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DEVELOPING A MODEL TO SUPPORT CLIENT'S DECISION-MAKING PROCESS ON INTEGRATED CONTRACTS

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Abstract. *This paper discusses how public clients in the Netherlands can play an important role in fostering innovation in the construction industry through the implementation of integrated contracts according to UAVgc2005. Integrated contracts –in which 'integrated' refers to the degree of integration of the design and build, as well as maintain, finance, and operate components of a construction project– encourage the transition to a more competitive, innovative and creative construction industry. However, up to now the broader application of integrated contracts still faces many challenges. This paper describes an ongoing applied research project at TNO which aims to develop a model to support the client decision-making process for selecting the type of integrated contract and optimizing it. The model is being developed based on both theoretical knowledge on contractor-led innovation, public-private partnership, and dynamic life cycle management according to the Living Building Concept; as well as practical knowledge derived among others from case studies of railway HSL, highway A59 and waterway Hansweert-Kramersluizen in the Netherlands.*

1 INTRODUCTION

In the Netherlands, a set of regulations and a model-contract in UAVgc2005 (*Uniforme Administratieve Voorwaarden voor geïntegreerde contractvormen*) have been developed to guide the implementation of integrated contracts. This paper focuses on integrated contracts according to UAVgc2005 for construction projects by public clients in the Netherlands. Public clients play an important role in fostering innovation in the construction industry. Many people acknowledge that a change in the construction industry will start with a strategic change at the demand side. One of the most significant opportunities to realize innovation is through a new approach for tendering and contracting. There has been a shift from traditional contract, in which the client establishes a contract with each of the parties in the supply chain, towards integrated contract, in which the client established a contract with a contractor that is responsible for the whole or most of the work.

Integrated contracts encourage the transition to a more competitive, innovative and creative construction industry. Among the public clients in the Netherlands, the awareness of the potential of integrated contracts has been growing and numerous projects have been carried out accordingly. However, up to now the broader application of integrated contracts by many

public clients in the Netherlands still faces many challenges.

In a project, the client has to select the most appropriate type of integrated contract that fits to the goals and resources of both the project and the organization. For doing this, adequate knowledge of the characteristics, strengths and weaknesses of integrated contract is essential. Integrated contracts comprise different types according to the kind of responsibility transferred from the client to the contractor. In the public sector in the Netherlands, the range generally includes Design and Build, Design Build Maintain, Design Build Finance Maintain, Design Build Finance Maintain Operate, and Design Build Finance Maintain Operate.

Furthermore, to benefit from the innovative and creative power of the private parties in the market, the public clients ought to be able to develop an open-solution program of requirements. This aspect of transition from traditional to integrated contract requires a shift of mindset by the client. In an integrated contract the client is supposed only to describe his problem and develop functional program of requirements for the project; leaving sufficient room to the contractor for finding an innovative solution to the client's problem. Subsequently, the contractor should carry out the design, construction and delivery of the project; in some cases the contractor is also responsible for maintenance, operation and financing of the project.

Integrated contract also pictures a new professional relationship between the parties involved in a construction project. The line of contract between the parties involved differs from the traditional approach. Instead of a three-party contractual relationship between the client, architect (for design), and contractor (for construction), in an integrated contract the client only holds a contractual relationship with the contractor who will be responsible for both design and construction. In an integrated contract, it is essential for the client and contractor to have a fair and open collaboration in which both can optimally use their competencies. Next to this, more and more public clients rely on public-private partnerships in realizing construction projects. The success of the collaboration is much determined by the client's capacity and strategy to organize innovative tendering and contracting procedures.

In many cases, integrated contracts may deliver the most benefit for the client if a long-term contract is established. For this purpose, the practical knowledge of life cycle management and the implementation of its principles are necessary for optimizing integrated contracts and ensuring a sustainable contractual relationship between the client and contractor.

This paper describes an ongoing applied research project at TNO which aims to develop a model to support the client decision-making process for selecting the type of integrated contract and optimizing the contract using the knowledge of contractor-led innovation, public-private partnership, and dynamic life-cycle management according to the Living Building Concept. Brief literature review over this knowledge will be presented in the next section of this paper. This will be followed by a quick scan of three projects in which integrated contracts are applied. Subsequently, the methodology and the current state of development of the model to support the decision-making process will be explained. In the end, the potential scientific and practical impacts of the model and the strategy for further research and implementation will be concluded.

2 THEORETICAL CONCEPTS OF CONTRACTOR-LED INNOVATION, PUBLIC-PRIVATE PARTNERSHIP AND LIFE CYCLE MANAGEMENT TO OPTIMZE INTEGRATED CONTRACTS

As described in the previous section, there are challenges in the transition from traditional to integrated contract, among others regarding stimulating and creating sufficient room for contractors to bring forward innovation, configuring new forms of collaboration, and incorporating life cycle considerations in tendering and contracting. In this section, several theoretical concepts which offer innovative ways to tackle these challenges are presented.

2.1 Encouraging contractor-led innovation through two-stage contracting and open-solution specification

The traditional tendering process is designed to produce direct price competition for a specified product. The project will be awarded to the lowest price tenderer. The organization of the work method to minimize costs is confined by the boundary of the client's specification and design. It is believed that integrated contract in contrast to the traditional one would encourage innovation in the building process. Integrated contract imposes single point of responsibility on the contractor for the complete building. Its tendering process differ from that of the traditional one as the tender will be evaluated based on quality and innovativeness of the proposed solution, contractor's capability, time and work method, next to the price. This paper discusses how to enhance the contractor-led innovation in integrated contract using two-stage contracting or 'tendering contract' and open-solution specification as functional program of requirements.

In the recent development in the regulation related to tendering, two-stage contracting or tendering contract has emerged. The invitation to tender, which is traditionally only considered as no more than an indication that the client is ready to do business, is now in some circumstances to be treated as an offer to make a contract which a tenderer accepts when it submits a conforming tender. Such contract is described here as a tendering contract or elsewhere as pre-award contract or process contract or first contract. Obligations of a contractual nature arise between the client and each tenderer who has submitted a proposal. The client becomes obliged to each tenderer to perform its side of bargaining. By the same token, tenderers become obliged to not simply withdraw their tender; under the tendering contract principle, a tenderer who makes a mistake may find that the tender is accepted with no opportunity to escape even if there is an error in tender compilation.[1]

All tenderers are, besides their obligation, entitled to know the basis on which tenders will be evaluated and on which a contract-award decision will be made. Tender conditions for project involving design must include criteria for evaluating that design, as well as criteria for evaluating performance. If innovation from tenderers is required, the client must expressly create the right for a tenderer to submit an alternative tender. If the right then exists, the owner is obliged to consider such proposals. Tenderers must be informed of criteria for evaluation of such alternative proposals. Tender conditions must define the scope of alternative tenders. This scope must not be too tight so as to restrict innovation, but not too wide so as to result in a proposal for a scheme quite different to the one originally tendered for.[2]

By trusting the contractor in finding the innovative solution, the client needs to formulate its functional requirements instead of detailed technical design. The contractor will transform the functional program of requirements into work packages for design and construction. The functional program of requirements should offer sufficient room for creativity of the contractor. A working method to develop open-solution program of requirements based on systems engineering has recently been introduced in the Netherlands.[3]

2.2 Public-private partnership in integrated contracts

Integrated contracts can be used in several forms of strategic collaboration, such as public-private partnership (PPP) as becoming more commonly used in the Netherlands.[4] PPP encompasses a cooperation between public and private parties based on the share of risks, tasks, responsibility and authority between the public and private parties as determined in a contractual arrangement.[5] Such arrangement typically involves a government agency contracting with a private partner in whole or in part of a project that provides a public service. The private-sector party can be involved in a variety of ways, from designing the public-purpose facility to undertaking its financing, construction, operation, maintenance, management, and/or ownership. The private-sector party usually makes a substantial at-risk equity investment in the project. All partners share in income resulting from the partnership.[6]

In the Netherlands, the commonly used practices of PPP take the form of Design-Build-Finance-Maintain contractual arrangement. There are two types of PPP project: the governmental project and the combination project. In a governmental project, with usually non-revenue generating goals, a public partner is responsible for the project initiation, and it involves a private-sector partner for the project realization and operation. The public partner pays the private-sector partner for public services delivered by a finished and functioning project. In a combination project, a public partner works together with a private-sector partner to initiate and realize a project containing both public and commercial goals. In such project, the public partner gains access to new revenue or service delivery capacity without having to pay the private-sector partner.[7]

2.3 Dynamic life-cycle management principles according to the Living Building Concept (LBC) for integrated contracts

In most construction projects, initial investments and construction costs are the most important consideration in tendering and contracting. A well-known problem if the whole life-cycle of the building is not taken into account in the beginning is that the client may be confronted with more effort and higher costs to maintain the quality and functional operation of the building. Life-cycle cost analysis has emerged as a method to estimate to assess the total cost of facility ownership. Its purpose if used during the design phase is to estimate the overall costs of project alternatives and to select the design that ensures the facility which will provide the lowest overall cost of ownership consistent with its quality and function.[8] However, this method also has shortcomings. By focusing only on minimizing costs over the life-cycle of a building, it does not automatically assure the optimal value for the users and owners during the building life-cycle. Moreover, life-cycle costs should not be considered as

static as there are possible changes in the building during its life-cycle which affects the costs.

In order to advance beyond this, the Living Building Concept (LBC) was introduced.[9] LBC comprehensively describes a dynamic life-cycle management approach for contracting a construction project. LBC promotes a shift from focusing only on minimizing the costs to focusing on maximizing the total benefit that can be gained from the project. Furthermore, LBC introduces an approach of dynamic contracting for complex projects in less-predictable circumstances. Since a building usually exists for a longer term while technology and use change more quickly, the contractor is expected to propose and realize dynamic solutions to client's requirements and the project environment that may change in the future. In contrast to the static approach to calculate work and costs, an integrated contract based on LBC does not define a fixed-price, but rather an agreement on value-price balance.

LBC foresees the shift from the traditional demand-based and one-off project development in the construction industry towards the market-based product innovation, as commonly known in the manufacturing sector and consumer goods. LBC supports contractor-led innovation by suggesting clients only to describe their problems and needs, let contractors propose innovative solutions in the market, then select the most optimal solutions available.[10]

3 CURRENT APPLICATION OF INTEGRATED CONTRACTS IN SEVERAL INFRASTRUCTURE PROJECTS IN THE NETHERLANDS

Since the public clients still play the major role in the infrastructure sector in the Netherlands, three infrastructure projects are selected in this paper to describe the current application of integrated contracts by public clients. These address the three challenges in the transition from traditional to integrated contract, as described in the previous sections. The focus of the so-called 'quick scan evaluation' of the projects is on understanding the motives and implications of the public clients' decision to apply integrated contract.[11]

3.1 Design & Build (DB) contracts for High Speed Line (HSL) railway project

The High Speed Line (HSL) can be considered as one of the most important infrastructure projects in the Netherlands with high expectation for technical innovation. The project is much discussed both for its importance in terms of political, economical, technology and construction process innovation, as well as for its problems in terms of budget and time overruns. The HSL connects the major cities in the Netherlands, Belgium and France. The railway supports high-speed trains capable to transport people and goods between the cities. The HSL project in the Netherlands extends from Amsterdam through Rotterdam to the Belgian border. The HSL project in the Netherlands is divided into three parts: the substructure (underground), superstructure (railway tracks), and infra-provider (electrical and mechanical systems, etc.). This paper focuses on integrated contracts for the substructure work. For tendering and contracting purposes, the HSL project in the Netherlands is divided into five tracks to allow the contractors to introduce innovative construction solutions within the scope of each sub-project, as well as to perceivable amount of the risks to each contractor. There are five Design & Build (DB) contracts signed with five consortiums of contractors.

An example of innovation proposed by the contractor is a custom-made substructure which

is novel in the Netherlands. To support the train, travelling at very high speed, special substructures have been developed. The so-called Embedded Rail Construction (ERC) allows trains to travel at high speeds, while keeping the maintenance costs low. Another example is the development of a calculation method capable of predicting the change in pressure when a train enters a tunnel at high speed. Using this, tunnels can be developed and constructed with great accuracy while conventional ways of technical designing still depend on empirical tests.

Although several components of the project have been delivered beyond client's expectations, and this shows the innovative capacity of the contractors, the level of innovation is not yet satisfactory. Some important lessons can be learned from the application of integrated contracts in the HSL project. First, the client should consider extra management effort required to coordinate the sub-projects contracted to different contractors. Second, despite the high complexity of the project, they should be able to let go its preliminary design solutions and trust the contractors with their innovative solutions. Now the contractors have put some remarks that the room for creativity is limited. Third, the client should consider the acceptable price for transferring risks to the contractors in a very complex project. Since the client did not provide adequate risk analysis, the contractors submitted their tender with a higher price to include a 'safety buffer' in case of unforeseen risks. As a result, integrated contracts in this case have not been able to significantly reduce the costs. The complicated political negotiations and legal procedures have also contributed to budget overruns and delays.

3.2 DBFM contract for public-private partnership (PPP) project of highway A59

The A59 is stretch of 9 kilometres highway between the cities Geffen and Rosmalen in the Province of Noord-Brabant in the Netherlands, which needed major renewal. The Dutch government alone did not have the financial capacity to realize the plan to rebuild the highway in a short term. Therefore it was decided to form a PPP aiming at a faster project realization by the availability of sufficient financial resources from the private parties. This was the main motive for the public client to establish a DBFM contract within the PPP. Next to this, another motive for integrated contract was the interest and support of the government to promote a PPP Knowledge Centre in the Netherlands. This knowledge centre was particularly expected to consolidate the experience from PPP pilot projects, such as A59, for the learning process of the public clients in the Netherlands to successfully carry out such kind of projects in the future. Through integrated contract, the public client also aimed to achieve innovation in construction processes through the creativity of the private parties, as well as to obtain more value for money.

The project has been carried out in 2003-2005. In the contract, a maintenance period of 15 years is included, from 2005 to 2020. Within the PPP, the Province of Noord-Brabant as public client has established a partnership with contractors and project manager joined in De Poort van den Bosch Consortium. The evaluation of the project using Public Sector Comparator (PSC) tool shows that 14% of financial added value has been gained. The shift of responsibilities and risks from the client to the contractor has been considered as successful.

However, attention to the following aspects is needed to improve the application of

integrated contracts in future projects. Despite the support of the PPP Knowledge Centre, the choice for integrated contract has posed some challenges in the preparation and realization of the project. The designers (who were a part of the consortium of contractors) could not effectively use their creativity and expertise due to the rigid plans and standard criteria of the Dutch government for highways. Next to this, the transaction costs to prepare the DBFM contract and to arrange for private financing were high. In general it is assumed that a DBFM contract will deliver significant benefit for large-scale and high-value projects. The scale and value of the A59 project have been considered limited for optimal benefit of DBFM, especially regarding the relatively short length of the highway and the scope of work of the long-term maintenance contract.

3.3 Service-provider maintenance contract for waterway Hansweert-Krammersluizen

Hansweert-Krammersluizen is an existing waterway in the Province of Zeeland. In line with the policy for a greater involvement of the private sector, the Department of Public Works and Water Management has set-up a pilot project of service-provider contract for the regular and incidental maintenance of the Hansweer-Krammersluizen waterway.[12] The public client is looking to establish a long-term maintenance contract with one responsible contractor instead of to have many different contracts with different contractors for various works.

The client intends to apply the principles of life-cycle management and to achieve a balanced risk-sharing between the client and the contractor. The tenderers will be assessed based on their propose maintenance technique and their innovative capacity. Furthermore, the contractor is required to take the life-cycle costs into account. The contractor will not make agreements on what kind of work will be performed, but rather on the quality and state of maintenance must be achieved in the contract period. The client will formulate performance criteria and how the performance can be measured. If the quality of maintenance is better than initially agreed, the contractor will be entitled of bonus.

The maintenance contract also offers certain degree of flexibility to be able to respond to the dynamic circumstances. The contract includes a certain calculation method to allow innovative proposals from the contractor during the contract period to be negotiated with the client and then incorporated in the contract. Uncertain situations and variable factors can still be included in the contract; they will be calculated based on a certain formula instead of a fixed price. Since the development of such contract is still ongoing, the implications and results still need to be evaluated in the nearer and farther future.

4 DEVELOPMENT OF A MODEL TO SUPPORT THE CLIENT DECISION-MAKING PROCESS ON INTEGRATED CONTRACTS

To assist clients in the Netherlands in their decision-making process on the type of integrated contract that suits its organizational goal and ability, the project type, and the legal and market framework, a guideline for integrated contracts and a decision-support system (DSS) have been developed. The guideline[13] and DSS (www.leidraadaanbesteden.nl) provide a client with an overview of the aspects of integrated contract, a checklist to assess the client's criteria, and project references. While using the DSS, the client is guided by a set of questions

and ‘filters’ to consider general and specific aspects of tendering and contracting. The system seeks the match between the considerations and actual project, market and organizational situation. It then provides the client with advice on the most relevant types of contract, the possible implications, and some practical reference from preceding projects.

The guideline and DSS can be considered as rational instruments to structure the decision-making process. The instruments are meant to be practical and sustainable. New knowledge, experience and regulations can be added by the users to the list of considerations, and project references. The output is generic advice that still needs to be elaborated and adapted to specific organizational and project circumstances.

The research described in this paper intends to extend the existing DSS by a model which transforms the theoretical principles of contractor-led innovation, new ways for collaboration, and dynamic life-cycle management into practical applications in an integrated contract. After a client select a type of integrated contract uses the DSS, the model will assist the client on how the selected contract can be further optimized.

Some examples of the elements of the model are shown in Table 1. The aspects included in the model can be added, reduced, or modified according to the implementation of the model in a certain construction sector (e.g. infrastructure sector, housing sector, or health sector). The client can assess the relevance of each aspect through a set of questions regarding the client profile, client ability, market and legal framework, and key project characteristic. If the criteria are met, applicable innovative principles to the particular aspect are described. The practical implications will be defined based on the combination of the matched criteria. These practical implications may take form as an additional element to the integrated contract or an adjustment in the tendering and contracting procedures. The definition of this additional contractual element and/or procedures is to be consulted with an advisor / legal expert.

1.	**Optimizing the selected type of integrated contract for enabling creative solutions from the market**		
	Example of criteria and considerations:		*Example of relevant principles:*
	- What the client wants:	The client wants to be surprised by an innovative solution for its problem.	Change in the building supply-chain towards construction-led innovative product development from which the client can choose the best alternative available in the market.
	- What the client is able to:	The client is able to compose open-solution programme of requirements.	The client describes its requirements in terms of functions and wishes instead of detailed specifications of the products.
	- How the project is characterized:	The project goal can be achieved through different ways.	Creative interpretation of the problems to explore all possible solutions, for instance the goal to connect two cities separated by a river can be achieved by building a bridge or a tunnel, or even by virtual business network.
	- How the market and regulations are organized:	There are various alternatives available in the market for competitive prices, and the urban plan allows any alternative to be implemented.	Market orientation and consultations with the potential market parties to explore the possibilities; consultations with the local authority on the permitted procedures for adjustment of the existing urban plan.

2.	**Optimizing the selected type of integrated contract for a sustainable and innovative partnership**		
	Example of criteria and considerations:		*Example of relevant theoretical principles:*
	- What the client wants:	The client wants to shift certain projects risks to the private-sector partner.	Allocate certain risk to a certain party which is most capable and experienced to comprehend and manage it.
	- What the client is able to:	The client is able to create measures on risk assessment and minimizing transaction costs, and reasonably cover contractor's transaction costs.	Tenderers contribute in-depth risk analysis calculated as part of the tender price; use of standard tendering procedure to avoid extra legal costs to submit and evaluate a tender.
	- How the project is characterized:	The project comprises significant public and private importance as a basis to establish a PPP.	A clear contractual arrangement on the partnership defining share of investment, tasks, responsibilities, project outcome, etc.
	- How the market and regulations are organized:	Private-sector parties are interested and capable to carry out the project through PPP; there are clear regulations on open or limited invitation for tender.	There are proper number of tenderers, not too few tenderers to stimulate a healthy market competition, but also not too many to limit the transaction costs.
3.	**Optimizing the selected type of integrated contract for steering on value during object life cycle**		
	Example of criteria and considerations:		*Example of relevant theoretical principles:*
	- What the client wants:	The client wants a long-term maintenance contract which covers uncertainties and allows the contractor to optimize the object life cycle value.	Uncertainties are not to be calculated as a fixed price paid by the client, but included in the contract as a variable to be calculated based on future scenarios.
	- What the client is able to:	The client is able to formulate its definition of values and to measure this transparently in the tender and contract.	Application of methods for value quantification and value-based (instead of low-price based) tender evaluation.
	- How the project is characterized:	The object exists for a considerably long time needs maintenance interventions during its life cycle.	Cost effective decisions on maintenance intervention are based on a dynamic model to compare the generated added value (for instance to prolong the object life cycle and function) and the cumulative costs.
	- How the market and regulations are organized:	The private-sector parties have adequate experience with long term maintenance contracts for similar projects and can show their potential of innovative maintenance initiatives.	A contract period which is long enough for the contractor to find and implement innovation, but also short enough for a competitive market when a new contractor is assigned after a contract period.

Table 1: Example of some elements of the model to support the client in optimizing an integrated contract

5 CONCLUDING REMARKS

Innovative tendering and contracting require innovative instruments and supporting tools. Integrated contracts place a greater responsibility on the contractor for the design and realization, and in some cases also for the maintenance, financing, and operation of a construction project. In addition, integrated contracts enable the most creative solutions to be obtained from the market and a clear picture of the case-specific risks to be formed beforehand. However, the knowledge and experience of applying integrated contracts is still rather limited, especially at the public clients in the Netherlands as observed in this paper. The clients need appropriate instruments and supporting tools in deciding the most appropriate type of integrated contract and optimizing it.

The proposed model as described in this research may provide a better structure and a greater insight into many aspects involved in integrated contract. Subsequently, a better formulation of client's requirements and criteria for tendering may in turn stimulate innovation from the supply side. The model is intended to become a part of the toolbox in the Decision Support System which has been developed in relation to the guideline for integrated contracts in the Netherlands. Since the model also intends to transform theoretical concepts, such as the Living Building Concept, into practical instruments, a close and sustainable cooperation between academic experts and professionals is essential. In the next step of the research, the aspects, criteria, innovative principles, and proposed additional contractual elements in the model will be validated by these experts and tested in pilot projects.

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