluation process had no openings for variants, among contractors often called side bids. Even if variants were not explicitly excluded, they were very seldom approved nor encouraged for further development, by the principal. Absence of a comparison method\textsuperscript{44} and time constraints of the evaluation staff were explanations given (VV 2004g). The problem of comparison puts the finger on the difficult practical matters where the Act of Public Procurement (APP) give little guidance (Section 7.5) and to which a solution is proposed in this study, as addressed and explained in Section 7.4 of this study.

Purpose

Experiment 1 consists of not only allowing side bids, but to encourage and promote them by making them into a soft parameter.

The purpose is to produce innovations by creating a lane for technical development, through side bids, without violating the Act of Public Procurement. The rate of success of the experiment 1 can be expressed in the total number of variants (side bids) proposed to the principal. The quantity could be taken as a measurement of how well the principal has succeeded to create an innovative climate. More important however, for long-term development of the industry, are the quality of the innovations. The quality of the side bids would be an indication of the industry’s actual ability and capacity to innovate.

Method

Some new text explaining how innovative side bids would benefit to a main bid was added to the tender documents. All seven regions were invited to use the text as an encouragement method for side bidding. Side bidding had been allowed in many regions before, but with little explanation how they would be valued and compare to the main bids.

Six phases could be identified:

\textsuperscript{43} These terms are explained elsewhere in this study, see e.g. Section 7.2 Soft Parameters.

\textsuperscript{44} This explanation comes from the Banverket survey referred in Section 10.13.4, but is assumed as explanatory also for Vägverket.
1. Finding an appropriate place for a text stimulating innovation in the existing tender documents, or add an additional document with this aim

2. Develop a text withstanding the legal demands of the Act of Public Procurement as well as stimulating to innovation

3. Develop an evaluation model to enable comparison of combinations of specified services and (unspecified) innovations

4. Use the model to evaluate and rank the submitted bids

5. In case an innovation would be part of the winning combination, follow the implementation of the innovation.

6. Interview the bidders and non-bidders

**Deviations from intended method**

Ideally, the principal would have undertaken all activities so that the researcher could have concentrated on only being listener and reporter. Since slimmed organization and more urgent obligations might however have delayed the project, at the worst the full five years of the planned PhD, the project formulated a text, which was fine-tuned with Vägverket’s legal department and the regions.

In the pilot study, the total prices of all bids were published, probably because the principal is obliged to publish the grounds for the decision. All bidders had demanded their bids to be classified confidential. Thus the studies of the bids themselves were replaced by letting the bidders explain their bids verbally.

**Results**

Five of the seven regions were not interested to participate. One of the remaining two was interested at first, but pulled out in the last minute. The last region however participated and concluded the experiment. The text was placed in a paragraph labeled “Alternative side bids”. The text is presented in the original language (Swedish) in Section 10.13.2.

The evaluation resulted in a public decision note announcing the winner. All bidders main bids and parts of their bids were presented in the decision note, perhaps to fulfill the APP obligation to provide the reason for the award. The lowest bid was the winner.

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45 All figures are approximate and citations are summarized and simplified, related to losses by not having any tape recorder at the interviews. The reasons given may have been mentioned in another order, a slightly different context and in other words.

46 In the original language (Swedish): *Tilldelningsbeslut*

47 The tender contained another experiment as well: combinatorial bidding. The principal could combine parts of bids. No mentioning of any side bid values. To ascertain, the principal was contacted by email. It turned out that a side bid had been provided. But it had been valued to nothing. Why? “A two-line explanation and no calculation”, said the principal.
In the following table, the information of the first line (the main bid value) could be found already in the decision note. The rest has been collected by interviews by phone and, in the case of the only side bidder, a two hour interview in the bidder’s office.

Table 8.1 The lowest bid, by E, amounted to 29 MSEK. The only bidder with a side bid, B, was second with 32 MSEK. The principal valued the side bid to 0, but even if it would have been valued to the full claimed value, the 1.5 MSEK, it would not have been sufficient to win the contract in any case. The bidders reasons for submitting or not submitting a side bid are in line with the findings of our previous interview empirics, and also later confirmed by the final outcome of the side bid experiment

<table>
<thead>
<tr>
<th>Question</th>
<th>Answers from bidders</th>
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<tbody>
<tr>
<td></td>
<td>A</td>
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<tr>
<td>Main bid</td>
<td>No bid</td>
</tr>
<tr>
<td>Why no bid?</td>
<td>Lack of personnel</td>
</tr>
<tr>
<td>Side bid</td>
<td>No</td>
</tr>
<tr>
<td>Claimed Approved</td>
<td>-1.5 MSEK</td>
</tr>
</tbody>
</table>
| Why no side bid?  | - No time for calculation  
|                   | - Tendered area far from head office and outside main area  
|                   | - Tender not important  
|                   | - Tasks uncomplicate and straightforward – little room for innovations  
|                   | - Historically no positive response to side bids  
|                   | - Low trust in evaluator’s comparison methods.  
|                   | - Principal demands pay back on investments too fast.  
|                   | - Innovations used in other projects without credit to innovator.  
|                   | - No sharing of the profit with bidder.  |
|                   | - Historically no positive response to side bids  
|                   | - Easier to cut costs after having received the contract.  |

Bidder A, which did not submit any bid, explained that it had just lost key personnel and had to focus on fulfillment of existing contracts before calculating bids for new ones. All bidders clarified, that once having won the contract, they would sit down and discuss smarter ways to do it. Those not having used the side bid clause were still positive to it. “It cannot hurt. Sharing the profit would be a very positive signal.”

“Not enough incentives for preventive maintenance. The contract may include a fix price for mending a certain road surface, e.g. 100,000 square meters. No routines how to
regulate if the number differs from specified. Might lead to unnecessary patching, since it is in principle breaking the contract if not doing it all. Waste of money.”

“A requirement of the personnel is 5 years experience of operations and maintenance. In principle, only Vägverket employees have such a long experience. These old men (I am one of them) have an unduly good bargaining position, like a spot market. It is both an asset and a load to have such much experience. The demand should be replaced by criteria allowing young people to enter the market. Before it was a soft parameter, but now it is a minimum demand, which is even worse.”

The side bidder B had noticed that the gain from its side bid was not enough to catch up the lowest bid. Still B wondered why the principal did not give any value at all to it. It would have been an encouragement. Instead, Vägverket had asked B what they would say if it gave it to its competitor, the lowest bidder, E.

The character and long-term profit of the innovation, according to the bidder

All bidders demanded their bids to be classified. We are however authorized by the side bidder, to reveal as much as might be necessary to benefit to science and to help promoting an innovative climate in the industry. We have tackled this balance, by explaining all main characteristics of the side bid by replacing the particular idea by a principally equal idea. We have also altered the figures in the calculation. Still the imaginary idea below, with its figures, contains all the principal issues that were at stake in the real evaluation.

Let us assume the following side bid (innovative idea). Instead of running the electric installations along the roads by using the “the two holes in the wall” method (i.e. buying the electricity from an external company), the side bidder proposed to build an own electric plant. The cost of building the plant would be paid back in less than two years. The depreciation of the construction cost plus the annual operation cost of the new plant would be less than the annual cost of the externally produced electricity. Vägverket would save money, each year.

Some may argue that “well, what! Would you call that an innovation? An electric plant!” But in this study, and also in the tender documents, it was quite clearly expressed that anything reducing costs would qualify as “innovative” side bids. The “technology” may be well known. Using it in this particular spot was new, since it did not exist there, nor was the idea mentioned as a future option in the tender documents provided by the principal.

Can we trust the calculation?

First we had the construction cost. For this type of innovation, a civil engineering structure, it is natural, that the bidder (being a civil engineering company) would have received the contract to build it. This was also what B had in mind in this particular case, why B had no reason to underestimate the construction cost. B confirmed to the researcher that the construction cost could be taken as a binding offer.

Secondly, we had the stated depreciation time. Here it would be in B’s interest to overestimate the technical life of the installation. But B had used very careful figures. 15 years life for an installation that could last significantly longer than that, according to external consulted experts. More exact figures cannot be given without investigating the ground properties of the precise location of this “electric plant”.

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In this particular evaluation situation, the technical life length was not crucial. Even if reduced to only 10 years (which the evaluators insisted on), the annual depreciation cost was small compared to profits. (As it was paid back in less than 2 years anyway)

Thirdly, we have the operation costs. Just like the construction, it lies in B’s own interest to set the operation costs on the high side, since B would be the one to undertake these activities. Also in this regard, the principal could have asked B to make the calculation binding in order to eliminate Vägverket’s risk in this regard.

Fourthly, what about the cost of the current solution? The costs of electricity supply from the “two holes in the wall company”? It lies in the interest of the bidder to overestimate this value. In this case however, the real case, the side bidder had had the previous contract period in the area. B knew exactly what the cost of the current technology was. An evaluator leaving nothing to chance would request the original verifications, the electricity bills from the previous period, and verify with the issuer of the invoices that they were not only correct but also complete.

The side bid character and its value according to the evaluators

According to the evaluators the side bid was vague and the bidder had hesitated on the figures in the follow-up meeting. The bidder had not verified if the necessary permits could be obtained and could not give a clear response to a question such as who would carry the risks if running into rock. The principal was not impressed by the innovation as such. It existed in other contract areas. The principal denied that the side bid was worth nothing, but could not remember any attributed value. It was stressed that the side bid would not help to obtain the contract anyway. The next contractor might not want to use the innovation. Who would know the costs and the savings, when the next contractor runs the installations? The investment must be paid back during the contract time. The proposed innovation now belonged to Vägverket, who has the right to use it for all tenders. No payment necessary to the side bidder. In the particular area, the principal might offer the idea to E, B’s competitor, the winner of the contract. The demand for the bid and its contents being classified was just a request. It did not mean that it received it.

Biases

Since all regions were invited, but only one volunteered, we have empiric support that the sample was more positive to alternative methods than the other six regions. Secondly, when it turned out that the side bid evaluation would not be decisive for the award of the contract, the principal had an opportunity to encourage the bidder, at no cost. This would also tend to have created an over-positive evaluation of the side bid, as compared to if the side bid would have been decisive for the contract. Thirdly, since the evaluators knew that they were participating in a pilot study on how to evaluate innovations, supervised by Vägverket’s headquarters and KTH, this might also have favored a positive side bid evaluation.

The combinatory bidding complicated the tender evaluation procedure and might have had a negative influence on effort and time left over for the side bid evaluation.
Conclusion

The side bid proposed in the experiment was worth considerably more (5% of the contract) than had been expected (fractions of percent). The side bid calculation was sincere, credible and fully in line with the instructions in the tender documents. It was unfortunate that it could not be realized, which was mainly because another bidder submitted a lower, total bid.

The coherence of the results of the interviews with the observations of the experiment combined with the analysis of bias above, strengthens the probability that this study has given a true answer to the research question, despite its ambition of only being explorative. The claims by contractors that the principal turns down side bids, claims the ideas to be known already, requires it to be paid back in an unreasonably short time, is prepared to take the idea, give it to competitors and use it in future tenders without any royalties paid as if it was its own was confirmed by the experiment. We cannot know if the idea had been discussed between the contractor and the principal before, and, if so, who was the initial source. But compared to the tender documents and current practice in the area in this case, the idea was new. If the side bidder had not proposed it, the idea had not been up for discussion at this moment.

8.3 Survey (Banverket)

In Banverket a completely different approach was chosen to identify the incentives. Within the context of a two-day seminar, 15 responsible high officers of Banverket within maintenance and operations were assembled to identify and discuss obstacles to technical development and methods to promote innovations in their particular domain. A survey was conducted, where the respondents had to rank 36 incentives-related hypotheses in order of importance. The 36 hypotheses can be regarded as a summary of statements and impressions from all interviews and other data in this study.

The five highest ranked obstacles for technical development according to this study was:

1. Too detailed specification of how to do things instead of describing the result
2. No routines to note down experiences and forwarding them to others
3. No room for innovations, due to 1. above.
4. Too short contract periods
5. No organization to take care of innovations.

The full result of the survey is presented in its original language, Swedish, in 10.13.4. An idea for the future is to run the same survey with Vägverket and its contractors to improve the precision and enable better generalization of the results.

8.4 Participatory Observation (Banverket)

After having interviewed Banverket’s procurement group, we also wanted the other parties’, the bidders’, points of view. The first method to obtain these was, as usual in this study, to interview representatives of the contractors, mainly Banverket Produktion (BVP 2003 - 2004). The results of these interviews have been accounted for in chapter 4 and Section 8.1.1, but some more will follow in this section. As all other activity in this study, the final topic and objective of the interviews were to map the innovative climate,
the incentives to innovation. However, aware that innovation is usually not essential short-term for the operations, nor the operative persons, the interviews usually start with questions regarding the normal operations. What is the present technology like, and does it function reasonably to keep the trains rolling?

If these warm up questions happen to show, that the current procedures do not function, we have found an answer to our research question right there. If all effort must continuously be used to extinguish fires, i.e. urgent, short-term emergency solutions to keep the business running, there will hardly be any time for innovations. Not until a reasonable control, head above the water, has been reasonably reestablished, there will be any earnest interest in innovations for long-term development, the topic of this study. A mechanism how surplus time leads to technical progress is accounted for by Stenbeck (1996).

We followed a real tender from a bidders viewpoint. By keeping a continuous dialogue with one of the bidders, we received a first-hand impression of the whole process from invitation to bid until an awarded contract. This bidder had not participated in any Banverket tender before. The story below contains altered details to prevent identification Like the rest of this study, the presentation is intended to give ideas for improvement.

Banverket wanted to procure project data registration in conjunction with a new railroad investment. The industry able to produce this registration would be a specific branch of the general, IT consultant firms, not the railroad-specific industry.

Hundreds of internal Banverket regulations were referred to in the tender documents. Only five of the regulations were enclosed, as if they would be particularly important. The not enclosed documents were for sale. Since this was a non-railroad industry, one wonders how Banverket could assume the other regulations to be familiar to the bidders. Two of the five enclosed regulations were about environment and security. In this tender these factors had very low relevance, since the tendered services were to be conducted indoors, nowhere near any train or railway environment. Still, extensive plans and organization of these non-existing activities were demanded by the principal and attributed value in the bid evaluation. Some examples of information were mentioned, as a description of what data that Banverket wanted to be registered. The vagueness in such a scope of supply description would have made it legally possible to deliver a more or less empty data file.

Side bids, alternative ways to perform the contract, were encouraged, at first. Then, at the end of the same paragraph, was suddenly stated: Side bids will not be evaluated.

It was pointed out that the delivery time was the most important aspect. Still, the documents were contradictory on what date of delivery that was preferred by the principal, and how a lower price would compare with a later delivery time. Two days before submission date, it was clarified that the earlier date was the valid one and that it was a strict demand on all tenders. The decision was made just before a holiday period,

48 Here used in a wide sense, including products and processes, as well as their organization.
49 A possible description of Banverket’s commitment in performance-specified terms.
50 As we did with Vägverket in 8.2.1, we have replaced the real product and figures of a real tender evaluation with a made-up case with a product having characteristics enabling the same discussion.
51 It cannot be excluded that more information about the actual data to be recorded existed in the non-enclosed documents. If so, the verdict would depend on whether the judge would find the not enclosed information as binding, which may depend on their accessibility.
so that the 10-day appeal period coincided with when many bidders were not working. This caused a maximum reduction of the effective appeal period.

Scope of supply was in practice flexible, but price was clearly expressed as allowed to be flexible. Hourly pays for different categories of personnel were to be stated and the bidder was asked to indicate a budgetary total price. Price was to have only 20% influence in the evaluation. The final result of the bid evaluation however coincided closely with the order from the lowest to the highest budgetary bid. The positive correlation between the price and the other evaluated factors is surprising, since it seems reasonable that a high level of quality, planning, environmental concern etc. would rather raise the price than lower it, which would imply a negative correlation between price and the other factors. A similar correlation has been the case also for two out of two studied tenders in operation and maintenance. There the price was however fixed and its weight 70% of total.

The description of the current states of the installations as well as the precise scope of supply will never be perfect, and hence tender documents can never be perfect in these aspects. The point we want to make is that their level of accuracy influences the incentives to innovation. If scope of supply varies 20%, only innovations reducing costs more than the 20% will be more important for the contractor, than trying to do as little as possible. Interpretation of the tender documents by lawyers will be more profitable and prioritized before innovations.

Limited competence in the technical details of Banverket regulations refrains us from knowing to what extent the scope of supply is, in practice, flexible in the operations and maintenance contracts. The winner of the tender may be able to reduce the scope of supply until desired level of profit arises, without violating the contract legally. The documents look OK. Banverket Produktion, however, wonders if and are worried that the private contractors do not realize the scope of the work to be done. They are now at own cost developing a technical scope of supply description (BVP 2004e). On the other hand, the private contractors (BV 2003b) wonder if Banverket Produktion realized all works that they were supposed to have done. Why would these bidders worry, if the scope of supply were well described in the documents?

Technically detailed research would be needed to more precisely determine the extent of the scope of supply ambiguity. At the same time, the principal is continuously working to eliminate the ambiguities, why it can be assumed that the report will be out of date already when it is published. The findings will be difficult to generalize to other companies and industries. Thus such a study may be of limited value for science, but an incontournable exercise for a principal with a sincere wish to create fair conditions for bidding. It seems that the exercise should precede other methods to stimulate innovation.
9 Conclusions and Proposals

The interest of the financiers of the study has been to find ways to stimulate R&D in their particular organization, with as small changes of the existing practices as possible. From a scientific point of view, the study has deepened knowledge in e.g. the following areas52:

1. Whether and how incentives contribute to the definition of an innovation system.
2. External effects (spillovers) can have a negative effect for the technical development outcome of an innovation system, if they disable innovators from harvesting the profit and the honor of the innovation.
3. A method to compare qualitative aspects of bids has been developed.

A first, explorative, round of interviews have been conducted, followed by an experiment to verify the information received, as well as to test a particular way to stimulate innovations. A second round of interviews was conducted after the experiment, with its participants. The observations in the experiment and the second round of interviews confirmed the lack of incentives to innovation expressed by the respondents in the first round of interviews.

The result indicates that system factors, human factors, time pressure and other factors have reduced the incentives for innovation to such a low level that it fully explains the absence of innovations in the industry. Development of the principals’ routines around bidding and follow-up, and a higher degree of generosity, may suffice to significantly increase the rate of technical progress. These measures may cost a little, to start with, but with probable payback within few years.

This result of the study being that innovations might be possible by in-house measures should be good news for the principal, since it means that most of the action is inexpensive. By it being internal, the action plan does not include having to persuade contractors and other external actors. The principal has only to convince itself and its own personnel in the first step of a strategy to increase the rate of technical progress.

This first step does not exclude, that more costly methods need to be added later. Subsidies of various kinds to spur innovation can always be considered as a future, second step. Many of these measures are however problematic, since they are not only costly, from the principal’s point of view, but also somewhat contradict the philosophy, and merits, of market economy competition, equality between bidders and other main principles of the European Union and modern economics.

9.1 Answer to the Practical Question

Background to the study was a feeling of technologic progress and innovation frequency slowing down. Purpose has been to find explanations for this feeling. Finding the explanations is intended to be a first step towards an innovation strategy. Developing and implementing such a strategy in detail is not within the scope of the study, but some possible elements of a strategy is provided in Section 9.3. The

52 Although in slightly different wording, please note the similarity with the research questions and hypotheses presented in Section 1.3.
experiment, in the study used just as a means to provide explanations, may also be possible to use, after some development, as a practical way to stimulate innovations.

Has technical development ceased in operations? If so, why? If not, why does it seem so?

Theory and interviews provided four hypotheses:

1. **All already invented.** After 2,000+ years of technical development, we have finally reached our creative limits.

2. **Absence of incentives to be innovative.** Innovations are not welcome, perhaps even despised. The most rational behavior is to concentrate on other tasks than innovations.

3. **Innovations do not show.** There are innovations, but they have a non-conspicuous, non-materialistic nature.

4. **Innovations are kept secret.** There is no advantage for the innovating company to reveal innovations to the competitors.

The study’s answers to the four hypotheses follow below.

1. **All already invented?**

Starting wide, a first hypothesis could be that we are experiencing a quite natural, life cycle related phase of technologic progress. Stenbeck (1996) develops a hypothesis how and why creativity may suffer from diminishing returns, related to saturation of needs. Salter (1966) implies that it seems reasonable, that after a period of intense mechanization of the most imminent manual tasks, a limit to mechanization may be reached, with a period of slow development. The law of diminishing returns reduces the number of ideas and the number of innovations with a potential to be profitable.

Otherwise very few scientists support diminishing returns to be applicable to technologic progress. On the contrary, economic historians, e.g. Sauvy (1980), point out how technologic progress has brought increasing returns. New technology creates its own new demand or reduces the price so that volume compensates for price reduction.

Market and creativity saturation would have been an attractive way for both contractors and principals to answer the questions in the study, of no cost neither to themselves nor the other party. Still very few seized this opportunity to blame a third factor. One such exception was Bidder C in the experiment, Table 8.1.

From this we draw the conclusion that this industry has not, at least not yet, reached its development limits. The reason for the feeling of decreasing technologic progress is neither an absence of needs for innovations, nor an absence of ideas. The *All already invented* hypothesis has thus been rejected by the study.

2. **Absence of incentives to be innovative?**

The road and railroad innovation systems seem to be designed for pure altruists, which however may be small group in these modern times. It can be argued that the market economy does not allow any long-term room for this category. In the market system, everyone is expected to sorry for himself or herself, and it is the invisible hand (Smith 1776), which will deliver the optimal result for us all.
The experiment and participatory observation supported the interviews regarding that Vägverket and Banverket show no or little interest in other methods than those specified in the tender documents and in sharing profits with companies generating and developing new ideas. The examples in 8.2.1 are taken as grounds that deficiencies in new ideas have been searched fiercely and unfairly without any concern for the long-term effects on the incentives. The incentives hypothesis being responded with yes, the mystery of the disappearing innovations appears fully explained, even if there would be further contributing factors. Not until these obstacles have been removed, it will be sensible to search for other reasons or propose other, less natural, political, means to increase the number of innovations. There is even a risk that if introducing advanced, academic, expensive means of stimulation of innovation, such as financial rewards, into the reality described, the innovative climate might suffer further by even more frustration.

The claims that contractors never submit any side bids were falsified. The hypothesis that submitting side bids was a waste of time for the bidder was supported. The hypothesis of lack of incentives for innovation was supported.

3. Era of non-conspicuous innovations?

An industry dominated by engineers, might have a tendency to focus on technical, materialistic, innovations. But after decades of technical innovations, the 1990s was simply a decade during which organizational and other non-materialistic and thereby less noticeable innovations had a higher return on investment. The 20 % - 30 % reduction of input, achieved by the organizational innovations of the 1990s, would have been difficult to realize with technical innovations. With this aspect, a slow-down in the traditional types of innovations in favor of non-materialistic ones can be seen as natural and rational market behavior.

The literature of the last decades is in line with this hypothesis. Having had a technical and materialistic viewpoint, it now often stresses the importance of markets and products in their organizational context. Products are regarded and sold packaged together with logistics and after-sales services. Networks and distribution channels may be more explanatory to success than the technical features of the products themselves.

The interviews also support that organizational innovations have been, and still are, seen as the most productive way to increase productivity in the last decade.

Even those claiming disappearing technical innovations, admit that the organizational turmoil has been substantial. Most also agree that important productivity gains have been reached in this way.

The 1990s being an era of non-conspicuous innovations provide some excuse and explanation that the evaluators were critical in the side bid experiment. It also gives a touch of support to the first hypothesis about decreasing returns on technical progress.

This third hypothesis is thus also supported, being a partial explanation of the feeling of lack of innovations.

4. Innovations nowadays kept secret?

In general, the tendering procedure does not favor other methods than the one specified. It has been easier to bid as proposed and then save costs and find smarter methods once the contract has been signed. Only if necessary and in opposition with the specification, the principal needs to be involved. There are competitive advantages of keeping as much as possible secret, and since the principal has not paid for information, there are
several innovations in the companies kept secret. When interviewing the contractors, plenty of innovations have been presented. Thus, this fourth hypothesis has been supported. Having seen the evaluation of ideas in a bid situation, it also seems that the keeping secret strategy will be the most profitable in the near future.

9.2 Answer to the Scientific Questions

According to the interviewees in our industry, the road and rail operations and maintenance, no secrecy\textsuperscript{53} is rather a problem than an asset. The openness and keenness to copy in this industry reduce each actor’s economic incentives to participate actively in technical progress. The result of this study thus negates the spillover theory. Since none of the authors in Fischer & Fröhlich (2001) find the innovators’ individual incentives important enough to allow the word incentive or equivalent appear in a title or a subtitle, it is our hope that our inclusion of incentives as a factor is a contribution to current research on innovation systems.

Vägverket’s and Banverket’s tasks can be characterized as encouraging innovations on one hand, and to spread the information of recent and existing innovations on the other hand. In some aspects, the two are contradictory. The inventors may only be interested in their innovations being spread, if they have some benefit from this spread. Otherwise, the threat of others taking their innovation could be a negative incentive for them to innovate in the first place. The social benefits of coming up with clever solutions should not be overvalued. In many cases the social benefit is negative and need to be compensated by financial or other rewards.

The international patent system may have been one of the first institutions dealing with this issue, but it has become somewhat costly and bureaucratic. Thus, it does not constitute an option to the majority of the minor incremental innovations on the daily level, which would be beneficial to the Swedish society, if they were brought to life.

The study supports the intuitive feeling that a description of an innovation system without analyzing each actor’s incentives to contribute to its total performance is of little value. Examples have been given where incentives would explain the empiric findings of many innovation system researchers’ studies. Incentives would partially bridge the prevailing gap between ex post and ex ante in innovation system science.

9.2.1 Multicriteria Evaluation

Another area where the study may have pointed out a direction of further development is in multicriteria evaluation. (As this was not an aim in itself, a corresponding literature review was however not published in this study). Sections 7.3 and 7.4 addressed some problems when comparing different bids containing different advantages and disadvantages.

Our method is as follows:

All quality parameters are recalculated into their long-term, yearly benefit to the principal. Easiest is to use the price unit, e.g. SEK/year, as the common denominator unit.

\textsuperscript{53} In this study, no secrecy and similar colloquial expressions are treated as synonyms to the scientific term spillovers.
The principle is quite straightforward and easy to explain. Executing it and calculating the long-term benefit of each of the apples and pears, is however not as simple and uncontroversial. We hope however, that this becomes a science of its own and that the method details will develop in cooperation between principals and bidders. Although discussion on the issue has already brought us some ways into the details, we have in this study invited to more development. We have tried to “keep the creative ball in play” by letting the bidders themselves, as good as they can, calculate the benefit of their proposals, as well as presenting the basis of their calculation to the principal in the bid.

The idea was practiced in the experiment and one bidder understood the instructions well and calculated and explained its innovative side bid with a relevant degree of detail, without overdoing it or leaving important bases for the calculation out. The short-term immediate economic benefit was well explained. A higher value of the innovation could perhaps have been reached if the environmental benefit could also have been quantified in a credible manner. A positive environmental effect was just mentioned without pricing it.

### 9.3 Practical Ideas and Proposals

Some practically implementable ideas will be mentioned in this section. They are based on the study but should still be seen as somewhat personal ideas by the researcher himself and treated accordingly.

The principal can vary the strategy over the years to create and maintain the competition, as long as all bidders know the rules of the bidding in due time. 4-5 bidders per tender could be a target number.

The contractor could be required to specify what he has done to get paid, straight into the principal’s public database. This not only saves work for the principal, but also assures that the registration really takes place, in the most effective way for the taxpayers. Only the principal’s own observations need to be registered by the principal itself. The contractor should register all other data before being paid.

A print out of actions and responsibility performed by the contractor could be demanded to be included with each invoice. This list can then be compared with the observations from the controllers. At this comparison bonuses and penalties are calculated. The resulting amount is then to be paid.

After payout, the observation protocols need no more be kept secret, but can be made public. This final step will probably create a strong incentive for the contractor to perform without remarks. Besides the immediate financial reasons, honor before, or fright for harassment by, the public would probably create a strong incentive.

The above-mentioned actions will hopefully support full performance and full respect for the other party in the long run, which is a prerequisite for technical progress, innovation, attraction of the industry and many others of the objectives that Banverket and Vägverket expressed at the start of this study. It is even a prerequisite for partnering, not opposed to it.

In the particular field of encouraging innovations, the following may be noted:

*Encouragement.* The principal has reason to encourage all ideas bringing long-term profit and has an own interest in keeping the contractors happy and in a good mood. Such an attitude may be difficult when reading a side bid with a well-known economic solution. Still this effort must be made.
Not mentioned = new. Everything in a side bid that was not mentioned in the tender documents should be treated as new ideas.

No stealing. Using an idea from a side bid, or tender it out for all to bid, until the idea has first been purchased properly from the side bidder, will be disastrous for the incentives to innovate long-term.

To make the tender evaluation more fair and effective, the following might be a route to success:

Start with a classical, execution defined, lowest price tender. Make sure somebody technically understanding the product or service to be purchased takes an active part in each of the following points. Change item by item to performance-specified procurement in an orderly and controlled manner. Add soft parameters one at a time, starting with only low percentages reduction for soft parameters.

Formal documents like ISO-certificates, is no warranty for performance. Instead of predefined amounts for soft parameters, the tender can contain commitments regarding how the principal will reward certain achievements during the contract period. Verify and reward actual action, after its fulfillment. This will probably create stronger incentives and more positive attitudes, than if first giving the award and then withdraw it in the form of penalties. If a reward generates no result, raise it until it does. For legal reasons, this rise may not be possible for current contracts. The principal, however, entering new contracts all the time, can raise the reward in the tender documents of the next upcoming tender, until the desired behavior results.

Bonus should be paid after verification. This turns “demands” (often perceived as negative) into “rewards” (often perceived as positive). The above contracted commitment by the principal; to pay extra if certain extras are performed will automatically include this later income into the bidder’s considerations. This should then reduce his basic price with an amount corresponding to the soft parameter value, and no further price reduction for soft parameter value needs to be effected by the evaluators when comparing the bids.

If the bidder is asked to submit some kind of project plan, to convince the principal that he has the competence to take on the contract, this should be a 0-1 (satisfying) variable, not an assessment along a continuous scale. The tender documents must state clearly what is required to receive a 1.

A 2- or 3-step tendering process would save work for all involved. The first step might be a tender only asking for the bidders’ general qualifications. With Internet, where the tender documents can easily be made available to any numbers of bidders, basing the first step on price instead may be more effective and fair. The bidders should add technical details only if deviating from the specification (cf footnote 16). This will however be rare, since anybody providing a bid without deviation will be normally be ranked higher, no matter the price.

The winner in this first step is given some weeks or months after having been notified to provide further details in order to convince the principal of actual capacity to fulfill the obligations. This second step of the procurement could include for example the project plan mentioned above, bank guarantees, CVs etc. They are to assure proper performance, and should thus be evaluated on a 0-1 (satisfying) basis. The principal must not hesitate to call the second lowest bidder, in case the required documentation indicates insufficient competence or capacity to carry out the task. If this threat is not effected now and then, the principal’s demands will not be respected in the long run. Once contract started, it should also be a test period until the contract is firm. This is the third step. Still the principal must of course maintain alternatives to the chosen supplier,
in case of underperformance. A similar three-step procedure is used, according to the
tender documents, by RFF, Banverket’s counterpart, in France.

All costs occurring for the principal in case of undue fulfillment of the contract are to be
borne by the contractor. Bid bond, performance bond etc. are internationally accepted
financial instruments to reduce the number of bidders while assuring their
professionalism by the bidders. Bid bond: All bidders provide a bank guarantee of 2 %
of the contract. The principal is allowed to draw this amount, from the first step winner,
if the required documents of the second step are not approved. Performance bond, often
10 %, is to cover if the third step fails.
Incitament till innovationer i drift och underhåll av vägar och järnvägar

Denna studie ingår i CDU\(^{54}\) och KTHs\(^{55}\), doktorandprogram och har finansierats av de privata entreprenörerna genom SBUF\(^{56}\), Vägverket och Banverket. Projektet startades i mars 2003 och är avsett att löpa till slutet av 2007.

**10.1 Bakgrund och syfte**


Studien är avgränsad till drift- och underhåll, i huvudsak drift. Det mesta av forskningen utgår från ett leverantörsperspektiv trots att det finns studier som visar att teknisk utveckling till största delen, 75 % enligt vissa forskare, beror på beställaren (Westling 2001). Detta är en anledning till att vi utgått främst från beställarperspektivet i denna studie. En annan är att, i ett marknadsbaserat system, torde det vara kunden som utdelar belöningar och bestraffningar för att systemet ska styras mot samhällsoptimum. Om frånvaron av innovationer har med avsaknaden av drivkrafter att göra, är det då rimligt att utgå från beställarens perspektiv. Om vi hade funnit att incitamenten mellan Vägverket/Banverket och deras entreprenörer varit goda, hade det funnits anledning att fortsätta sökandet uppströms i förädlingskedjan, mot entreprenörernas underleverantörer, för att söka orsaken till avsaknad av innovationer. Då studien dock fann stor brist på incitament redan i gränssnitten beställare - entreprenörer har den fortsatta sökningen uppströms skjutits på framtiden.


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54 Centrum för drift och underhåll  
55 Kungliga Tekniska Högskolan, Stockholm  
56 Svenska Byggbranschens Utvecklingsfond  
57 drivkrafter  
58 uppfinningar, alternativa metoder, nya organisations- och kontraktsformer
10.2 Innovationssystem kompletterat med incitament


10.3 Vägverkets organisation för teknikutveckling

Ett motiv till införandet av modellen beställare-utförare för Vägverkets drift och underhåll 1992, då produktion i egen regi ersattes av upphandlad produktion, var att införa funktionsentreprenader och därigenom frigöra kreativitet (Olsson 1993, VV 2003a). Efter de första 10 åren av konkurrensutsättning verkar vinster och besparingar ha uppnåtts med omorganisation snarare än teknisk utveckling. Beställare och utförare uttrycker viss besvikelse över resultatet i tekniska termer, och viss maktlöshet när de gäller att åstadkomma innovation och förnyelse i branschen. I några regioner har viss
återgång till utförandekrav och volymbaserad ersättning skett (VV 2003a). Riksnorm är
dock att drift- och underhåll ersätts per uppfylld funktion inte antal inrapporterade
färdade kilometer. För att reglerade funktionsentreprenad uppnås genom att ersättningen
kopplas till av tredje part (SMHI) uppmätta meteorologiska data. Anbudsgivarna
ansvarar själva för vad ett väderutfall innebär i arbetsinsats, vilket är ett relativt
komplext åtagande. Att ersättningen kopplas till våderutslag innebär därför inget avkall
på prestationsskavet gentemot beställare och allmänhet. Vägarna ska hållas fria från snö,
halka och andra hinder oavsett antalet registrerade väderutfall. Vid uppenbart orimliga
vänderfall (trasig sensor etc.) genomförs dock någon form av förlikning.

Målet på sikt är att beställarens insats ska begränsas till att mäta resultatet och att endast
detta ska styra ersättningen till entreprenören. Bonus för överprestation används i regel
inte. Däremot används viten då bristpåpekanden ej åtgärdas. Vägverkets
produktionsenhet, som bjuder i konkurrens med den privata marknaden, har 60% av
marknaden. NCC har sedan 1992 vuxit till cirka 20% och resten delas av Skanska, Peab
och lokala entreprenörer, exempelvis Stockholms och Göteborgs egna gatubolag.

Efter beställarens utarbetande av upphandlingsunderlagen (ca 4 månader), följer
anbudsräkning (ca 1 mån), utvärdering (ca 1 månad) och genomförande (ofta 5-6 år).
Kontrakten löper i regel från 1 september året efter att upphandlingsprocessen inleddes.

Vid upphandlingen används Vägverket en värderingsmodell i huvudsak baserad på en
lägsta pris – filosofi, men där mjuka parametrar i form av miljö- och
kvalitetscertifierade processer vägs in med 1% avdrag vardera på anbudssumman.
Ytterligare 0,5 – 1,5% avdrag kan erhållas för en viss minimibemanning med
kompetenskrav på den anställda personalen. Under kontrakts löptid har beställaren
i regel en representant som träffar entreprenören månatligt med möjlighet att göra
stickprov och egen uppföljning däremellan. Såvitt projektet kunnat bedöma används
ännu ingen riksenhetlig stickprovsmodell, utan beställarrepresentanter skapar sina
egna mallar för uppföljning och dokumentering. I Mälardalen (VMN 2003) upphandlas
kontrollen externt.

10.4 Banverkets organisation för teknikutveckling

I Banverket påbörjades förberedelserna för upphandling av drift och underhåll under
slutet av 1990-talet. Sedan 2001 har ett tiotal stråk upphandlats i konkurrens och några
av kontrakten har tillfallit privata anbudsgivare. Jämfört med Vägverket är processen i
Banverket således ännu i sin linda, och det kan anses vara för tidigt att börja den
finslipning som införande av incitament till innovationer innebär, då arbetet med
tillståndsbeskrivningar, upphandlings- och uppföljningsrutiner bör föregå denna.

Studien har i Banverkets fall därför främst inriktat sig på att bidra till att de normala,
operativa rutinerna ska fungera vid upphandling och uppföljning.

Banverket är, till följd av den inte så avlägsna monopoltiden och stort inslag av specifik
järnvägsteknik, ofta lätt att en viss leverantör beträffande de tekniska komponenterna.
För drift- och underhåll har man i utgångslaget i många områden varit lätt till sin egen
produktionsenhet, Banverket Produktion. I storstadsregionerna och i anslutning till
enstaka privata banor har det dock varit möjligt att skapa konkurrens, och
konkurrenssatsningen inleddes därför med anslutningsspår till privata spår som
Inlandsbanan och banområden kring Stockholm, där Stockholms Lokaltrafik innehar
liknande kompetenser. Utländska bolag visade snart intresse för den begynnande
marknaden för drift- och underhåll, och har köpt in sig efterhand.

Upphandlingsprocessen följer inte en årlig cykel, som i Vägverket, utan nya ärenden
påbörjas löpande. Man använder en värderingsmodell med större andel mjuka
parametrar (30 % i de fall som studerats) och betygsätter även organisation, referenser mm. Delbetygen viktas och summeras, i region öst enligt figur Figure 4.3 på sid 44. Även priset översätts till en betygsskala enligt en matematisk formel och viktas sedan med koefficienten 0.7.


10.5 Svenska underentreprenörer, franska vägerfarenheter

Incitamenten mellan entreprenörer och deras underentreprenörer och leverantörer verkar i dagsläget fungera bättre än mellan huvudmännen och huvudentreprenörerna. Till exempel kan nämnas GIS och GPS – utveckling för att i realtid hålla reda på var vintervåghållningsutrustning befinner sig. Sådana system breder för närvarande ut sig pga. att huvudentreprenörer krävt det av sina underentreprenörer, inte för att huvudmannen begär det. Underentreprenörerna verkar glada för att få visa sin kundvar, hur och hur väl de utför sitt arbete. Ett visst mått av förtjusning över att få delta i teknikens frontlinje har konstaterats.


10.6 Franska järnvägens innovationssystem


Den tydliga ansvarsfördelningen, där varje nivå har någon ovanför med begränsad budget till vilken man måste sälja sina idéer, har spritt sig in i SNCF. Inte heller forskning och utveckling har någon gräddfil. De måste hitta en operativ verksamhet som tror på deras idéer och förmåga. (SNCF 2004).


En intressant idé att importera till Sverige vore den fungerande budgetrestriktionen som skapats genom RFF, att dess medel ska prioriteras att täcka allt drift- och underhåll och

10.7 Teorier kring teknisk förändring


10.8 Empiri


10.8.1 Intervjuer

Intervjuer har förts löpande, i olika skeden av studien och med forskningsmetodiskt olika syften. För att åtskilja dem metodiskt, kallar vi den första omgången intervjuer för sonderande intervjuer, intervjuer av explorativ karaktär. Resultaten av dessa återfinns framförallt i 8.1 men även bakgrund- och faktabeskrivningar i övriga delar av denna rapport bygger till stor del på dessa intervjuer. Deras syfte var att lära känna området för att därigenom kunna höja kvalitet och precision på utformningen av experiment och enkät. Som bieffekt gav de explorativa intervjuerna även ett indikativt svar på forskningsfrågorna. Sven var så pass samstämmiga och likartade oavsett vilken
entreprenör som intervjuades, statlig såväl som privat, att känslan av att ha funnit ”sanningen” infann sig efter ett tag. Likväl har en ny, oberoende omgång intervjuer genomförts efter det genomförda experimentet som presenteras nedan. Andra omgången intervjuer syftar till att förklara experimentet och omvandla dess resultat till den typ av kvalitativa primärdatal, idéer hur innovationer kan stimuleras, som det är vår förhoppning ska bidra till mer innovationer i framtiden.

10.8.2 Experiment

Tabell 10.1 Eftersom lägsta bud uppgick till 29 MSEK och anbudsgivaren med sidoanbud bjöd 32 MSEK, och yrkat värde på sidoanbudet var 1,5 MSEK, räckte sidoanbudsvinsten inte till för att få kontrakt.

<table>
<thead>
<tr>
<th>Anbudsgivare</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Huvudanbud</td>
<td>Inget bud</td>
<td>32 MSEK</td>
<td>46 MSEK</td>
<td>37 MSEK</td>
<td>29 MSEK</td>
</tr>
<tr>
<td>Varför inget huvudanbud?</td>
<td>Brist på personal</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sidoanbud</td>
<td>Nej</td>
<td>Ja</td>
<td>Nej</td>
<td>Nej</td>
<td>Nej</td>
</tr>
<tr>
<td>Yrkat</td>
<td></td>
<td>-1.5 MSEK</td>
<td>0.0 MSEK</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Erhållet</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Varför inget sidoanbud?</td>
<td>Tidsbrist</td>
<td>Beläget långt från nuvarande kontrakt</td>
<td>Mindre viktigt kontrakt</td>
<td>Drift- och underhåll är relativt enkla verksamheter - låg potential för innovationer</td>
<td>Historiskt sett ingen respons på sidoanbud</td>
</tr>
</tbody>
</table>

Tabell 10.1


I intervjuerna med deltagarna efter experimentet upprepades en hel del av de negativa incitament till teknisk utveckling som framkommit i de explorativa intervjuerna. De redovisas dock på nytt i experimentavsnittet 8.2, då det kan vara motiverat ur forskningssynpunkt och stärker deras trovärdighet att liknande resultat uppnåddes med en annan metod. Samstämmigheten med tidigare intervjuer har inneburit att ytterligare försök eller intervjuer kring vad frånvaron av teknisk utveckling kan bero på inte känns nödvändigt, annat än som ett medel för att i så fall förändra och utveckla det innovativa klimatet och eliminera de negativa incitamenten ett efter ett.

10.8.3 Enkät

Som tidigare nämnts, har upphandling i konkurrens påbörjats betydligt senare (ca 1998) i Banverket än i Vägverket (ca 1990). Arbetet med att tekniskt definiera vad huvudanbudet ska omfatta och hur det ska värderas pågår fortfarande i en sådan omfattning att vi bedömt det som tveksam att komplicerar det hela med sidoanbud, i alla fall i den detaljerade form som åsyftats med experimentet i Vägverket. Mycket tyder på kvarvarande vaghet i den tekniska beskrivningen av det åtagande som ska prissättas med anbudsgivarens huvudanbud, vilket kan åsidosätta rättssäkerheten. Detta har i så fall betydligt större negativ inverkan på innovationsklimatet än sidoanbudet. Någonsin kan kompensera för. I Banverket vill projektet gärna bidra till att anbudsunderlagen och kontrakts uppföljning, hantering av tilläggsbeställningar mm fungerar, innan specifika teknikutvecklingsaspekter läggs till.

Följande metod valdes som ett sätt att både undersöka och bidra till de operativa processerna och teknikutvecklingstakten. I ett seminarium syftande till internt erfarenhetsutbyte och omvandling av detta till ett gemensamt och personligt handlingsprogram, fick 15 chefer och sakkunniga inom drift- och underhåll svara på forskningsfrågan i enkätform. Deras uppgift var att rangordna ett antal hypoteser kring orsaker till frånvaro av teknisk utveckling inom Banverkets drift- och underhållsverksamhet. Fyra av de fem regionerna valde att delta i seminariet.

För mycket hur-spec och för lite vad-spec, inga rutiner för att nedteckna och förmedla erfarenheter, ingen organisation för att ta hand om innovationer och ingen metod för att utvärdera sidoanbud är de främsta orsakerna till brist på teknisk utveckling enligt den enkät som genomfördes i samband med seminaret (avsnitt 10.13.4 nedan)
10.8.4 Deltagande observation (Banverket)

Deltagande har skett dels som observatör på beställarsidan, vid ett möte innan anbudsräkning och ett efter tilldelningsbeslut. Vidare har deltagande skett som observatör ”över axeln” på en anbudsgivare och de problem denne ställdes inför som budgivare till Banverket. Några av intrynken från dessa tre observationer redogörs för nedan. Syftet är inte att döma, utan att förse vardera parten med några mer eller mindre spontana reaktioner på ”den andra sidan”. Urvalet av anbud är för litet för att kunna anses vara representativa för offentliga beställares rutiner, och observatören har varit nybörjare i branschen, vilket kan ha lett till misstolkningar, men kanske kan de inkomna synpunkterna ändå vara till nytta för Banverket för att utveckla upphandlingsrutinerna.

Omfattningen av de mjuka parametrarna som baseras på anbudsgivarens inre organisation mm, innebär risk att det egentliga föremålet för upphandlingen drunknar i pappersexercis. Förmågan att utföra kontrakten bedöms inte utan endast förmågan att formulera åtagandet med fina ord.


Tidigare erfarenhet och referenser av liknande objekt har vägts in vid utvärderingen och för drift- och underhåll har krävts redovisning av en organisation, med namn på personer och deras exakta meriter, för att ta hand om uppdraget. Nya anbudsgivare har klagat över att ett sådant villkor gynnat tidigare kontraktarbetare, då en ny anbudsgivare inte gärna kan skapa en sådan organisation i detalj, anställa folk osv., förrän uppdraget vunnits. Efter att förfördelade anbudsgivare påpekat dessa aspekter har beställaren avskaffat eller viktat ner betydelsen av precisa namn och CVn. Det är den totala kompetensen hos företaget som är intressant eller, ännu mindre krävande, företagets förmåga att se vilka kompetenser som kommer att behövas, i de fall rekrytering måste ske till följd av ett nyvunnet avtal. Samtliga parter har ett visst intresse att ”återvinna” den personal som för närvarande arbetar i området, i händelse av byte av entreprenör. Även EU delar denna sociala syn. För Banverket ökar möjligheterna att skapa konkurrens väsentligt, om personalen som gör själva jobbet tillåts tas över av den nye entreprenören, eftersom alla järnvägsspecifika kompetenser då inte måste mångfaldigas för att möjliggöra konkurrens. Motstånd mot organiserat sådant övertagande har dock funnits tidigare i Banverkets ledning.

10.9 Slutsats Vägverket


En lösning på problemet är ett genomtänkt, matematiskt rättvist stickprovssystem som genomförs systematiskt men ändå (stokastiskt) regelbundet av beställarombuden. Det kommer sannolikt att öka respekten för beställaren, höja prestationen gentemot allmänheten, trygga rättssäkerheten i upphandlingen och som lök på laxen höja det innovativa klimatet och branschens attraktionskraft vid rekrytering.

En stor mängd entreprenörer menar att de under årens lopp presenterat en mängd sidaanbud och innovativa förslag för beställaren. Ingen intervjuad beställare har dock kunnat dra sig till minnes ett enda riktigt bra, lönsamt förslag. Ändå har entreprenörerna sett sin innovation erbjudas till konkurrenter, eller finnas med i upphandlingsunderlag så att alla kan ge anbud, kort efter att de föreslagit den.

Förklaringen kan ligga i att innovationen inte varit så fantastiska som anbudsgivaren själv tyckte, utan att deras idé i själva verket var en effekt av en allmän strömning. En stor del av innovationerna är också enkla och självklara i efterhand.


Avslutande bedömning, inte bara pga ovanstående överväldigande majoritet för att mycket teknikutvecklingsmöjlighet återstår, utan i första hand baserat på den egna observationen och intrynken av experimentet, är till fördel för entreprenörernas syn. Lås men detta i experimentet framförda innovationen var över förväntan och den motiverande kalkylen överraskande övertygande. Åndå lyckades beställaren hitta fel i stort sett på samtliga punkter, för att slutligen intala sig att idén var dess egen och inte ny överhuvudtaget. Därmed ansåg sig beställaren ha både juridisk och moralisk rätt att införa den i samtliga områden utan ersättning till idégivaren.

I denna sammanfattning har nämnts de hypoteser som studien styrker, genom att intervjuer, experiment och observationer utföll samstämmigt. Därmed inte sagt att det

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inte kan finnas ytterligare bidragande orsaker till frånvaron av teknikutveckling och åtgärder som skulle kunna stimulera teknikutvecklingen till en högre takt.

10.10 Slutsats Banverket


I det andra fallet kommer ett överantal besiktningens åtgärdningar att genereras. Det skapar inte personliga samveteskval, men innebär att beställaren betalar för överkvalitet. Åtgärdande av konstaterade fel utförs helst slarvigt och temporärt, för att felet snart ska återupptäckas på nytt, helst akut på övertid.


Ovanstående var ett exempel på hur beställaren tagit på sig onödigt ansvar. Anbudunderlagen och dess förutsättningar har varit för detaljerade, på ett sätt som skapar negativa incitament för både prestationer och innovationer. Men kommentarer från såväl privata entreprenörer som den statliga entreprenören tyder också på att
anbudsunderlagen i vissa avseenden är för vag och odetaljerade. Avgående entreprenör undrar om den nya verkligen inser hur mycket arbete kontraktet innebär (BVP 2004e). Tillträdande entreprenör undrar vad den tidigare överhuvudtaget gjort under den föregående kontraktsperioden (BV 2004b). De verkar således ene om att det inte är entydigt var ansvarsgränsen går enligt anbudsunderlagen och vad som ingår i kontraktet. Rälschipning, till exempel, utförs kanske endast någon gång per år med särskild utrustning, varför det ofta inte anses ingå i entreprenaden. Banverket Produktion är så bekymrade över konsekvenser av de vaga underlagen att de på eget beväg utvecklat en teknisk specificering (BV 2004e) som nu används i Västerås banområde, där Banverket och Banverket har ett samarbetskontrakt.

Det är olyckligt att undanta vissa moment från åtagandet. Ansvaret tydliggörs bättre om banans tillstånd i vart ögonblick inom kontraktsperioden är utförarens ansvar. Behovet av exempelvis rälschipning kanske kan uttryckas med ett funktionsvärde (viss blankhet, friktion, eller maximal rosttjocklek), ett tillstånd som det åligger utföraren att uppfylla i varje ögonblick. Om beställaren har egen rälschipningsutrustning erbjuds den lämpligen utföraren, som sedan själv avgör hur ofta den behöver hyras in.

Vaghet beträffande vad som ingår bör reducera incitamenten till teknisk utveckling med en ungefär motsvarande procentsats. Om avtalsjuristerna tillsammans med teknikerna finner att åtagandet kan minskas med 10 % utan att entreprenören bryter mot avtalet, kommer denna typ av aktivitet prioriteras före alla innovationer som inbringar mindre än 10 %. Tills vagheten underskrider cirka 10 % (kan i viss mån mätas som ändrings-och tilläggsbeställningar) verkar det mest rimligt att driva teknisk utveckling genom samarbetskontrakt (partnerskap).

Incitamentsmodeller kräver tillståndsbeskrivningar. Resultatet, åtminstone före och efter, gärna regelbundet och löpande, behöver mätas och dokumenteras. Detta saknas det idag ofta rutiner för.

10.11 Slutsats för vetenskapen

På det akademiska planet, har studiens resultat utmanat antagandet att öppenhet inom en bransch gynnar teknisk utveckling. Ingen intervjuad har angett detta som en positiv faktor. Flertalet har tvärtom direkt och indirekt påpekats svårigheten att hålla nya lösningar hemliga som en orsak till bristen på tehnikutveckling. Även innovatörer måste idag vara lönsamma. Det blir de inte om deras resultat avslöjas till konkurrenter innan de haft möjlighet att tjäna in forsknings- och utvecklingskostnaden.

Incitamentens betydelse är relativt lite behandlad i innovationssystemteorin. I avsnitt 6.5 ges exempel på studier som genomförts av andra författare, vars resultat ej verifierat den hypotes forskaren studerat, men som eventuellt skulle kunna förklaras av de bristande incitament som uppstår i öppna branscher (spillover-effekten). Innovationssystem-forskningens problem med att studier baserade på ex post data visat sig inte hålla ex ante, skulle eventuellt också kunna förklaras till viss del med den incitamentspåverkan som denna studie påtalat.

Denna studie innehåller även i avsnitt 6.4 en belysning av Wilfred Salters (1966) modell för teknikutveckling. För innovationssystemen bidrog incitamenten till förklaring. I Salters fäll dåremot, bidrar incitamenten snarare till förvirring. Salters empiri tyder på att ju mer innovationspräglad branschen är, desto mindre är vinsten till innovatören. Vinsten verkar istället tillfalla konsumenterna i form av lägre priser. Detta skapar förvisso större volymer, men det är inte helt tydligt att detta kompenserar prissänkningen fullt ut. Om inte, frågar man sig varför innovatörerna inte söker sig till
en för dem personligen mer lukrativ bransch. Kanske nöden allena är uppfinningarnas moder.

10.12 Slutord

Det finns i dagsläget fler negativa än positiva incitament till prestation och utveckling inom drift- och underhåll av Sveriges vägar och järnvägar. Mot bakgrund av de förhållanden som noterats i denna studie känns det inte förvånande, att innovationsintresset avtagit drastiskt, och att entreprenörerna slutat bidra till huvudmannens teknikutveckling. Det är vår förhoppning att denna rapport genom att peka ut problemen kan få fart på teknikutvecklingen igen.
10.13 Bilagor

10.13.1 Bilaga 1 – Bättre produktkvalitet

Vägverkets riktlinjer för hantering av alternativa utföranden


2. Förfrågningsunderlag – kravspecifikation – skall utformas så att entreprenörens möjligheter att lämna förslag till alternativt utförande inte försvåras.


4. Alternativa utföranden ska antas om de uppfyller ställda krav och kan betraktas som ekonomiskt mest fördelaktiga.

5. Hänsyn ska tas till entreprenörernas behov av sekretess för innovativa förslag såväl under som efter upphandlingsprocessen (jfr sekretesslag 6 kap 2§, 8 kap 10§). Alternativa utföranden får ej utsättas för ny anbudskonkurrens i samma upphandling.

Källa: Vägverket (VV 2004d)

10.13.2 Bilaga 2 - Sidoanbudstexten

(får ej användas på nytt utan författarens medgivande)

Upphandlingsföreskrifter: UFB.312 Alternativa utföranden, sidoanbud


Anbudsgivaren ska tydliggöra fördelar och är ansvarig för att redovisa nackdelar. Sidoanbud kan vara både dyrare och billigare än huvudanbudet, men ska för att kunna antas, med beaktande av erhållet mervärde, utgöra det ekonomiskt mest fördelaktiga anbudet.


Innovationsvärderingsmodell 2004

Om innovationerna innebär långsiktig vinst ges mervärde med denna. Den långsiktiga vinsten måste tillfalla beställarens verksamhetsområde som väghållare enligt de transportpolitiska målen (att tillhandahålla ett tillgängligt, högkvalitativt, säkert, miljömedvetet, regionalt utvecklande och jämställt transportsystem).
Anbudsgivaren ska beskriva innovationen tillräckligt utförligt för att den ska kunna värderas i monetära termer, dvs. bifoga kalkyl av vilken minst framgår investeringskostnad, driftskostnad, livslängd och årlig besparing med beaktande av avskrivning, som underlag för beställarens värdering av innovationen. Inför anbudsjämförelsen reduceras sidoanbudspriset med det av beställaren framräknade mervärdet som är likvärdigt med den årliga långsiktiga vinsten av innovationen under hela dess livstid. Mervärdet är maximerat till 10 % av huvudanbudssumman.

Om sidoanbudet leder till kontrakt, så måste investeringar och liknande initiala åtaganden enligt sidoanbudet vara genomförda innan mervärmedelen av kontraktet får börja faktureras. Investerningar och utfall av innovationen ska vara redovisat till beställaren för den period faktura avser. Utbetalningarna är alltid lika stora och jämnt fördelade över kontraktsåret, med undantag för indexreglering. Ersättning som avser mervärmedelen och som inte kunnat faktureras enligt uppgjord tidplan pga. dröjsmål med genomförandet eller redovisningen som inte är obetydligt, utbetalas inte.

Sidoanbudet är bindande, om det beställs. Beställaren kan dock avstå från att anta sidoanbudet, om beställaren bedömer att det inte medföra utlovade vinst, eller på annat sätt inte motsvarar ställda krav. Ett sidoanbud kan inte ha negativ påverkan på bedömningen av huvudanbudet.

**Exempel:**

**Huvudanbud:** Grundpaket drift erbjuds utföras enligt specifikation till en årlig kostnad på 20 Mkr i fem år.

**Sidoanbud:** Med den nya metoden … enligt bilaga … kan en besparing på 1,5 Mkr/år erhållas. Detta fordrar dock en investering årlig på 5 Mkr som avskrivs linjärt på 10 år. 5/10 = 0,5 Mkr avskrivning per år. Vinst efter avskrivning = 1 Mkr/år. Jämförelsevärdet: 19 Mkr

**Beställarens prövning:** Beställaren är intresserad av innovationen men gör bedömningen att vinsten är överskattad och reducerar den därför från 1,0 Mkr till 0,5 Mkr. Jämförelsevärdet blir 19,5 Mkr.

**Kontrakt:** Kontraktssumman är 105 Mkr. Avdrag från kontraktssumman för brister i kontraktsåtagandet avseende sidoanbudet görs med max 7,5 Mkr.
10.13.3 Bilaga 3 – Överprövningsfall sekretesslagen

Regeringsrätten beträffande 8 kap 10 § Sekretesslagen

Fråga om utlämnande av en sammanställning över anbud som lämnats vid kommunal upphandling. Allmänt hällna uppgifter om bl a effekterna av ett utlämnande vid kommande upphandlingar har ansetts inte utgöra tillräcklig grund för sekretess enligt 6 kap 2 § sekretesslagen (1980:100). Inte heller har sekretess ansetts föreligga enligt 8 kap 10 § samma lag.

Styrelsen för Lunds energiverk beslöt den 12 december 1989 genom sitt arbetsutskott att anta anbud som gällde inköp av sammanlagt 1 200 elmätare. I beslutsunderlaget ingick en handling som innehöll dels en förteckning över infordrade och inkomna anbud med uppgifter bl a om företag, fabrikat och styckepris, dels förslag till leverantörer med uppgifter om företagets namn, antal enheter och totalkostnad. Som motivering till förslaget hade antecknats: "I samtliga fall billigaste alternativ".


Hos regeringsrätten fullföljde Peter D sin talan.


På anförda skäl finner regeringsrätten att sekretess inte föreligger för uppgifterna i den begärda handlingen och att denna därför skall lämnas ut.
10.13.4 Bilaga 4 - Hinder för teknikutveckling (Banverket)

Enkäten genomförd som del i incitamentseminarium för teknikutveckling, totalt 13 upphandlare, DrU - ansvariga och sakkunniga från regioner och huvudkontor. (BV 2004b)

<table>
<thead>
<tr>
<th>Rang Hinder (vars eliminering skulle höja teknikutvecklingstakten)</th>
<th>Poäng</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. För mycket hur-spec och för lite vad-spec</td>
<td>50</td>
</tr>
<tr>
<td>2. Inga rutiner för att förmedla och nedteckna erfarenheter</td>
<td>46</td>
</tr>
<tr>
<td>3. För tydligt specifiserat, inget utrymme för innovationer</td>
<td>45</td>
</tr>
<tr>
<td>3. Ingen kontroll om man verkligen fått det man beställt</td>
<td>45</td>
</tr>
<tr>
<td>5. För korta kontraktperioder (ange &quot;lagom&quot; längd)</td>
<td>34</td>
</tr>
<tr>
<td>5. Ingen organisation för att ta hand om innovationer</td>
<td>34</td>
</tr>
<tr>
<td>7. För krångliga rutiner, ej användarvänliga informationssystem</td>
<td>32</td>
</tr>
<tr>
<td>8. Ingen metod för att utvärdera sidoanbud (=alt. utf.)</td>
<td>31</td>
</tr>
<tr>
<td>9. Tim- och volymersättningar missgunnar teknisk utveckling</td>
<td>28</td>
</tr>
<tr>
<td>10. För litet, faktiskt utömt lite vid underprestationer</td>
<td>26</td>
</tr>
<tr>
<td>11. Dålig rekryteringspolicy och kompetensutveckling</td>
<td>25</td>
</tr>
<tr>
<td>12. För lite erfarenhetsutbyte, för lite tid utvärdera själva upph.proc.</td>
<td>22</td>
</tr>
<tr>
<td>12. För små driftområden (ange vilken storlek som vore &quot;lagom&quot;)</td>
<td>22</td>
</tr>
<tr>
<td>14. Fel saker dokumenteras, medan det man behöver saknas</td>
<td>19</td>
</tr>
<tr>
<td>15. Stor budget bra för karriären (inget incitament spara)</td>
<td>19</td>
</tr>
<tr>
<td>16. Fiffigare lösningar riskerar drabba kollegors arbetstillfällen -</td>
<td>18</td>
</tr>
<tr>
<td>17. Ingen känner ansvar för kostnaden, ngn annan betalar</td>
<td>17</td>
</tr>
<tr>
<td>18. Ingen extra belöning för innovativa sidoanbud</td>
<td>14</td>
</tr>
<tr>
<td>19. EU / LoU / Konkurrensumsättning - feltänkt från början. Motverkar all teknikutveckling.</td>
<td>12</td>
</tr>
<tr>
<td>19. För lite utbildning i LoU, otydliga tillämpningstillsägningar</td>
<td>12</td>
</tr>
<tr>
<td>21. Många medarbetare bra för karriären (inget incitament spara)</td>
<td>11</td>
</tr>
<tr>
<td>22. Byggbranschen ÄR inte innovativ</td>
<td>9</td>
</tr>
<tr>
<td>22. Jantelagen - tro inte du är smartare än vi andra.</td>
<td>9</td>
</tr>
<tr>
<td>24. Fel sammansättning på upphandlings-teamet</td>
<td>6</td>
</tr>
<tr>
<td>24. Ingen belöning för överprestationer</td>
<td>6</td>
</tr>
<tr>
<td>24. Status att vara &quot;dyr i drift&quot; (mycket resor, mycket mobiltelefon lite produktivt arbete)</td>
<td>6</td>
</tr>
<tr>
<td>24. För öppen bransch – går inte att hemlighålla och tjäna pengar på innovationer</td>
<td>6</td>
</tr>
<tr>
<td>28. Mindre tryggt och mindre belönat att vara utförare, trots att det är här kompetensen</td>
<td>2</td>
</tr>
<tr>
<td>28. behövs mest (är det?)</td>
<td>2</td>
</tr>
<tr>
<td>28. Kanske allt inte är uppfunnet, men det blir i alla fall svårare och svårare att komma på nya grejer</td>
<td>2</td>
</tr>
</tbody>
</table>

Av minst en deltagare framförda ytterligare hypoteser:
(ej rangordnade, då övriga ej haft dessa att ta ställning till)

Budget
Föråldrade uppföljningssystem
Svårt att se orsak-verkan-samband
Ej användarvänliga uppföljningssystem
För svag ambition att systemen skall innehålla detaljerade och riktiga uppgifter.
Rapporterar hallre symptom än verklig orsak. Motivation.
För stor osäkerhet i uppföljningssystemen. Felprocent upp till ca 30-40 %
Svårt att koppla samhällsekonomin mot tågstörningstimmrar.
Vad är egentligen KBK inom punktloshetsområdet?
Saknad av belöningssystem. Bonus för rätt?
Saknas "Projektledare" med hela ansvaret
Kontraktsperioder 3 år slår idag inte igenom i budgeten
Värderingskriterier av upphandlingen
Beställarrollen - kompetens-projekt
Malldokumentet DrU - 3 ben: Norm, teknik, verksamhet. Incitament i varje del önskvärd.

10.13.5 Bilaga 5 – Egna idéer
Dessa tips bör betraktas som forskarens personliga och kan tas med en nypa salt för den som så önskar.


Vidare kanske utfört arbete med tillhörande erfarenheter bör dokumenteras bättre så att de tas tillvara för framtidiga upphandlingar. Beställaren kan se till att dessa data tillfaller beställaren, så att erfarenheten kan användas i nästa upphandling och under nästa kontraktsperiod som eventuellt innehavas av en annan entreprenör. Dessa data bör, eftersom de påverkar omfånget på entreprenörens åtagande, finnas tillgängliga på nätet eller CD-rom redan under anbudsskedet till den påföljande kontraktsperioden.

Vägverket
Vägverket har vid det här laget byggt upp ett tillräckligt antal tillräckligt erfarna entreprenörer att välja bland, för att det ska verka lämpligt att fortsätta och ständigt förbättra funktionsentreprenadformen, av praktiska och politiska skäl och för teknikutvecklings skull. Funktionsentreprenadkontrakt kommer förmodligen alltid innehålla ett mindre antal utförandekrav, sådana som har betydelse för trafikanterna men är svåra eller olämpliga att formulera som funktionskrav.


Det kan också hända att kritik uppföljning av kvalitetskrav, med fullfölja, utdömda, väl avvägda bonus eller viten, medför att kvalitetsfaktorerna efterhand blir inkluderade på ett naturligt sätt i priset på det totala åtagandet. Mjuka faktorer behöver i så fall inte

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viktas in separat vid anbudsvärderingen. Viktningen återspeglar sig i vitets eller bonusens storlek.

En viktig del av arbetet med att återställa förtroendet för beställarens värdering av anbuden, handlar om beställarens attityd till innovativa förslag.


Även vid funktionsentreprenader kan dock anbudsgivaren få idéer som strider mot underlagen, vilket tvingar denne att påkalla beställarens uppmärksamhet. För att stimulera utvecklingen på lång sikt har beställaren mer anledning att vara okritisk och tillmötesgående än att hävda att man själv är källan till den innovation entreprenören föreslår. En positiv attityd kan yttra sig i form av självpåtaget tystnadsplikt, intresse, lyhördhet, generositet och ett totalt ointresse av att utnyttja en ny idé utan att först betala för idén. Positiv sårbehandling av anbud som innehåller lönsamma idéer och metoder som anbudsgivaren inte tänkt på bör premieras. Principen bör vara att allt som löser uppgiften med någon fördel och ingen nackdel för trafikanterna och skattebetalarna, på ett sätt som förfrågningsunderlaget av dess formuleringar att döma inte tänkt på, är att betrakta som nytt och vårt att genomföra.


**Banverket**

Vid uppföljning av ett upphandlat kontrakt är det tveksamt om det bör överlåtas på kontraktsinnehavaren att kontrollera sig själv, åtminstone inte i de fall kontrollen blir avgörande för den egna ersättningen. Vidare vore det en fördel om upphandlingarna kunde rensa från irrelevanta föreskrifter och dokument, som mycket väl kan hindra teknikutveckling. Återstående bör bifogas upphandlingsunderlagen eller finnas tillgängliga på nåt. Beställaren bör tänka sig in i anbudsgivarens situation och se till att de faktorer som påverkar omfånget (arbetsmängd, behov av specialutrustning etc.) i entreprenörens åtagande finns med i underlagen, och att dessa data är korrekta. Nya entreprenörer bör ha tillgång till kostnadsdrivande information om specifika förhållanden i det konkreta driftsområdet för att både avge ett korrekt anbud och genomföra uppdraget utan försprällan av människoliv.

Först när de priskritiska uppgifterna finns med är det lämpligt att komplicerar med mjuka parametrar och liknande. Minimikrav är en enklare form av mjuka parametrar som kan var värdd att bibehålla tills beställaren skapat sig egen erfarenhet av de olika anbudsgivarnas verkliga prestationer. Pris och förmåga att leverera den kämpbrick eller tjänst som är ursprunget till upphandlingen bör inte komma bort bland den omfattande pappersexercis som är regel idag. Ett rent anbud, dvs ett anbud som

Banverket kan med funktionsentreprenad bara kringgå en del av det detaljerade beskrivningsbehov som rättvis konkurrensutsättning kräver. Funktionsentreprenad kan däremot vara en lämplig samarbetsform under monopolistiska förhållanden med Banverket Produktion, som på det sättet ges incitament att ge förbättrad service trots frånvaro av konkurrensutsättning. I relationen mellan Banverket och Banverket Produktion är beskrivningsbehovet mindre då de tillsammans har den data som övriga marknaden saknar.
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