

THE ROAD TOWARDS SUSTAINABLE INFRASTRUCTURE - A REVIEW OF DUTCH EXPERIENCES WITH INCLUDING SUSTAINABILITY ASPECTS IN DESIGN & BUILD CONTRACTS

M.B.G. KETELAARS & M.A. ALTAMIRANO

Department Strategic Studies and Policy Analysis, Deltares, the Netherlands

MONICA.ALTAMIRANO@DELTAIRES.NL

A.A.M. VENMANS

Department of Geo-Engineering, Deltares, the Netherlands

arjan.venmans@deltares.nl

ABSTRACT

The Dutch government has set ambitious goals with respect to sustainability. One very significant goal is that starting from 2010, 100% of the products and services purchased should be sustainable. The Dutch highway authority Rijkswaterstaat has set advanced goals with respect to reduction of CO2 emission, energy neutral design, sustainable use of materials and spatial quality of infrastructure. By setting these goals, Rijkswaterstaat, being one of the main clients of the road construction sector, wants to set an example for other infrastructure asset managers and give an incentive for sustainable development.

Moreover, innovative contracting schemes have significantly changed the relationship Public Client – Contractor. The changes in the dynamics of this relation are presented, as well as a number of ways in which public authorities can manage risks within this new context.

The authors propose a novel approach called Eco-Dynamic Design, to meet the more advanced sustainability goals in the setting of innovative contracts. Eco-Dynamic Design is a consistent and integral approach towards sustainability and guides the government client to translate their overall sustainability goals into ambitions for the project itself. A next step translates the project specific ambitions into (quality related) award criteria and end user specifications. Eco-Dynamic Design uses the potential of the project location and the natural system at the project location to generate added value for the project objectives. Experiences with Eco-Dynamic Design were analyzed and success factors and barriers to procurement of sustainable infrastructure projects identified.

1. SUSTAINABLE PUBLIC PROCUREMENT IN THE NETHERLANDS

Sustainability is a term defined in many different ways. The interpretation given to sustainability within this article related to finding a good balance between ecologic, economic and socio-cultural development. These three aspects are indicated by the so called triple P: People, Planet and Profit. Sustainable development has been defined by the UN commission Brundtland (Our common future) from 1987 as: *a development that fulfils the needs of the present generation, without compromising the ability of the future generations to fulfill their needs* [1]. The Brundtland definition is commonly accepted, and adopted by the Dutch environmental policy.

Some of the core principles of sustainability are:

- No shifting in time and space
- Interdependency between scales: sustainability at the local level does not necessarily mean sustainability at the higher level, or vice versa.

- It is a multi-actor problem, because it is about people's needs.
- Therefore an integral approach is needed, because sectors are only one piece of the whole puzzle.

There are not only many definitions given to sustainability, but also each government organization has set their own sustainability ambitions and goals. In order to achieve these goals government organizations have started with sustainable procurement. Through their procurement process government bodies have to match their sustainability goals with the interests of the different market players that will in fact implement the needed works. The present article examines two steps within this procurement process. The first step is to translate ambitions or policy goals to functional specifications. The second step is to build in contracts the right economic incentives so that market players indeed cooperate with the achievement of these goals.

The first objective of this article is to offer a first analysis of the sustainable procurement initiative of the National government (Rijksoverheid), and more specifically of Rijkswaterstaat as agency of the Ministry of Transport, Public Works and Water Management. In our analysis, we mainly aim at presenting a new method, Ecodynamic Development and Design (EDD), which ensures or aims at a design that balances infrastructural as well as ecological needs. Based on our experience as consultants not only for government organizations but also for market parties, we conclude on a number of success factors and barriers for the effective implementation of sustainable procurement that play a role within current practices.

2. FROM AMBITIONS TO STANDARD PURCHASING CRITERIA

2.1. Government ambition: 100% of the products and services sustainable procured

The national government in cooperation with local governments wants to stimulate the market of sustainable products. By setting a good example and procuring all their services and products in a sustainable way, the intention is to give a significant impulse to the market of sustainable products. Accordingly, Rijkswaterstaat has set itself the goal to purchase 100% of their products and services in a sustainable way, starting January 1st of 2010. Meanwhile municipalities aim at 75% by 2010 and 100% by 2015; and provincial governments and water boards aim at a minimum of 50% by 2010 and 100% by 2015. In fact different government instances have already started procuring in a sustainable way, but the official counting has started the 1st of January of 2010. The concrete goal of 100% sustainable procurement by 2010 means that at least the sustainability requirements (purchasing criteria) developed by Agentschap NL (part of the Ministry of Infrastructure and Environment, I&M in Dutch) are applied to all contracting out procedures.

Government purchases per year amount to up to more than 50 billion Euro, and represent therefore a significant share within the total market for, between others, office furniture and equipment, road and construction activities, transport and energy.

2.2. Development of the purchasing criteria of Agentschap NL (VROM)

Commissioned by the Ministry of I&M, Agentschap NL has developed a list of purchasing criteria. I&M has decided upon this list of criteria in cooperation and agreement with the different government organizations and market parties. Subsequently it has been agreed with the Parliament (Tweede Kamer) to focus sustainable procurement particularly on the types of products where significant sustainability benefits can be achieved in the short term. The resulting sustainability score (of the procurement process) is then calculated as

a ratio; the volume of products or services sustainable procured versus the total volume of the products –within a certain category- purchased. Besides the development of criteria, Agentschap NL also monitors the use of these criteria.

The purchasing criteria of Agentschap NL are seen as a standard instrument for a wide variety of government institutions, the great majority. The ambition level of this standard instrument is therefore relatively low. This has been a conscious choice; the goal is to take on board everybody no matter their point of departure, to promote awareness, to start an education process and to provide a level playing field for the market. Nevertheless, sustainability pioneers within the market do see a number of disadvantages of this approach; only proven technology gets a chance, there are little incentives for innovation and market players are not challenged to come up with distinguishing alternatives.

These standard instruments were derived from a collective ambition. This implies that procuring authorities are not stimulated to think about the translation of their own sustainability ambition to concrete objectives and criteria. The most significant sustainability benefits are often realized by offering custom-made criteria for the local situation en through cooperation with the local stakeholders. Project specific or location specific opportunities are however difficult to capture with the use of standard instruments.

2.3. Development of procurement instruments for Rijkswaterstaat

Rijkswaterstaat (RWS) has sustainability as a policy priority. Not only will RWS comply with the national goal, RWS itself has given itself additional, more challenging ambitions. In the Program RWS Sustainable (RWS, May 2009) these ambitions are formulated as follows:

- Energy: objects are self-sufficient or supply their own energy; there should be a significant contribution from RWS to the national ambition of using 20% energy from renewable sources.
- Sustainable use of materials and sustainable production methods should comply with the national ambition to reduce CO2 emissions by 20%.
- Spatial quality of the infrastructure should make a positive contribution to the surroundings and the society.

According to the additional goals just mentioned, RWS invest great effort in the development of instruments that allow the integration of these goals with their procurement process. An example of such instrument is the software tool DuBoCalc [2]. This program facilitates the assessment of the sustainability of materials used in infrastructural works. DuboCalc is based on Life Cycle Analysis, an approach that considers all environmental effects of the materials. This includes the energy consumption of a construction work starting from the extraction up to demolition and recycling. DuboCalc can be used within a procurement process as yardstick for the measurement of the environmental performance of a proposal; to decide whether the design process is sufficiently driven by sustainability considerations; or as selection criterion.

In the meantime, RWS is working in cooperation with Agentschap NL on an adapted set of purchasing criteria. These criteria are more ambitious than the criteria already in use by the majority of the government organizations. They demonstrate the forerunner role that RWS has had for years in recycling and sustainability. RWS is also working on a set of selection or adjudication criteria to consider sustainability in the evaluation of the Most Economically Advantageous Tender (MEAT, EMVI in Dutch).

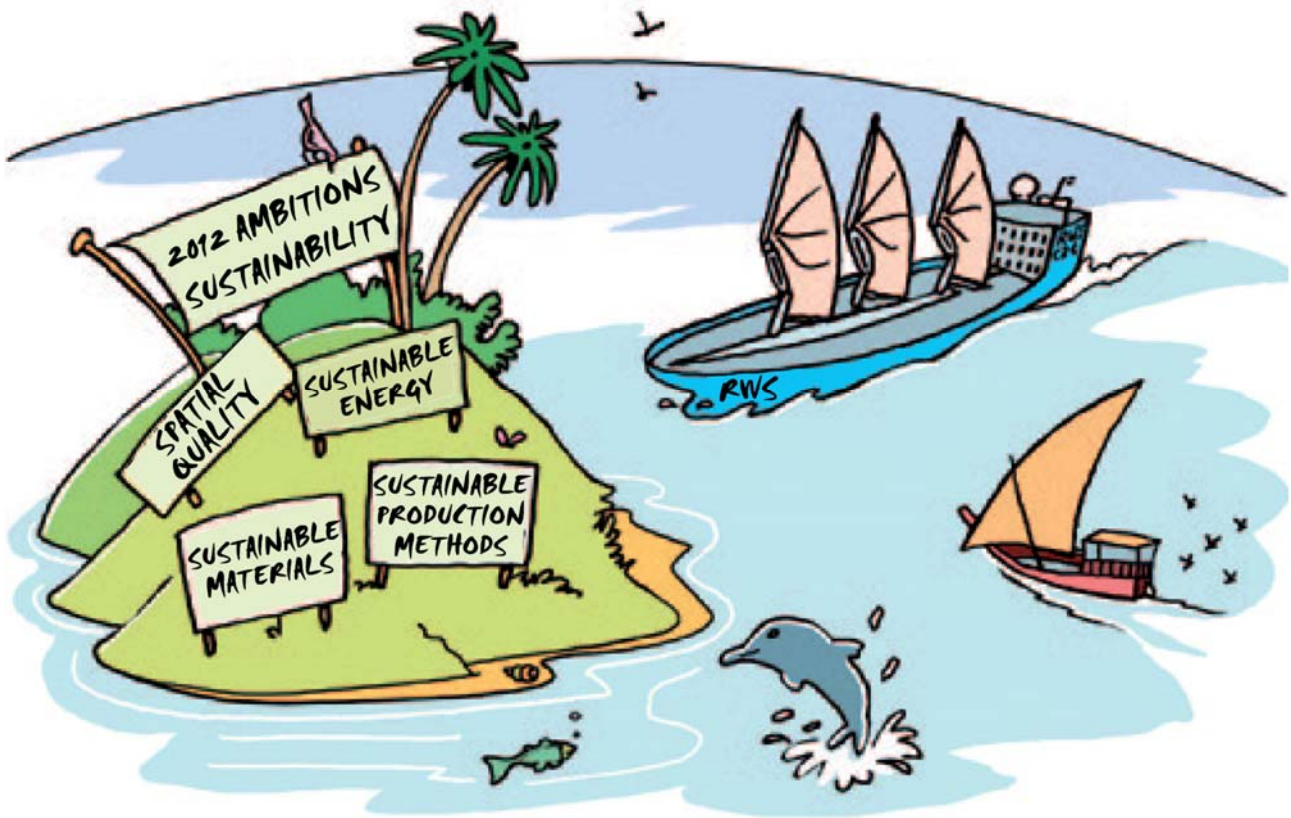


Figure 1 - Sustainability ambitions of Rijkswaterstaat

As the standard purchasing criteria of AgentschapNL, DuBoCalc and the adapted RWS purchasing criteria are aiming at creating a level playing field for the great majority of market parties. Also the adapted criteria will favor mainly well known materials and proven technologies. MEAT criteria do offer in principle more design freedom to the market, and therefore increase the possibilities for innovation and location specific solutions.

3. MARKET INCENTIVES

Given the recent changes in the procurement policy of RWS, it is important to first describe the relationship principal- agent or public client-contractor. This relationship has changed significantly in the last decennia, mainly due to the adoption of innovative contracting schemes, like Design-Build (DB) and Design-Build-Finance-Maintain (DBFM).

3.1. Innovative contracts

This section describes the relationship between public client and private contractors under the setting of innovative contracts, setting under which also sustainable procurement has to take place. Excerpts are taken from the PhD thesis of M.A. Altamirano [3], titled: Innovative Contracting Practices in the Road Sector. Cross-national lessons in dealing with opportunistic behavior.

The relationship between a government authority and a contractor or group of contractors, is called an *agency relationship*. Jensen and Meckling [4], define an agency relationship as a contract under which one or more persons (the principal(s)) engage another person (the

agent) to perform some service on their behalf which involves delegating some decision making authority to the agent. The agent is the individual or economic agent who undertakes the action and the principal is that one whose welfare (utility) is affected by agent's actions.

In other words, the roles of the principal are to supply capital, to bear the risk, and to construct incentives, while the roles of the agent are to make decisions on the principal's behalf and sometimes also to bear the risk [5]. If both parties are assumed to be utility maximizers there is good reason to believe that the agent (the contractor) will not always act in the best interests of the principal [4].

This conflict of interests between government authority (principal) and contractor (agent) has always been present. Nevertheless the introduction of innovative contracts, where risks are to be shared and agreed upon in advance, makes the resolution of this conflict even more complex.

Four trends are identified in road procurement practices: integrated project delivery methods combining different phases of the life cycle of the road; use of higher-level indicators in contracts to grant contractors more design space; long term contracts; and projects privately financed. While these innovative forms of contracting are expected to provide the road sector with more flexibility, more innovation, higher performance and lower costs without putting public values at a disadvantage, previous empirical evidence suggests that they increase the room for opportunistic contractor behavior, thus endangering the safeguarding of public values [6].

Innovative contracts by their very nature are bound to remain incomplete, thus increasing the possibility of, or the need for, renegotiations of contract terms in the future and requiring a different set of strategies to mitigate opportunistic behavior. Three major differences between traditional and innovative contracts that explain the root of this new problem are:

1. New contracts use a different incentive scheme [7]. Traditional contracts were often (quasi) cost-plus-fixed-fee or cost-plus contracts; contractors were paid in unit prices and project managers within authorities could easily estimate the profit margins of companies submitting a tender. Thus contractors hardly bore any risk. This is considered a very low-powered incentive scheme. Innovative contracts are often fixed-price contracts or so-called lump-sum contracts, under which the winning firm is residual claimant for its cost savings. The road authority does not de facto reimburse any of the costs; it pays only a fixed fee; the contractor runs almost all project risks. This is considered an extremely high-powered scheme.
2. The item being contracted is no longer a physical "product" or delivery of a physical asset or facility, but a "service" and the availability of such service for an x number of years.
3. Contract terms of this new type of contracts are often longer, from 3 or 5 to up to 30 years or more.

All three points above only mean a significantly higher amount of risks being transferred to the private sector, for which a fair price has to be negotiated up-front. Innovative contracts also mark the beginning of a new attitude or way of managing contractors at a distance, which means that public authorities in their role of clients have less possibilities and authority to influence the process or steer contractors directly in a particular preferred direction. Thus again, many more aspects need to be decided up-front than in traditional contracts.

To summarize, road authorities in their new role of quality regulators, or at most network operators, have to find new ways of dealing with new types of opportunistic behavior. The most difficult task is to arrive at a balanced and acceptable sharing of responsibilities, risks and rewards together with the private sector. This challenge holds in general for all innovative contracts in the road sector, and therefore also for sustainable procurement.

3.2. Risk management by government authorities

There are five different sources of risks for any given project, 1) Risks related to the public client 2) risks related to the environment or the surroundings of the project 3) risks related to the market 4) risks related to the project itself and its organization and 5) risks related to the (technical) system.

The public authority in charge of the project can manage these risks mainly through their:

- Set of functional requirements, and performance indicators;
- Procurement strategy, including the criteria for the selection of the Most Economically Advantageous Tender (MEAT), and the virtual bonuses attached to each of these criteria,
- Tendering procedures, like the so-called competitive dialogue, and
- Payment mechanisms

Through all these four aspects, the authority needs to build a consistent set of incentives that reward high quality and cooperative behavior of contractors and penalize the opposite behavior. This logic holds for all aspects of the project, and therefore also for the sustainability one. Given that traditional Design-Bid-Build (DBB, RAW in Dutch) did seldom make use of positive incentives, the main approach of government authorities has been to sanction contractors in order to ensure a minimum level of quality. Innovative contracts offer the possibility to make use of positive economic incentives (bonuses) that lead to desired behavior of contractors. The next section presents two examples from the point of view of private contractors, which offer a good illustration of how these positive incentives could be formulated.

4. EXAMPLE ECO-DYNAMIC DESIGN: SUCCESS FACTORS AND POSITIVE INCENTIVES

4.1. What is Eco-Dynamic Design?

In this subsection we describe the experience of Deltares of applying a new method, Eco-Dynamic Design (EDD), which aims at a final design where ecological and infrastructural needs strengthen each other. This method is innovative, which means that the philosophy of EDD has not been incorporated yet in the purchasing criteria of Agentschap NL or RWS. EDD is the approach put forward by the long-term research program Building with Nature (BwN), financed by the EcoShape foundation [4]. Building with Nature is an initiative of Dutch industry, engineering consultants, specialist institutes (like Deltares) and universities. Together they implement a variety of research project and pilot projects.

The philosophy of EDD is to “capitalize on the dynamics of natural ecosystems in the design of hydraulic engineering projects in fresh, brackish and salt water zones”. Ultimately, better insight into natural dynamics, whether or not affected by the hand of man, will provide ever more valuable contributions to sustainable, and socially responsible,

physical development. Where nature and construction integrate and combine from the very beginning to strengthen and reinforce each other.

Even though at first developed for hydraulic engineering projects, the principles of EDD could also be applied to the design of road infrastructure. The point of departure is the identification of the guiding factors of the natural environment. Subsequently the possible adaptations or adjustments of the natural system that could bring significant added value for a society's point of view, are examined. This approach contrasts with the traditional design approach where the main goal is the limitation of environmental effects (so-called mitigation) of the proposed infrastructure project. Scales are linked from large to small, from Climate - Relief - Water and soil to vegetation and wildlife. By adopting such a proactive design approach, opportunities are maximized, aiming at the best solution instead of a compromise. Another characteristic of this design approach is that experts of different disciplines and organizations work together along the different project phases. The added value created does not necessarily translate in higher costs; there is a constant search for win-win situations!

For the seawall next to the Maasvlakte 2¹ a EDD design approach was chosen, as well as for the dike at Steurgat in Noordwaard (Biesbosch). In both projects the original design exclusively focused on flood protection. EDD added the functions nature and recreation. In other words, a multifunctional design was created where materials locally available are used and natural resources are reused. An additional advantage of this multifunctional design was also a reduction of project costs.

Deltares has applied the principles of EDD not only to hydraulic engineering projects but also to a number of road construction projects [8]. In the case of ground infrastructure the main question is "how could a road be designed and built in such a way that it delivers the largest added value to the environment". Within this approach a road is not an obstacle or a barrier anymore, but a transition or connection, across the road as well as along the road. In comparison with the original Building with Nature approach, the EDD for road construction takes into account a number additional of aspects such as the exhaustion of natural resources, using energy from renewable sources, neutralizing CO₂ emissions and health and safety impacts.

Even though EDD delivers project specific measures, the following measures often result from the application of this approach:

- Make use of gradients and work in a robust, diverse and dynamic way.
- Design roadsides and sound barriers in such a way that attractive migration routes are created along the road.

¹ The project Maasvlakte 2, is the port of Rotterdam expansion project. Directly to the west of the current port and industrial area, a new top European location for port activities and industry is to be created in the North Sea. Maasvlakte 2 will shortly cover 1000 hectares net of industrial sites, located directly on deep water. The reclaimed land will emerge after the construction of a combination of hard and soft sea defences in the North Sea. The land reclamation will measure around 2000 hectares in total. Half of this will consist of infrastructure, such as sea defences, fairways, railways, roads and port basins. The other 1000 hectares will provide the space for industrial sites.



Figure 2 - Roadside stream (left) en spawning ground for pikes (right)

- Design the roadsides in such a way that new habitats can develop in the area; in this way, biodiversity is promoted. An example is the creation of a stream on the roadside (Figure 2).
- Make functional use of vegetation, for instance to catch fine particles, or to keep drivers “awake”.
- Design tunnels and crossovers in such a way that people as well as animals can profit from them.
- Strengthen the recreational value that originates from the increase in biodiversity. An example is the creation of spawning grounds for pikes (Figure 2).
- Develop balances for construction materials (natural, concrete, asphalt) and aim at closing the balances for the project.
- Keep the use of energy to a minimum, not only during the construction phase but also during operation. Make use of renewable energy sources.
- Contribute to a CO₂ neutral infrastructure: cultivate top soil and vegetation as to maximize CO₂ capture and storage.

4.2. Success factors and positive incentives

Determining factors for the success of these projects were:

- An interdisciplinary approach was followed since the beginning of the project: in order to maximize the potential of a system an integral approach is needed. A number of disciplines (ecologists, hydraulic engineers, road engineers, etc.) have to cooperate all the way from the drafting of the first concept.
- Involvement of the whole network of stakeholders: a proper implementation of interdisciplinary solutions requires that networks and connections are built between all the organizations involved. Understanding of political processes is crucial to ensure that project implementation is effective and efficient.
- The unavoidable uncertainties are managed efficiently: an EDD design brings about, almost by definition, a number of inherent uncertainties and risks. Successful EDD projects deal with these uncertainties by providing enough mitigating measures.
- Small adjustment and design adaptations are possible: in the search for win-win situations often small adaptations to existing designs are enough to create added value for the same or even lower project costs. More is possible with less!

Translated to positive (contract) incentives these success factors mean:

- The public client needs to have enough content-wise and technical expertise at their disposal (in-house) for all the involved disciplines, to be able to evaluate the

advantages and the consequences of the different design solutions, and to be able to discuss these issues with designers. Contract preparation, as well as tendering procedures and contract management should leave enough room for discussion about these content related aspects.

- A tendering firm should have the possibility to close agreements with all the parties that are critical for the successful implementation of the offered design solution. In the case of water retaining infrastructure, these parties are not only RWS but also the water boards and municipalities in the area. These agreements also offer the private contractor more certainty that the design solution will be implemented and that consequently they will have the needed return on their investments.
- The risks related to a particular design solution should be carefully drafted in advance and allocated in a clear way to either public client or contractor. In order to arrive to an efficient allocation of risks, the motto is, "assign the risks to the one best able to carry it". Drawbacks have to be made explicit and to be accepted by all parties, as far as these can be anticipated.
- The contract specifications have to provide enough room for the realization of small but efficient adaptations to the design.

5. EXPERIENCES WITH EDD IN THE ROAD SECTOR

RWS has the ambition to realize a large number of road infrastructure projects in a sustainable way, and to continue operating these infrastructure projects also in the most sustainable way possible. Meanwhile Deltares has applied the principles of EDD to a number of projects, supporting the public client (RWS) as well as the tendering consortia. The current approach of RWS for sustainable procurement seems to result in a number of obstacles for the successful implementation of the EDD approach. These obstacles are nevertheless not only applicable to RWS and to their procurement strategy, but in general to road infrastructure projects and public tendering procedures; which are to great extent prescribed by the European and national regulations.

Based on their experience in RWS projects, the EDD project team of Deltares has identified the following obstacles for the sustainable procurement of projects:

- The current Right of Way procedure and the Environmental Impact Report (Tracé/MER in Dutch) aim both at mitigation (at counteracting the negative effects) instead of aiming at the creation of added value.
- There is significantly more design freedom during the earlier phases of a project. It is precisely at the starting phases where there is a plenty of opportunities for sustainability. Nevertheless sustainability is not yet on the agenda throughout the formulation of the Right of Way and the Environmental Impact Report; and consequently opportunities for sustainability are often unconsciously and unnecessarily eliminated.
- The profitability or the opportunities for market players to differentiate themselves from their competitors; are not taken into account in the formulation of requirements or MEAT criteria. Probably due to this fact, less sustainability is achieved that it would be possible with the same project budget. A possible solution could be to involve market players as early as possible in the project, for example through a market sounding exercise. In this way more opportunities are given to the tendering firms to develop distinctive and unique solutions.
- The procurement policy of RWS and other government organizations is based on standard instruments -like DuBoCalc- for the comparison of alternative tenders. Standard purchasing criteria lead to standard measures and offer the market few

opportunities to distinguish themselves from their competitors; which is also detrimental for innovation.

- Market players seldom receive the revenues from their investments in sustainability-oriented measures. In this way, the implementation of energy saving equipments – under innovative contracting – has resulted in savings only for the public client.
- Significant opportunities for improvements in sustainability arise from the combination of functions and from the cooperation between contractor and stakeholders in the surrounding area, or between contractor and suppliers. Nevertheless, within the current contracting schemes, market players are not allowed to offer sustainable solutions that depend on a third party for their implementation.
- The current contracting schemes do not offer the possibility of “experimental sites” where market players could test their innovative solutions. A possible solution to this problem could be to offer additional experimental room for sustainable solutions within the current innovation programs of RWS like “Wegen naar de Toekomst” or the “Innovatie Test Centrum”.
- The level of expertise within project teams (of public clients) is not sufficient to evaluate the quality of the work of engineering consultants and other specialists. In other words, the expertise is missing that is required to recognize the potential of sustainable solutions like EDD, and to integrate these alternative solutions with the original design.
- Both principal and market parties lack knowledge about the life cycle costs of non-standard sustainable solutions. The general perception is that sustainable solutions convey more risks. This perception is seldom based on facts, but it does lead to the exclusion of alternative design solutions.
- In addition, understanding is lacking of the performance of different sustainable measures. The public client seems to have high expectations, while in practice both public client and contractor show risk aversion. The lack of insight on the risks of the project, and a clear allocation of these risks; result in such risk-avoidant behavior. For instance, application of moss tiles for capturing fine particles still needs to be up scaled from laboratory to practice, and the effectiveness of trees for capturing fine particles is still questioned. This hold back contractors from offering such innovative solutions. Public clients offer seldom the opportunity to contractors to test out interesting but uncertain solutions.

These obstacles are not only applicable to the design alternatives or measures inspired in the principles of EDD, but to a variable extent also to other sustainable solutions that are not rewarded under the current standard purchasing criteria. Moreover, a number of obstacles mentioned above also hold for innovations in general. It is urgent and necessary to find a solution to these problems in order to advance.

6. CONCLUSIONS AND RECOMMENDATIONS

In order to reach their sustainability goals government authorities should build in contracts enough positive incentives to reward high quality and cooperative behavior of contractors. In the context of innovative contracts these positive incentives are related to the provision of opportunities and enough certainty to contractors to earn back their investments; to the design freedom been granted and to the length of the contract term. Negative incentives should be used only to prevent undesired behavior from contractors. A negative incentive may be for example the formulation of minimum

sustainability requirements, for which failure to achieve them would mean an economic sanction or payment deduction.

Many government organizations (RWS as well as provincial governments, municipalities and water boards) aim for sustainable procurement by making use of standard purchasing criteria. These standard criteria result in standard solutions and should therefore be used only to ensure a minimum level of sustainability. The inclusion of sustainability aspects in the list of MEAT criteria, offers contractors more possibilities to differentiate themselves from their competitors by offering sustainable solutions.

Our experiences with the EDD approach make us conclude that cooperation between procuring authority and private contractors is needed in order to achieve significant advance towards sustainability. This cooperation has to take place not only on content related issues, but also on an administrative and procurement level. There appear to be far too many obstacles under the current practice within the road sector that prevent market players from implementing innovative solutions that promise great advance toward sustainability. The experience of the Building with Nature program within the hydraulic engineering sector proves that such advance is possible. The question remains, who will take the initiative to introduce change in the road sector and remove these obstacles.

REFERENCES

1. United Nations (1987) Our Common Future: Report of the World Commission on Environment and Development, General Assembly Resolution 42/187. New York, United Nations, 11 December 1987.
2. DuBoCalc.
http://www.rws.nl/wegen/innovatie_en_onderzoek/schoner_en_duurzamer/duurzaam_inkopen/dubocalc/
3. Altamirano, M.A. (2010) Innovative Contracting Practices in the Road Sector. Cross-national lessons in dealing with opportunistic behaviour. PhD Thesis, TU Delft.
4. M. C. Jensen and W. H. Meckling. Theory of the firm: Managerial behavior, agency costs and ownership structure. *Journal of Financial Economics*, 3(4):305–360, 1976.
5. R. A. Lambert. Contracting theory and accounting. *Journal of Accounting and Economics*, 32(2001):3–87, 2001.
6. M. A. Altamirano and P.M. Herder (2006) Systems dynamics modeling for road contracting. In *Transport Research Arena, Europe 2006*, page 8, Gothenburg.
7. J.-J. Laffont and J. Tirole. *A theory of incentives in procurement and regulation*. MIT Press, Cambridge, MA, 1993.
8. Eco-Dynamisch Ontwerpen voor droge infrastructuur: <http://www.deltares.nl>