

Key factors to accelerate innovation: lessons from the Dutch water and construction sector

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Summary

Improving the cooperation between government, private sector and knowledge institutes is regarded as one of the great challenges to create more innovations. By better cooperation the creativity and the quality of the sector can be optimally used which in the end will lead to smarter, cheaper and quicker solutions.

Therefore it is regarded important to study more closely how a more efficient cooperation can be reached and to find out which barriers need to be overcome to make this possible.

The Ministry of Public Transport and Water Management and the Network Deltatechnology have therefore started a study to gain more insight in the system of innovation in the cooperation between government, private sector and knowledge institutes. The goal is to identify the most important barriers that are seen in the practice of innovating in the water and construction sector. Based on those barriers a systems analysis is carried out to gain insight in ways to cooperate and in conditions that may improve this cooperation.

This has resulted in eight key factors that can be influenced to come to a better cooperation and to overcome barriers. These key factors all appear to be related to the barriers return on investment and the risk distribution. Recommendations are given how and by whom this key factors can be influenced and how the barriers can be dealt with.

References

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1 Introduction

1.1 Background

At the moment, a better collaboration within the triangle government – business community – research institutes is considered one of the major challenges to achieve more innovations. The so-called Topteam Water, a committee of water experts that recently advised the Dutch government how to improve the export position of the Dutch water sector, and the Dutch Ministry of Economic Affairs, Agriculture and Innovation have stressed the importance of this collaboration repeatedly. The Ministry of Economic Affairs, Agriculture and Innovation even uses the words *golden triangle* when referring to this collaboration. The water sector can make the most of its creativity and quality to achieve smarter, cheaper and faster solutions by working together within the triangle.

There are obstacles that negatively affect or even hinder the collaboration within the triangle. That's why the cluster Market and Alliances of the Corporate Innovation Programme of Rijkswaterstaat and the Working Group Innovation Acceleration of the Deltatechnology Network took the initiative to analyse the system of innovating within the triangle. Obstacles and key factors to achieve innovations have been brought to the fore. Subsequently, ways have been assessed how those involved within the triangle can deal with these obstacles. With that, learning experiences from practice have been used as much as possible.

It is in the interest of all stakeholders within the triangle to deal with these obstacles in a smart way and thus mutually strengthen their power to innovate:

- The government gets innovative (better) solutions for social issues at a better quality – costs ratio, and thus better social yields;
- The business community gets an innovative home market that strengthens the export position;
- At research institutes goal-oriented knowledge development gets an impulse due to successful innovations.

1.2 Aim

This system analysis and assessment of obstacles aims to generate insights into the factors that contribute to a better collaboration within the triangle of Dutch authorities – business community – research institutes to achieve innovations. With that the assessment of the so-called key factors is at the centre stage: factors that can be influenced to make the most of the creativity and knowledge of the private sector and the research institutes to achieve smarter, cheaper and faster solutions. In addition, this study aims to formulate strategies to help those involved dealing with a number of these obstacles.

1.3 Reading instruction

The most important themes that play a role in innovating within the triangle that result from the interviews are:

- Cost recovery models and dealing with transaction costs
- Dealing with risks and their distribution
- Culture en procedures
- Competences

Through interviews (all four themes) the obstacles to achieve innovations have been inventoried and are presented in chapter 3. Through a system analysis eight key factors have been defined through which the process of innovating within the triangle of government, business community, and research institutes can be influenced (chapter 4). Both the perspective to act from these key factors and the dilemmas that go with them are presented in chapter 5. In chapter 6 recommendations are presented on how to deal with these obstacles classified in the four themes mentioned above.

2 Method

2.1 Interviews

Several people from the Dutch business community, government authorities and research institutes that are involved in innovating within the triangle from different perspectives have been asked about obstacles in effective collaboration within the golden triangle, steps that can be taken to deal with these obstacles, and examples from practice for learning experiences. Annex A presents an overview of the interviewees.

2.2 Systems analysis

A systems analysis of the cooperation structure between these three parties was carried out based on a number of interviews. Firstly, an inventory was made of the main barriers experienced. Secondly, a number of causal loop diagrams portraying the main mechanisms of the system were built in order to discover the most important leverage points for effective innovation and on this basis propose a number of changes and boundary conditions needed to promote a faster adoption of innovative technologies in the sector.

Leverage points are factors that have a high multiplier in the performance of the system; and on which therefore efforts should be concentrated in order to have the maximum effect on the innovation performance of the sector.

These key factors stem out from the mechanisms discovered, which in combination determine and drive the behaviour of the system, explaining its poor performance in terms of innovation. These key mechanisms refer to two themes:

- Cost recovery models: ensuring enough deal flow and dealing with transaction costs
- Risk allocation in contracts

This is why Causal Loop Diagrams (CLD's) are only to be found on these two themes, and not on the other two; culture and procedures and competences.

The causal relations and dependencies between all factors that play a role in innovating within the triangle have been visualized through so-called Causal Loop Diagrams (CLDs). Every system behaves in a certain way due to the factors that influence the system. Some of these influences can be altered or minimized, some not. The Causal Loop Diagrams show how a series of factors/variables influence one another and thus form a sequence of causes and consequences (variable X on variable Y, variable Y on variable Z, etc.). By studying these sequences or mechanisms, the resulting behaviour and performance of the system becomes clear. This method allows for the study of complexity. Thanks to this method we are not restricted to the interaction between two single variables but the entire system and its complex dynamics can be studied.

A Causal Loop Diagram consists of a number of factors/variables that are connected with arrows in which these arrows indicate how one variable affects another. A plus sign means that when a variable changes in one direction, this also holds for the other variable. In case of a minus sign two related variables change in opposite directions.

CLDs are visual representations of cause-effect relationships in a system. Such relationships are represented by arrows between each pair of related variables and a sign -plus or minus- depending if the relationship between them is positive or negative. A (+) sign near the head of the arrow is placed if an increase (or decrease) in variable at the tail of an arrow caused a corresponding increase (or decrease) in a variable at the head of the arrow. If an increase in the causal variable caused a decrease in the affected variable, a negative (-) sign is placed near the head of the arrow. The analysis of the dynamic behaviour of the system based on CLDs is conducted by identifying all feedback loops present in the system. Feedback loops can be reinforcing or balancing. Reinforcing loops reflect positive feedback systems. They can represent exponential growth or declining behaviour over time. Unlike reinforcing loops, balancing loops reflect negative feedback systems and seek stability or return to control (Sterman 2000). The interaction and interdependencies between these loops influence the overall dynamics behaviour of the system.

Based on these insights a number of leverage points can be identified. *These are places within a complex system (a corporation, an economy, a living body, a city, an ecosystem) where a small shift in one thing can produce big changes in everything" (Meadows D. Leverage points: places to intervene in a system. Hartland, VT, USA: Sustainability Institute; 1999, pagina 1)*

Through these factors the behavioural patterns of the system can be altered. They have a high multiplier in the performance of the system; and therefore efforts should be concentrated on them in order to have the maximum effect on the innovation performance of the sector. Measures that change the value of these factors need to be formulated in order to neutralize the mentioned

3 Obstacles for the realization of innovations

3.1 Introduction

On the basis of the interviews obstacles have been inventoried. This inventory is presented and elaborated below, for the four themes that are mentioned before:

- Cost recovery models and dealing with transaction costs
- Dealing with risks and their distribution
- Culture en procedures
- Competences

For each theme a number of obstacles can be distinguished. The obstacles are numbered continuously.

3.2 Cost recovery models and dealing with transaction costs

The costs of innovative contracts and technological innovations are often much higher than those of standard projects because a new approach is needed, with different skills, that demands more time and effort of providers, and because of higher investments for the

implementation (in the case of technological innovation), such as adjustments to installations and additional research. Possible solutions are measures that reduce the costs or that assure that these investments can be recovered.

1. Value of the contract too low

The value of the contract is determined by choices such as the length of the contract, the geographical scale and the phases of the life cycle of the product in the contract. In the construction sector often a pledge is made for large, long term contracts. It is important to be aware of two opposite effects:

- Large, long term contracts do have a positive effect on the efficiency on the long term because less procurement procedures are needed, less contracts need to be managed and less transaction costs are needed. Also, contractors can offer their services for a lower price due to the size of the project.
- On the other hand, the risk of market concentration plays an important role on the long term. Large contracts limit the choice of contractors because of the needed equipment, expertise and risks involved. Often only the large contractors can execute these large projects. The small contractors are put at a disadvantage and may go bankrupt. In the next phase of the contract the larger contractors can then heighten the prize.

So, therefore it is important to find the right balance.

2. High transaction costs

According to contractors the design process goes too far at the moment in the Netherlands and their gigantic costs are by no means covered by the offered design compensation. One contracted gave an example of a road infrastructure project with almost € 13 million tender costs and a design compensation of only € 1 million. Abroad design compensations in road infrastructure projects often cover almost 30% of the tender costs.

3. Lack of deal flow

.According to the interviewees of private companies the authorities too often arouse expectations that they do not fulfil. Investing in innovation is therefore risky because the government is not consistent in their policy. An example that was mentioned a lot is the approach of the Afsluitdijk: companies were asked to present proposals but at a certain moment the authorities drew the line by indicating what was not allowed or with what measures they did not have enough experience. As a result companies will not join the next consultations. It is crucial that authorities do not arouse wrong expectations and consider the rules of engagement carefully at the start.

A way to handle this better is to create a sufficient deal flow by making innovation programmes in stead of separate projects. Also it is possible to create a large scale long term innovation programme with multiple assignors, so-called joint procurement.

4. Value of knowledge

Research and the development of knowledge are at the basis of technological innovations but who will pay for this, authorities or the business community? For companies a free flow of knowledge means giving away your position. Research institutes do have to let their knowledge flow, but if they get privatized more and more and continue to get fewer subsidies for the development of knowledge, how is the recovery of their investments guaranteed?

More knowledge of, among others, the behaviour of the natural system in which new technology is being applied, helps clients and contractors to better control risks and the final results. Knowledge, therefore, positively influences the return on their investments. Already in the phase of tendering specialist knowledge helps contractors to prepare a competitive offer; they can offer a lower premium on risks than other contractors because they control risks better.

Procedures are needed to quantify the value of knowledge in the process of tendering and to indicate to what extent client and contractor profit from this. One option is to explicitly create debits for knowledge and divide these over both parties.

5. Budgetary room in project

The less budget is available within a project, the stronger parties will withdraw to their own positions and the more they will be focused on their interests. Granting based on the lowest price often results in behaviour of heavy negotiations and “cut-throat-competition” with a negative influence on the atmosphere and trust between parties. Ample budgetary room in a project combined with a clear view on what the client wants often results in a better relation and a more proactive attitude of contractors.

The budgetary room that on average is available within a project also determines to what extent companies in a certain sector invest in R&D.

6. Monofunctionality as assumption

Cost recovery models are often calculated for one function only. However, the combination of functions can make a business case cost-effective, but only if the investment costs are being spread over several functions. Monofunctionality as assumption is an important obstacle for innovations that are focused on multifunctionality of infrastructure and where local parties play an active role.

3.3 Dealing with risks and their distribution

7. Distribution of risks a tricky issue

Many private sector players complain that they have to accept too many risks. It would be more efficient if authorities would cover these risks themselves, especially when the private sector is not capable to control some of these risks.

An interviewed contractor states that innovations in projects can only be realized in collaboration with the client and not in competition where the contractor covers all the risks, as European rules demand. An interviewed client confirms this by stating that the new way of procuring (EU rules and innovative contracts that lay down the risks at the tendering party) no longer allow real technological innovations. According to him the authorities should take back some of the control in situations where the market cannot run the risks. An interviewed consultant adds to this that the innovation risks the authorities have run in the past, have resulted in an enormous market potential of Dutch companies abroad.

8. Performance of wet infrastructure is hard to define

It is much more difficult to measure the performance of wet infrastructure (dikes and engineering works) than the performance of roads because:

- Dikes are designed for a possible disaster (and their performance only shows under extreme conditions);
- The performance is influenced by more external factors such as the weather and happenings in other regions or even abroad;
- A lot of variables determine the performance;
- The time of a contract is much shorter than the life time of the infrastructure (50 years for a dike, for instance).

Because of this, no objective, functional requirements can be called for and no performance contracts and/or D&C contracts can be closed with which contractors are settled up on the basis of performance. This is an obstacle because especially these contracts offer a lot of freedom to the contractor in the design phase, and thus room for (technological) innovation. The distribution of risks is a key factor for innovations especially in hydraulic engineering.

Also, with respect to watertechnology, innovations on deltatechnology (including hydraulic engineering) are much harder to realize, due to differences in scale. Water purification processes, for instance, are so controlled that laboratory results can be translated to practice fast. In deltatechnology there are far less predictable processes due to the characteristics of the subsoil. An interviewed contractor adds to this that in hydraulic engineering safety and major consequences are at stake if things go wrong; contractors tend to choose the familiar old system that they know how to control.

9. Focus on risks

Technological innovation asks for knowledge of the natural system and the interaction between the system and the infrastructure. The attention to risks is very different.

Research institutes must be mobilized to visualize risk categories and to determine who could run the risks best. They must also be able to start the discussion on how to deal with the risks to be able to control them. The obstacle is that employees of research institutes often lack the right competences for this. Needed are:

- A more process-oriented and solution-oriented approach, instead of an analytical approach focused on the details behind the comma;
- A different personality that thinks in terms of challenges instead of threats;
- More focus on sensitivity analyses (20-80% rule) and dependencies in the system

Also between contractors the attention to risks is very different. More knowledge on risks may harm a company because it may lead to a more expensive tender and thus a relatively bad position in the competition with others. Companies that are not good do not see the risks. Companies that are good do see more risks and are more expensive because of that. On the longer term authorities benefit from a company that has a better view on risks and is therefore more capable in dealing with them adequately.

10. Extreme risk aversion at all parties

Innovating means you have to accept risks. All parties involved must accept that in order to innovate investments are needed in experiments that can fail. In practice there is often (extreme) risk aversion at all parties involved that makes it impossible to get innovations going. Clients appear unwilling to commit themselves to a large number of these projects. This aversion affects private parties and research institutes. Those involved reinforce each other's perception of risk and capture one another in a vicious circle in a context where failures cannot be explained politically and are no longer accepted.

11. Once-only contracts

This obstacle is closely related to the key factor *Number of similar projects to be tendered in the future* (see 3.4). Once-only contracts and the lack of a continuous flow of assignments result in quality risks for the client. In the public water domain there are, in fact, too few clients which causes an imperfect market. The contractors thus rely on a limited number of clients. The assignments are large, there is a lot of debate, and then all over a sudden there is a tender. There is no room to practice; you have to deliver at once. But you need, in fact, repeated assignments to improve yourself. Due to the lack of a continuous flow of assignments there is no continuous process of improvement. This brings risks to the clients. Authorities can deal with this obstacle by cutting an assignment into pieces or by getting contractors involved in an earlier stage of the tender process (early contractor involvement).

12. Contracts fixed too much in an early phase

The longer the term of a contract is the more financial certainty for a contractor to invest in new technologies. There is, however, also an important dilemma related to long-term contracts. On the one hand it is advisable to fix agreements in contracts as detailed as possible so that the obligations of client and contractor are clear. On the other hand sufficient flexibility is needed to accommodate changes in the context. Summarized by Baird (1990, p. 586)¹: *'This tension between the need to fix responsibilities at the outset and the need to readjust them over time permeates the long-term contractual relationship'*.

The importance of sufficient flexibility increases with the innovative character of projects, when the effect of proposed, innovative techniques and their impact on the long-term performance of infrastructure are less well known in advance. Therefore, not only the contract but also the mutual relationship is important for the parties involved. From interviews with clients and contractors it is clear that trust and good mutual relations are essential to them. Contractors state the government's culture is focused on judging contractors on their results, while collaboration with the market asks for a more flexible approach.

13. Limited design freedom

In interviews officials of Rijkswaterstaat brought some additional obstacles to the fore, such as the procedures that have to be followed at a TRACE-decision, and the fact that the introduction of new forms of contracts is not advanced at the same stage at all authorities. The latter could result in tensions at joint assignments with other authorities. The method of tendering based on functional specifications and letting assignments go is much further advanced at Rijkswaterstaat, for instance, than at provinces. In some cases the differences were so large that a project had to be cut in two: one project by Rijkswaterstaat and one by a province.

¹ Baird, Douglas G. (1990), 'Self-Interest and Cooperation in Long-Term Contracts', 19 *Journal of Legal Studies*, 583-596.

In the current way of tendering all contractors have to draw up their proposals in full details. This not only raises the costs for preparing tenders but also restricts the design freedom of the contractor to be selected. According to clients an additional problem is the fact that the design freedom is often not surpassed to subcontractors, resulting in the design freedom not being applied further on in the chain.

3.4 Culture and procedures

14. Intellectual property rights

The dilemma of how to address intellectual ownership is an issue for especially the water and construction sector, in which innovating in practice is common and it is easy for other companies to 'copy' innovations. It is therefore difficult for the innovator to gain a return on investment. According to an official of Rijkswaterstaat (August 2011) it is *"very difficult to register and protect innovations in the infrastructure sector. That is why these have to be recovered in the same project or programme"*.

Authorities can win parties over by financing part of the investments themselves and/or by granting parties a competitive advantage. This is highly debated, however: innovations that have been realized with tax payer's money should be part of a "level playing field". However, for a private party this means that his knowledge and experience can flow to other parties and he loses his competitive advantage.

It's up to the authorities to decide how innovations can be achieved within the current rules while the authorities have to put out to tender contracts in competition. According to contractors the Dutch authorities are too stringent in not allowing companies to make a profit out of authorities' investments. Elsewhere in Europe authorities focus more on the export potential of innovations and the advantages of having strong innovative companies. Officials of Dutch authorities are also aware of these advantages though: *"Intellectual ownership rights have a price. If companies can use that knowledge again, future contracts will be less expensive for us"* (Rijkswaterstaat official, August 2011).

15. Lack of empathy

The own interests, self-preservation and continuity of all parties in the triangle are at centre stage. All the parties involved within the triangle have their own interests. Basically, contractors want to make money by running the concrete mixer and consultants by making many hours. Research institutes want their knowledge to be used and thus prove their right to exist. Authorities want to run as little governance risks as possible. These different interests lead to a 'natural' field of tension. If all those involved are aware of each other's interests and are willing to give in, this can be dealt with very well. Lack of empathy is an obstacle that was mentioned in almost every interview.

This obstacle has several consequences:

- *Focus on own scope and authority*
All those involved have a strong incentive to stay within their scope. This behaviour impedes the realization of innovations. A wider scope of a project, for instance, may lead to delay when more functionalities are covered, which alters the risk profile of the project.

- *Prejudices about each others role*
Also, a lot of prejudices about each others role in the process exist. It is obvious that the contractors want to earn money, the same way it is obvious that the clients want to avoid as many risks as possible. It is an scientific challenge to overcome the deadlock between these parties. Getting into a real dialogue with each other and becoming more familiar with each others drivers by showing interest in each others goals may help in this process.
- *Lack of granting each other some profit*
One party fears that another may make a profit out of an innovation. Parties do not grant one another some profit. This is apparent in the entire chain, both from authorities to the business community and from contractors to subcontractors (60% of the work is subcontracted). Therefore, a lack of focus on opportunities is present in the entire sector. This mechanism is even reinforced because all parties in the triangle are cutting down: authorities have to do more with less, research institutes are confronted with shrinking budgets and companies are focused on surviving the crisis. All try to use the available room in budgets as much as possible. Innovations used to be realized by jointly stretching the ceiling but parties are now too conservative for this.
- *Insufficient sharing of problems*
People are scared to show their vulnerable site and therefore do not talk about the problems they face. People should adopt a more vulnerable position and take more time to get to know each other.

16. A strong focus on a ministry's own competences

Within authorities the principle of "freedom" is often interpreted as "mind your own business" and "do not interfere in the responsibilities of someone else". Because of this a client such as Rijkswaterstaat often doesn't want to consider other functions in its projects that may lead to discussions on competences.

17. A strong focus on transaction costs instead of transaction benefits

Both clients and big private (monofunctional) companies focus too much on transaction costs, the costs for coordinating action between parties. This leaves too little room for incentives to collaborate with more parties and find bottom-up solutions. After all it takes time and money to collaborate, which therefore should be kept to a minimum, is the idea. Big private parties that are qualified for large-scale contracts are often active in one sector (construction) and have little eye for the combination of functions.

18. Fear for market concentration

There is a constant tension between the advantages and disadvantages of large, long-term contracts. On the one hand these contracts restrict the transaction and tender costs (and even the production costs). Also, contractors are more stimulated to innovate because there are more opportunities to gain a return on investment. On the other hand, there are harmful consequences such as a concentration of the market. Smaller market parties may be disadvantaged and go bankrupt. This may result in less competitors in the market and higher prices for the government in following contracts. Also there is a tension between the capability to innovate versus other interests of authorities: innovating calls for long-term relations and partnership while authorities do not wish to commit themselves to one party but keep open several options and stick to competition. Creating parallel markets may be a way to deal with

this obstacle. An explicit distinction is made between projects that must stimulate innovation and projects to enhance the market competition.

3.5 Competences

19. Little knowledge of each other's worlds

Clients and contractors keep one another in confinement of ignorance because they do not know each other's worlds. A contractor often knows too little of governance, a civil servant often knows too little of technique, and financial/ legal experts involved on both sides often know too little of both.

20. Problem definition and functional specifications are tricky

Authorities are not transparent enough about what they want. They often do not know very well what they want, and when they do they hesitate to speak out clearly. Good governmental frameworks are lacking.

It is difficult to develop performance indicators for innovations that are not there yet. You don't know how the innovations work and how they are affected by their surroundings. Because of this companies get less design freedom than they might get otherwise. This makes the room for solutions look smaller than it actually is which impedes the creation of innovative solutions.

21. Companies find it difficult to translate knowledge to other projects

Companies are insufficiently interested and insufficiently capable in translating knowledge to other projects. Especially the translation of knowledge from large projects to smaller ones appears to be difficult: small and large do not mix easily. The question is how small projects can benefit from learning experiences of large projects.

22. Not all clients are sufficiently professional

Projects in the water and construction sector are often complex. Being a good client therefore requires a large number of skills and profound knowledge of multiple disciplines such as legal, financial, technical, risk management knowledge.

Some clients are not capable to be a professional client because of too little experience with the assignment at hand. Not every municipality, for instance, is capable to judge what is and isn't needed when building a bridge when this is a one time only project for them. The client will tend to believe those who say that something is not needed. This impedes room for innovations.

Another issue is that clients often already think in solutions in stead of problems. A good formulation of the problem at hand is quite a challenge but can create more space for solutions than when clients already start thinking about solutions.

23. Lack of knowledge leads to lack of vision and guts

To master the steps from an innovative idea to the implementation of an innovation it is important to have a coherent vision on the innovation. This vision must provide a long term perspective for the innovation and must be able to make people that are involved in the process enthusiastic. To accomplish this visionary people with charisma are needed that have sufficient knowledge to make hard choices when needed.

24. Lack of valorisation

Too little knowledge that is developed at universities and knowledge institutes is applied in practice by contractors and governments. Two important reasons for this problem are the lack of entrepreneurship at the knowledge institutes and the lack of communication between the knowledge institutes and the private companies.

A way to handle this barrier would be to encourage PhD students to include a valorization paragraph in their thesis to stimulate them to place their results in a commercial perspective.

4 Systems analysis: Key factors for the realization of innovations

4.1 Introduction

Companies need to invest more in innovations than in standard projects. The decision whether or not to invest not only depends on the return on investments within a given project, but especially on the number of future projects to be tendered where the innovation can be applied. The future return on investments is often uncertain. That is why the following question is crucial: What factors are key in the cost recovery model for these investments?

Three key factors are important for the return on investments within a certain project: (1) *The value of the contract*, (2) *the costs of preparing the tender*, and (3) *the percentage of the performance risks assigned to the contractor* (figure 1). For the future return on investments, two key factors are important: (4) *The number of similar projects in the future* and (5) *the competitive advantage of the company applying the innovation for the first time* (figure 2). In addition to these key factors on the return on investments three key factors have been defined that are crucial for dealing with (the sharing of) risks, namely (6) *the continuity and consistency of government policy*, (7) *the budgetary room within the project*, and (8) *the design freedom granted to contractors*.

All these factors are crucial for the decision whether or not to participate in an innovative process.

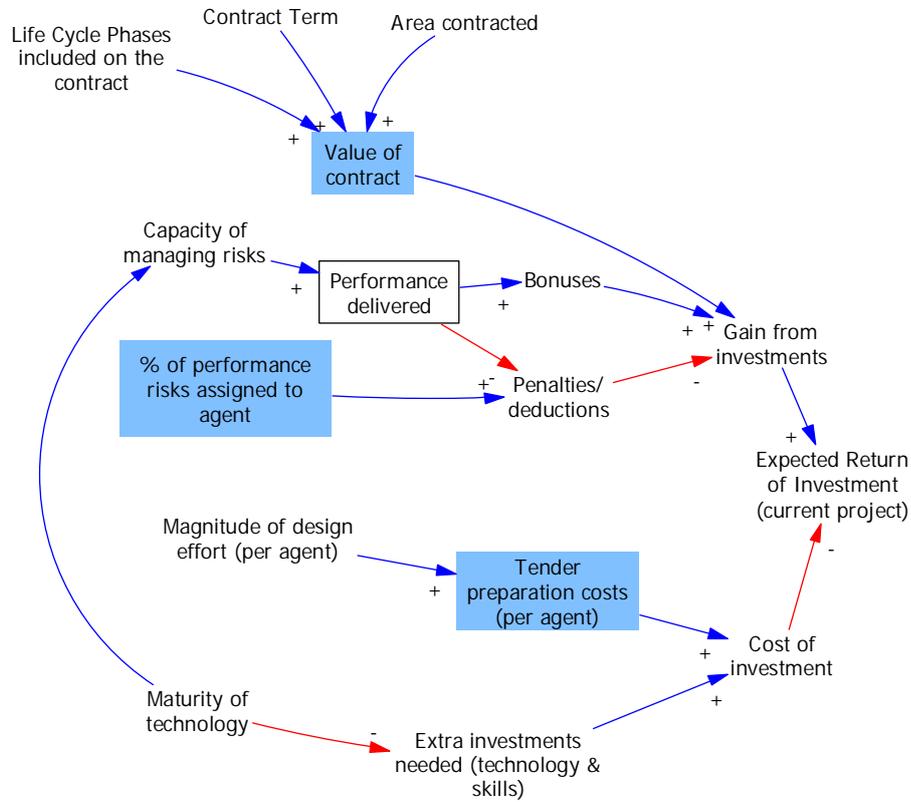


Figure 1. Causal Loop Diagram for the return on investments within a current project.

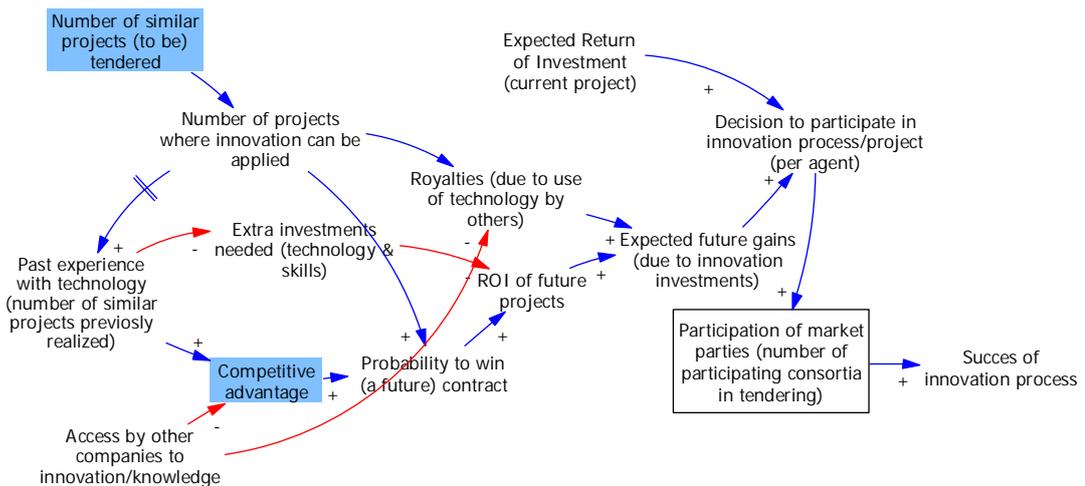


Figure 2. Causal Loop Diagram for the total return on investments of innovations, both within a project and in the future.

4.2 The value of the contract

The dilemma of the distribution of risks is illustrated in figure 4. More risks assigned to the contractor should lead to less cost overruns, and thus a higher efficiency in the use of public funds. If the contractor is not capable of controlling the risks, however, he will charge a risk premium, which reduces the efficiency in the use of public funds. Contractors act as insurance companies and innovative contracts are not meant for this.

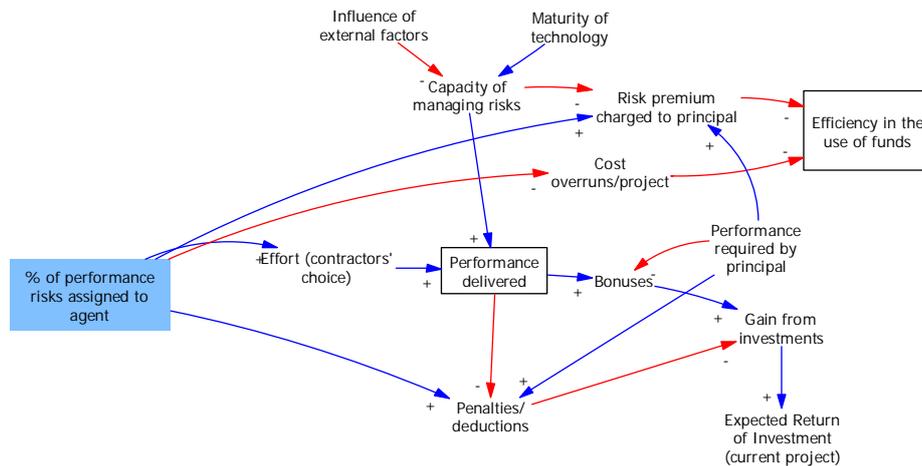


Figure 4. The Causal Loop Diagram for the dilemma how risks can be spread better in order to use public funds efficiently.

4.5 Number of similar projects in the future

With this key factor the magnitude of future benefits of innovations can be influenced. In combination with the key factor competitive advantage of companies can be increased and with that their chance to actually win future projects. Market parties could also be offered the advantage of licences with royalties each time innovations are applied by others. Winning ever more similar contracts strengthens the return on investments: each new project (n+1) asks for less extra investments (in technologies and skills) and reduces the transaction costs even in the tender phase.

4.6 Capability to distinguish

Capability to distinguish is a competitive advantage for companies. It is problematic to maintain the competitive advantage of companies for a long time. This is due to rules (authorities strive for a level playing field) and technological characteristics of the sector, especially within the sector Deltatechnology.

4.7 Continuity and consistency of government policy

In view of the relatively high costs of innovative solutions it is very important for companies to have the prospect of additional future applications to recover their investments. The continuity and consistency of government policy, therefore, is a key factor in cost recovery models

(figure 5). This key factor is being influenced by other factors, especially with respect to expectations raised at contractors, competitions, and the way of communicating between authorities and companies. Also important is the success of innovators within government organisations, usually freethinkers that often cannot get their ideas through the so-called “bureaucratic wall”.

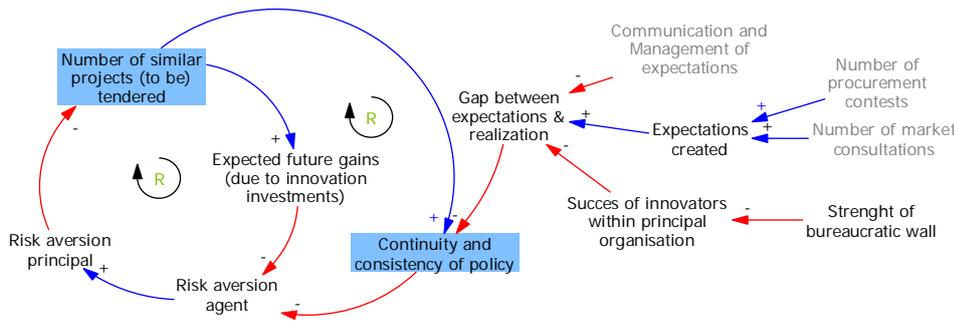


Figure 5. The Causal Loop Diagram for continuity and consistency of government policy.

4.8 Budgetary room in a project

More budgetary room in a project (figure 6) may lead to a better and smoother relation between client and contractor. Due to a positive influence on the contactor’s attitude he will put more effort into reaching a good result. This increases return on investments and strengthens the positive relation between client and contractor. Vice versa a limited budget may lead to a worsening relation and distrust between client and contractor.

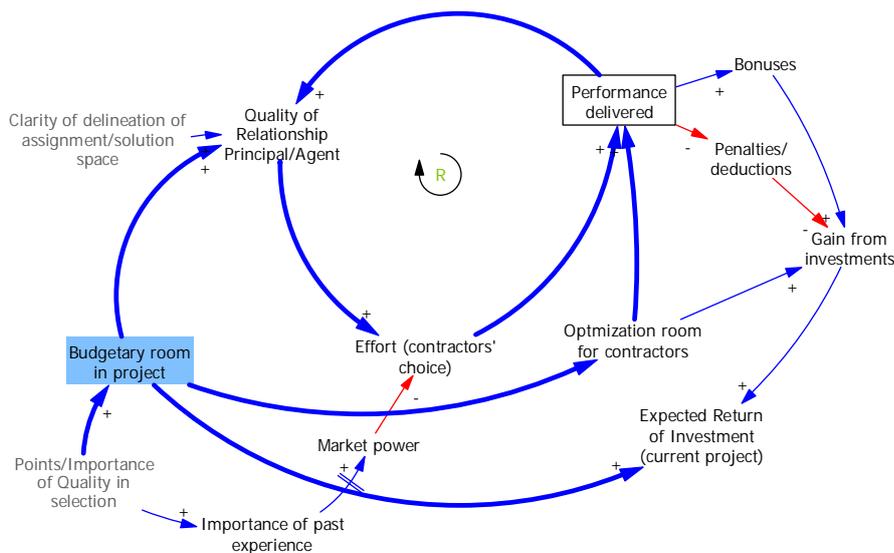


Figure 6. The Causal Loop Diagram for the influence of budgetary room on the relation between client and contractor.

4.9 Design freedom assigned to contractors

Innovative contracts (see box 1) aim to increase the freedom of design of contractors. Thus, contractors get more room to use their expertise and creativity and deliver a better performance (figure 7). More freedom is accompanied with a higher level of responsibility. Clients stimulate contractors to use their elbow room effectively and deliver an optimum performance by passing on a larger part of the performance related risks to them. If they do not deliver, they will be confronted with the consequences through a bonus/malus system. The performance not only depends on the efforts of contractors and their elbow room, but also on their capability to deal with the risks of the project. This capability is limited if the project is strongly influenced by external factors and/or uses a relatively new technique. In that case it is much harder to hold contractors responsible for the overall performance of the infrastructure (project).

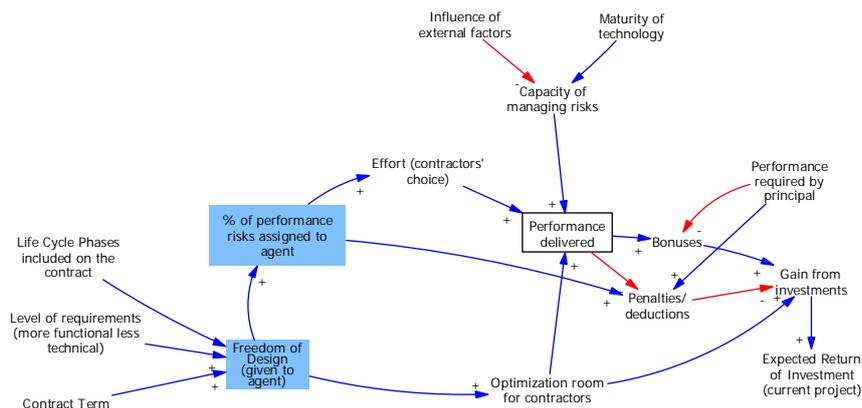


Figure 7. The Causal Loop Diagram for the distribution of risks in innovative contracts.

It is not enough to give contractors more design freedom or more rights to decide with respect to techniques and methods they can use for the implementation of the project. The term of the contracts also has to be long enough to provide them with the financial security that is needed to invest in new technologies and means of production (figure 8). Alternatively, payment mechanisms or other economic incentives can be included in the contract to stimulate these investments in new technologies.

In practice clients appear conservative in giving more design freedom to contractors. This is because of resistance at clients against change, because experience needs to be gained with new types of contracts (functional specifications), because client and contractor lack historic information on life cycle costs and infrastructure performance, and because it is easier to compare tenders on the basis of price than innovation.

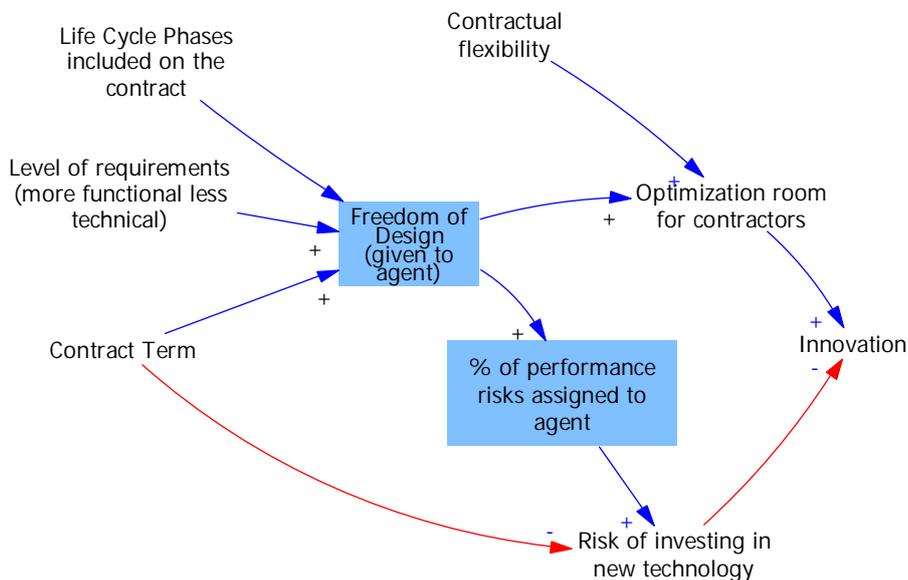


Figure 8. The Causal Loop Diagram for essential boundary conditions for innovation: design freedom and (long-term contract) flexibility.

Box 1. Innovative contracts

Authorities change the way they commission assignments. Four developments in the infrastructure procurement process can be perceived:

- Integrated contracts that combine several phases in the life cycle of a road. Design-Build or Design-Build-Finance-Maintain, for instance, instead of Design-Bid-Build;
- Contractors are given increasingly more freedom of design as the indicators used for monitoring their work become less operational and more performance based. Functional specifications are been adopted instead of technical requirements
- Long-term contracts;
- More projects are financed or pre-financed by private investors, such as under DBFM contracts.

With these innovative types of contracts the client expects to achieve more flexibility, more innovation, and a better performance against lower costs, without the public interest being jeopardized. Empirical research, however, shows that innovative contracts create more room for opportunistic behaviour of the contractor because of which the public interest may indeed be jeopardized (Altamirano et al. 2007)

In innovative contracts considerably more risk is transferred to private contractors than under traditional Design-Bid-Build contracts, and a reasonable price has to be paid for this. Innovative contracts have a different mechanism to stimulate the market: they are often based on fixed price agreements (lump sum) in which the winning provider determines his own profit margin. Besides, no longer a 'product' or the delivery of a concrete business or facility is being purchased, but a 'service' and, more important, the availability of the service for a number of years. The running time of innovative contracts is often longer, from 3 to 5 years, and sometimes up to 30 years.

Because of these differences more risks are being passed on to contractors for which a reasonable price has to be agreed upon in advance. Innovative contracts also mark the

beginning of a new attitude of steering contractors from a distance. This means less possibilities and authority for public clients to influence the construction process or to steer the contractor towards a preferred direction. Also more aspects have to be agreed upon in advance than in traditional contracts.

5 Key factors and the perspective to act

5.1 Eight key factors to realize innovations

In the previous chapter eight key factors to realize innovations have been identified. Causal loop diagrams have been used to analyze how these key factors and other factors in the innovation process influence one another. The table presents a summary of the results.

	Key factor	Is being influenced by	Influences
1	Value of the contract / magnitude of the assignment	Different life cycle phases in the contract, running time and area of the contract	The expected return on investments in a project, the decision of a contractor whether or not to participate in an innovative project/process, and the number of competitors
2	Tender preparation costs	The magnitude of the contractor's design effort in the tender phase, and thus the design freedom granted to the contractor and the phase in the design process when the winner is chosen	The investments that are needed to participate in an innovative project/process and the expected return on investments in a project
3	Percentage of performance risks assigned to contractor	The design freedom granted to the contractor and the risk aversion of the clients	The delivered performance, budget overruns, risk premium in the contract, the risk parties are willing to take with the new technology, application penalties, and the decision of a contractor whether or not to participate in an innovative project/process
4	Number of similar projects in the future	The risk aversion of the clients	Future return on investments, the decision of a contractor whether or not to participate in an innovative project/process, and the risk perception of all parties involved ²
5	Capability to distinguish (competitive advantage)	Access of other companies to the innovation/knowledge and	Future return on investments, the decision of a contractor whether or not to participate in

² Room for practise is lacking, you have to deliver at once. But you really need repeated assignments to improve yourself. Due to the lack of a continuous flow there is no continuous process of improvement, leading to risks for the client.

		the number of similar projects that has been realized before	an innovative project/process
6	Continuity and consistency government policy	The gap between expectations and realization, and the number of future projects in which the innovation can be applied	The clients' risk aversion and the decision of a contractor whether or not to participate in an innovative project/process
7	Budgetary room in a project	Importance of quality in selection	The quality of the relation between client and contractor, the contractor's elbow room to optimise an assignment and the actual performance that is delivered ³
8	Design freedom granted to a contractor	The different life cycle phases in a contract, the contract's running time and the abstract level of contract specifications	The contractor's elbow room to optimise an assignment, the percentage of the performance risks assigned to the contractor, the tender preparation costs and the room for opportunistic behaviour

5.2 The perspective to act through key factors

Once you know how key factors function in innovation processes you can use these factors as buttons and turn them to stimulate innovations within the triangle of authorities, companies and research institutes. Both authorities (the client), companies (the contractor) and research institutes come to the fore in this: all, more or less, have a perspective to act. This perspective is summarized below.

Factor 1. Value of the contract / magnitude of the assignment

The client can close long-term contracts for each project including different life cycle phases of the assignment to be realized. He can also add a pilot to an innovation path for each project to make it more interesting for contractors. For the long-term he can enlarge the scale of assignments and cluster several assignments or activities, or add a long-term maintenance component to the construction. An additional advantage of clustering projects is the stimulation of the learning process: several projects allow companies to learn from them and improve their performance.

The client can avoid the disturbance of competition due to concentration of the market by keeping parallel markets in place (large and smaller assignments) and granting projects to both markets; explicit choices have to be made in this for projects that serve the purpose of stimulating innovations and projects that stimulate competition.

³ Assigning projects based on the lowest price often results in heavy negotiations and "cut-throat-competition" that negatively influences the atmosphere and trust between parties. Sufficient budgetary room in a project combined with a clear vision of the client's goals often result in a better relation with a proactive attitude of contractors.

Factor 2. Tender preparation costs

The client has several alternatives for each project to lower the costs: he can compensate (part of) the design, he can choose a party earlier in the design process and continue with this party only, and he can demand full documentation of a tender from the winner only. For the long-term he can use uniform contracts in which the same approach is used more often.

The contractor can present his transaction costs more clearly and transparent for the long-term.

Factor 3. Percentage of performance risks assigned to the contractor

The client can start alliances with contractors for each project (share risks), or commission a focused development assignment (and run the risks himself). He can also follow a stepwise approach in which the rest of the work can be realized the familiar way in case a technical innovation fails. For the long-term he can use the knowledge of research institutes to clarify risk categories and the parties that should run these risks.

The client and contractor can collaborate more for the long-term to control risks and work more according to rules of engagement.

Research institutes can find a good balance between visualizing and controlling risks, both for each project and for the long-term.

Factor 4. Number of similar projects in the future

The client can increase the number of similar projects in the future and the capability to distinguish of companies by granting a programme with a sequence of projects instead of each project separately, and through joint procurement with a number of clients. He can also make good agreements with contractors on intellectual property rights. Companies can strengthen these key factors by delivering an innovation at a lower price to those authorities that participated in an innovation process.

Factor 5. Competitive advantage

The client can make good agreements on intellectual property rights for each project in advance, for instance by assigning these rights to the companies involved for a certain period of time, by using an agreement Intellectual Ownership, or by using open licences.

The contractor can deliver an innovation at a lower price to those authorities that participated in an innovation process, for the long-term.

Factor 6. Continuity and consistency government policy

The client can manage expectations well for each project, by not starting consultations with companies too early but first organizing a good 'internal governance alliance'. He can also agree clear rules of engagement in advance, taking in consideration the interests of the contractor as well, clearly define his assignment, and make a clear distinction between requirements and wishes.

The client can decide upon a pipeline of projects or a programme for the long-term.

The contractor can adapt a more forceful attitude by asking questions about the follow-up of a project. He can also present the transaction costs more clearly (transparent).

Factor 7. Budgetary room in a project

The client can use criteria for the 'economically most advantageous tender' (EMVI) when assigning contracts. In this not only the price but also qualitative criteria related to sustainability, project control, and the way a project aims at an audience are important. By using these (EMVI) criteria the elbow room of contractors can be enlarged and budgetary room can be created for innovators to recover their investments.

Factor 8. Design freedom assigned to contractors

The client has several alternatives for each project to increase the contractor's design freedom. He can choose a party earlier in the design process and continue with this party only. He can follow a new approach that allows him to get companies involved in an earlier phase of the design process.

5.3 Dilemmas related to key factors

Factor 1. Value of the contract / magnitude of the assignment

Risk of market concentration. Raising this key factor positively affects the expected return on investments (lower transaction, tender and even production costs), but may negatively affect competition on the long-term (market concentration).

Factor 3. Percentage of performance risks assigned to contractor

Return on investments versus incentive to perform. The dilemma of this key factor is the fact that the percentage of performance risk assigned to a contractor not only restricts his return on investments, and thus his choice whether or not to participate in an innovation process, but also is the most important incentive to make him perform well.

Alliances versus competition. A similar dilemma is the choice for alliances and long-term relations. Innovating asks for long-term relations and partnership (among others the term to recover costs and the sharing of risks), but authorities do not want to fasten down to one party and keep options open through competition.

A higher price for more risks. More risks assigned to a contractor should lead to less budget overruns and, therefore, a more efficient use of public funds. If the contractor is not capable of controlling the risks, however, he will charge a risk premium, which reduces the efficiency in the use of public funds. This way contractors act as insurance companies and innovative contracts are not meant for this.

Factor 5. Capability to distinguish

Legitimacy subsidies to develop innovations. How can authorities make sure that innovative products that have been developed with public funds are part of a level playing field instead of being exploited by one party only?

Factor 6. Continuity and consistency government policy

Whether or not to invest. Participants (private parties) have to invest more in innovative projects than in standard projects while the number of future projects in which the innovation

can be applied is uncertain. Continuity and consistency of government policy plays an important role in this.

6 Conclusions and recommendations for dealing with obstacles

6.1 Introduction

Two subjects that keep coming back in the discussion on increasing the capability to innovate through collaboration in the triangle are cost recovery models and dealing with (the distribution of) risks. Having insufficient eye for these subjects leads to a deadlock that hinders the realization of innovation.

6.2 Cost recovery models and dealing with transaction costs

Fiddling with key factors. The following three factors determine the expected return on investments of a project, the most important criterion for private parties when deciding whether or not to submit a tender.

- The value of the contract or magnitude of the assignment;
- The costs for preparing the tender;
- The percentage of the performance risks assigned to the contractor.

The client can take measures within his purchase strategy to raise the first factor and lower the last two. A balance needs to be found for each choice (key factor). Fiddling with the key factors 1 and 3 may have both positive and negative effects. Key factor 3 not only affects return on investments, and thus the contractor's choice whether or not to participate in an innovative process, but is also the contractor's main incentive to perform well. The raise of this percentage over the last decades is the logic result of the introduction of innovative contracts. The more freedom of design and room to manoeuvre a contractor gets, the larger his responsibility for the performance to be delivered.

6.3 Dealing with risks and their distribution

Alliances. A new way of collaborating is needed in which performance related risks are shared and controlled by the parties involved in a different way. An alliance model may be effective (figure 9), an alliance being defined as:

'Mutually organizing a collaboration in which benefits and disadvantages are shared such that during the collaboration the interests of the parties involved run parallel⁴.' An alliance is thus about a collaboration where the profit of one party does not mean a loss for the other party.

⁴ Chao-Duivis, M. A. B., J. G. J. Janssen, et al. (2008). *Assessment of the options to apply ALLIANCES by Rijksgebouwendienst (a study on characteristics and aspects of alliances)*, Rijksgebouwendienst: 105.

In an alliance model client and contractor share a larger part of both performance related risks and benefits. This way the alliance model solves the dilemma of the distribution of risks in innovative contracts. Alliances restrict the risks of the innovation process for private parties by reducing their share in the risks and by restricting the financial consequences of failure. Meanwhile the incentive for the contractor to realize a successful project remains. In the words of an interviewed consultant: *'I do believe in economic incentives. If we perform well together, we share the profit. If we fail together, we share the additional costs.'*

An interviewed constructor stresses the importance of the 'human factor' in successful alliances: *'The people that client and contractor bring forward have to match.'* According to an interviewed consultant research institutes should *'stand close to the authorities, help them to find the right companies, and take more risks together with them.'*

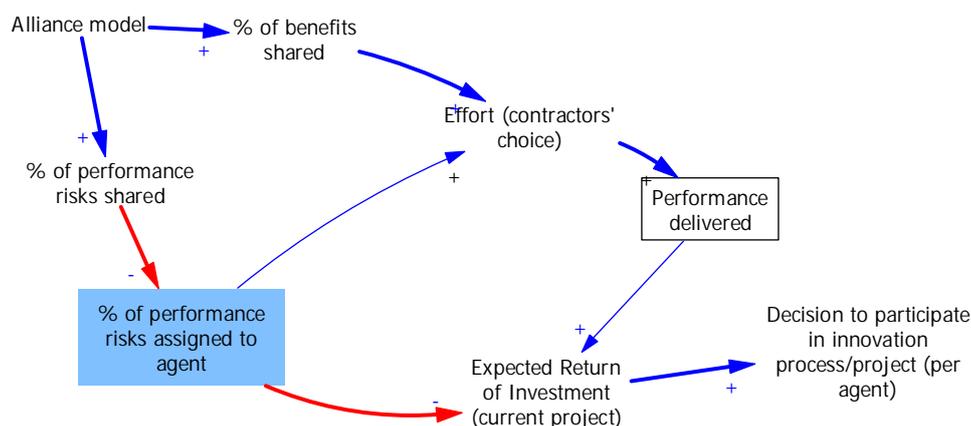


Figure 9. Causal Loop Diagram of the effect of the alliance model.

The alliance model could be a way to realize more flexibility in the contractual relation between client and contractor by:

- Not fixing all the details in the contract but making good agreements on rules of engagement;
- Having more eye for the relations between parties, following the principles of solidarity between parties and thinking in terms of give and take;
- Accepting that not all possible future events can be foreseen.

More research is needed into ways of increasing the freedom of design of contractors within the boundaries of EU legislation. A client could choose one party earlier in the design process, for instance, and work out the details of the design with this party only. Also a new market approach could be followed that allows the involvement of companies in an earlier design phase (such as interweaving tracé/m.e.r. procedures).

Best Value Procurement. Alliances ask more capacity of authorities, however, due to management guidance and knowledge with respect to the content. The availability of both is restricted at the moment. This problem could be covered with the method of Best Value

Procurement (BVP). BVP offers clients more certainty that the final goal will be reached within the agreed costs and time, and at the agreed quality, with a minimum effort and control of the client. BVP offers contractors the opportunity to show their expertise. BVP raises the efficiency and effectiveness in the entire chain. The 'expert', for instance, is selected by means of a number of filters (among others past performance measure, risks and possibilities file, interviews, pre-award/start up phase) and gets elbow room (by putting trust in him/her and by measuring the performance weekly). BVP is based on taking responsibility, dominant information and measuring performance. This leads to more transparency, also in the risks and how to control them.

6.4 Culture and procedures

According to some interviewees transaction benefits should be more at centre stage. This requires a paradigm shift towards a new economic model. Parties that work together in a project often continue that collaboration in other projects and thus save money. Besides they find solutions that are more efficient at the level of the system. In business cases according to this new model also the added value, including long-term effects, should be included.

The implementation of this new economic model could mean a restructuring of the purchase strategy of authorities: giving rights to local parties (through cooperatives and local authorities) instead of large-scale contracts in full to large operators. The way the authorities currently operate as a client must change. Possible options are:

- Introducing organizational incentives that stimulate project managers to widen their scope and/or incorporate other functions as well. A premium arrangement, for instance, or additional criteria in the performance measure of project managers, or extending the term to deliver innovative projects. Also explicit criteria related to innovation purposes could be included in Service Level Agreements between, for instance, Rijkswaterstaat and the ministry EL&I.
- Explicitly paying attention to the benefits of multifunctionality. Savings, for instance, through synergy between subsystems and functions, and reduction of environmental effects of infrastructure.
- Incentives at the central level for collaboration between ministries. By calculating savings not just for each ministry, for instance, but for the entire national infrastructure portfolio.

6.5 Competences

Making functional specifications is difficult and asks for other competences than traditional contracts. This holds for all parties: those involved must focus together on the functional requirements, the design, and the management of innovations (and removing any possible barriers). Besides knowledge with respect to the content the capability is needed to think abstractly. Research institutes must support authorities in this. All those involved must be able to understand what drives the other parties. The development of a role play that simulates the innovation process may help.

Research institutes are used to approach problems top down. Experts state that the line of thinking must shift from transaction costs to transaction benefits and this asks for a bottom-up approach (Prof. Van der Heijden, pers. comm.). Research institutes must depart from a new way of using their knowledge in practice in order for knowledge to be used under this new economic paradigm. Different skills are needed for this.

If companies do not address risks this could mean that they are not good enough to see the risks. Authorities must be prevented from working with parties that are not competent enough to see the risks and therefore present a relatively cheap tender. Authorities can ask companies to address the risks in their tenders. If authorities miss certain risks in a tender they can decide not to continue with the company at stake.

Annex: Overview interviewees

Authorities:

Cees Brandsen (Ministry of Transport, Infrastructure and Water Management, Director of Department of Infrastructure)
Wim Holleman (Ministry of Transport, Infrastructure and Water Management Staf DG, Market and purchase)
Gijsbert de Jong (Ministry of Transport, Infrastructure and Water Management, Head of Division of Purchase Management, Department of Infrastructure)

Business community:

William van Niekerk (BAM Infraconsult)
Jaap Boneveld (Volker Wessel Stevin)
Bart Budding (Rebel groep)

Knowledge:

Louis de Quelerij (Delft University of Technology/ Fugro)
Jurgen van der Heijden (University of Amsterdam, AT Osborne)