Performance Based Dynamic Contracting Mechanism

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Abstract— **Road infrastructure contracting is becoming more complex due to changing transport needs, new technology and because of these changed circumstances requirements will be different in the near future. Transportation agencies are struggling with this increased complexity and major changes in traditional construction procedures, including outsourcing of entire sections of roads, maintenance activities included. Providing timely improvement of transportation facilities is one of the major goal of agencies for their assets. Around the world, agencies have developed a variety of methods for undertaking outsourcing initiatives known as performance based contracting and total asset management planning. This paper investigates how to deal with changing circumstances in the outsourcing of construction and maintenance activities with respect to the Dutch national road network system. It is based upon work in performance based contracting in the Netherlands. With respect to the growing changes, performance measurement and development has emerged as a useful tool for transportation agencies. Using data from maintenance contracts from Rijkswaterstaat [1], we will develop a framework that can be used to compare several contracting practices and establish performance levels, by using variables such as performance measurements. Our methodology offers enhancement of significant improvements to road network performance outcomes, which enables an organization to maximize value and deliver its objectives in an effective way. The process can be used as an integrated approach to reducing agency costs and risks, while maintaining, upgrading and operating assets. The outcomes are useful to transportation agencies for making decisions about contract price methods based economic rationale.**

I. Introduction

The road infrastructure network system is rapidly changing due to developing economies, technological advances, demand for better quality, financial possibilities, budget constraints as well as changing requirements and regulations. Transportation agencies are struggling with increasing complexity and major changes in their traditional construction procedures, including the outsourcing of entire sections of road maintenance activities.

The accelerating growth of traffic and circumstances of changing requirements increasingly cause complex problems for road network systems. As the key component of this complexity is a gap in the life-cycle approach of the road network system. The faced problem is rapid changes in requirements (caused by human behavior) but the other side road design construction and maintenance activities are more slowly developing.

Developed countries have discovered that traditional ways of contracting, and project delivery methods do not meet current demands. Nowadays countries are paying more attention to adapting their road network system to changing circumstances with new perspectives for design management and maintenance of infrastructures. Providing timely improvement and delivering sustainable value for transportation facilities is a major goal of agencies for their assets.

Evolution of new methods for delivering road maintenance is one of the biggest and most common concerns for transportation agencies, because their revenue makes a large contribution to social value. Exploring cases in several road agencies around the world, governments are placing greater pressure on them to continue improvement of performance of road network and contracting mechanisms. The problems in Dutch road infrastructure network can be attributed to circumstances of changing accessibility and mobility during the construction process in terms of the dynamic character of the process.

This paper aims to provide answer of "how to deal with changing circumstances in the outsourcing of construction and maintenance activities in the Dutch road network system.

Road authorities need to realize that the environment of outsourcing initiatives which fix prices for long lead times in contracts results in failings of effectiveness and efficiency. Examining the proper relationship between road infrastructure contracting procedures and social benefit can be complex for outsourcing, due not to only long lead times but also to uncertainty about the future and suboptimal arrangements between parties such as asset owners and service providers. The lack of coherent processes between owner and contractors, lack of innovation, focus on lowest cost and fixed contracts reduces outsourcing initiatives and further implementation of contracting mechanisms.

During the lifetime of such contracts, the environment of the contract changes, information about relevant external factors is updated, client needs and therefore contracts goals will change [1]. There are a great variety of methods for undertaking outsourcing initiatives known as performance based contracting and total asset management planning. The concept presented in this paper is an introduction to the Dynamic Contracting mechanism (which contracts can be dynamically controlled and based on maximization of life cycle value delivery for road network systems) and based upon work in performance based contracting in the Netherlands.

In a rapid and continuously changing world, the road transport system is so flexible that it has the capacity to rapidly react to all new change and immediately redesign itself [2]. Areas where change might be necessary include performance metrics for road network systems. With respect to growing challenges and changes, performance

Rijkswaterstaat [1]; is the executive agency of the Ministry of Infrastructure and Environment in the Netherlands.

measurement and development has provided useful tool for transportation agencies. Rijkswaterstaat will have to provide assets, comply with demands and maintain a performance obligation for the outsourcing of work for the Dutch road network system. Outsourcing initiatives is designed to give an impulse to modernization in the field of value management. Value management for road network systems in the procurement phase must be performance based, not price based.

This provisional framework recommends that a Dynamic contracting mechanism is used to develop a set of requirements that establish goals and objectives with regard to project integrity and performance outcomes for the Dutch road network system.

II. COMPLEX PROBLEMS AND CHANGES IN DUTCH ROAD NETWORK SYTEM

The Dutch are used to a high standard of road network and their expectations are growing rapidly in a changing world. This imposes high demands both on the construction of new infrastructure as on the maintenance and operation of existing facilities [3]. As an executive agency Rijkswaterstaat develops and maintains the national infrastructure networks [4]. With respect to increasing demands, Rijkswaterstaat must continue to deliver services and facilities in an appropriate way in the Netherlands. ‘

Today’s road infrastructure contracting mechanism is becoming more complex, not only in the Netherlands but also all around the world. In the Netherlands we are now dealing with the first stages of introducing asset management [5]. Dealing with changes and organizing the life cycle process is complicated in asset management issues. The key components of the complexity of performance of road network systems are the gaps in the life cycle approach and non-correspondence between changing requirements and contracting methods. The conflict between Rijkswaterstaat and contractors as well as the static procurement of projects cause inefficient service delivery. The lack of coherent process between owners and contractors, lack of management perception, gaps in service quality and delivery, and focus on lowest cost, and fixed price based contracts reduce outsourcing and further implementation of innovative contracting mechanisms. For such reasons, unclear situations are reached and cost effects become negotiated.

A. Changes

Change is the only constant. Changes are regular instead of exceptions and should be incorporated in the contracts between demanding and supplying parties [6]. A successful outsourcing arrangement between these parties requires a mutual agreement to deal with changes and to improve service delivery for road network system. The relations between demanding and supplying parties as a part of an asset management system can be associated with the changing of network system process. (Figure 1)

The changes that occur during the contracting period can come from a range of sources. The factors that influence the road network system can be explored by looking at drivers for change from parties involved and policy loads in asset management strategies. The drivers of change motivate Rijkswaterstaat to expand contracting mechanisms for their assets.

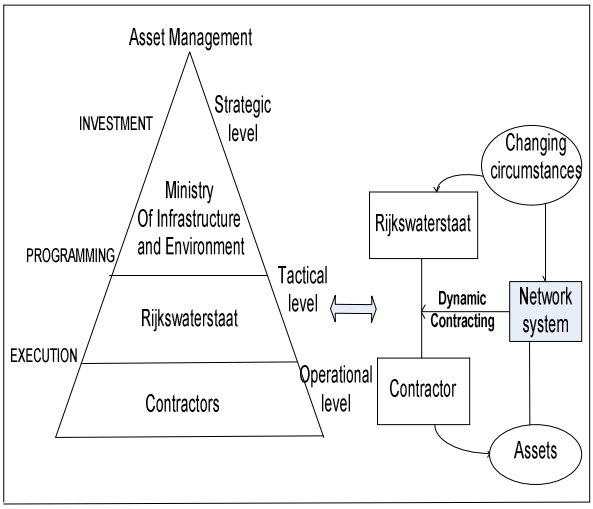

Fig. 1. Road contracting mechanism in relation to the road network and asset management system

Drivers for change from parties involved could include:

- Evolving of service provider requirements
- Restructuring of organizations
- Significant revisions on strategic, tactical and operational levels
- Responsibilities of institutions
- Cooperation between parties
- Risk allocation

Drivers for change from policy loads could include:

- Developments in technology
- Economic trends that affect profitability and social benefits
- Regulations
- Financial environment
- Climate change

It is preferable to identify the total needs of the project during the early stages but this is not always possible [7]. In this constant change, contracting arrangements must be adaptable dynamic mechanisms of life cycle management. In order to analyze the life cycle approach accompanied with asset management strategies, it is necessary to describe attributes of changing circumstances in a function of time. (Figure 2)

III. LIFE CYCLE VALUE OF ROAD NETWORKS

Life cycle asset management focuses on management options and strategies considering all relevant economic and physical consequences, from initial planning through to disposal [8].

In the road network system traditional contractual arrangements have been implemented with a single contract including all efforts and risks, which fixes the price for the life cycle of a project regardless of unexpected events. Demand is fixed in the early design phase and supply is only characterized by initial requirements of the road network. Assumptions made in the beginning of the process appear often to be not correct during the process leading to cost and time overruns, and not delivering the value agreed [9].

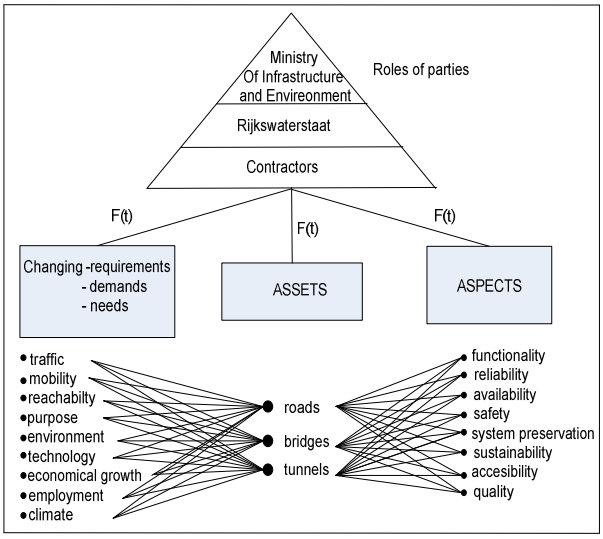

Fig. 2. Changing circumstances related to Aspects

Unfortunately some fixed price oriented road network projects falter because there is no single right way to respond the changes and adoption to alternative formats and may also worsen the problem of uncertainty and knowledge gaps. These uncertainties, such as, issues that are still unknown for the project, altering circumstances through the project and differences in multi agents systems call for a shift from traditional contracting with fixed prices to new contracting mechanisms which provide continuous value for the asset life cycle. To ensure the effective life cycle value delivery, such a contract if adequately implemented, should be robust to changes.

The concept of this new mechanism is an introduction to dynamic contracting that enables dealing with changing circumstances and providing incentives to achieve desired life cycle value delivery and quality of outsourced road networks. This mechanism defines new principles of relation between assets and environment of road network systems, alliances between involved parties structured at strategic, tactical and operational levels, procurement of value-price-cost strategies and consequently comprehensive and extensive understanding of business, relationships between all parties, network system and life cycle approaches associated with dynamic demand and supply strategies in asset management.

Nowadays, the most recent evaluation of outsourcing maintenance contracting is focused on the life cycle value to achieve performance standards. Life cycle value has been examined in parts of life cycle asset management, value management and engineering in literature. Value management is considered critical to the success of projects due to its ability to provide a basis for improving value for money in construction [10]. Life cycle value can enable a broader assessment of value for money than one based on cost alone. However cost alone based projects may only represent a small facet of the asset management system. Demanding and supplying parties tackle the broader issue of applying life cycle asset management to achieve the highest possible benefit.

This can be realized by combining value management, life cycle costing and life cycle asset management methods. When the total value could be interconnected qualitatively and quantitatively to the total costs of a built service and parties would agree on the algorithm between value and costs, than the collective of demanding and supplying parties can aim the process at achieving the highest possible benefit to the mutual advantage of both demanding and supplying parties [9]. (Figure 3)

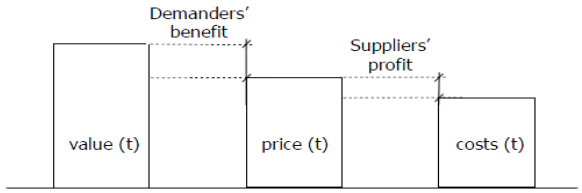

Fig. 3. Value, price and costs as time dependant variables [9]

Any technique that attempts to account for asset life cycle value should strive for maximization of value and decreased cost levels, and the positive balance between value, price and cost. Each party, to ensure delivery of the desired level of service for the road network system will then not indicate certain performance outputs against lowest fixed price but rather specify a balance pertaining to performance and price. This higher customer satisfaction oriented arrangement can then react quickly against demand and supply changes. Within such arrangement, the process can then be dynamically controlled, i.e. clients can alter their initial demand and calculate the impact on the initial price, and vice versa supplying parties are enabled to come up with new solutions that may reduce costs, or delivered additional value [9]. (Figure 4)

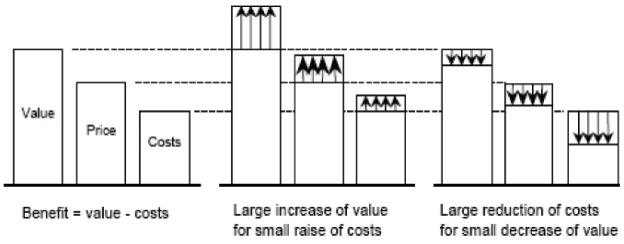

Fig. 4. Mechanism of dynamic control [9]

IV. LIFE CYCLE SERVICE DELIVERY PROCESS

The primary concern of Rijkswaterstaat is to optimize the difference between value and price to come up with new solutions for dynamic changes of demand and supply in the Dutch road network system. The primary interest of value supplying parties is to optimize the profit [11]. This means that value price and costs must be balanced in the most beneficial way for the involved parties, thus for value demanding parties as well as value supplying parties [12]. (Figure 5)

This balancing is a continuous process for life cycle service delivery. Project outcomes, performance levels and contracting methods are influenced by this balanced process. Therefore VPC (value-price-cost) model and evaluation

techniques must be linked to outsourcing and contracting methods for the Dutch road network system.

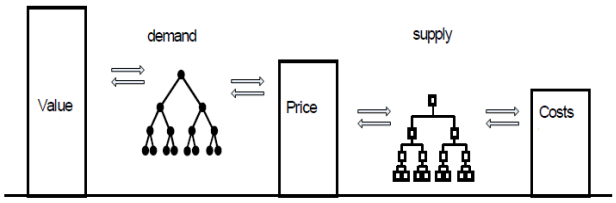

Fig. 5. Two directional coupling between value price and costs [12]

Since roads are infrastructural assets with long lives, maintenance activities need to be viewed from a life cycle perspective if an optimal balance is to be obtained between benefits and costs, and to assist in agreement between central and local road authorities on appropriate levels of service to provide road users [13].

The concept of the dynamic contracting mechanism approach that enables it to deal with demand and supply changes can be integrated into the VPC model. Figure 6 portrays a framework of linkage between a dynamic contracting mechanism and the VPC model. Notions of integration between VPC model and dynamic contracting can be used for optimal balance on benefits and costs and to identify best practices for life cycle value delivery. These notions form the basis of 'value for money' and 'money for value' objectives, especially for clients and contractors.

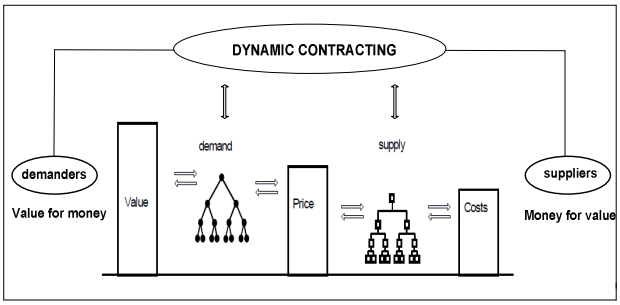

Fig. 6. Value, price and cost model integrated with dynamic contracting

V. LIFE CYCLE PERFORMANCE MEASUREMENT OF THE DUTCH ROAD NETWORK SYSTEM

Performance measurement is an essential part of modern road asset management system. Monitoring asset condition and performance throughout the asset lifecycle is important in order to identify under performing assets or those which are about to fail [8].

Particularly for road assets, the ultimate purpose of measuring and monitoring performance is to improve transportation services for users. This is in fact essential for assessing the current and future state of road infrastructure, as well as agency/institutional efficiency in service and safety provision for users, productivity, cost effectiveness, environmental protection, preservation of investment and other functions [14]. With the expectation that what is measured can be better managed, performance measurement is being a core component of management processes in public sector agencies [15]. The performance measurement for road networks is an integral component and a useful tool for infrastructural asset management system. Figure 7 provides an overview of life cycle asset management processes and interconnection with performance measurement.

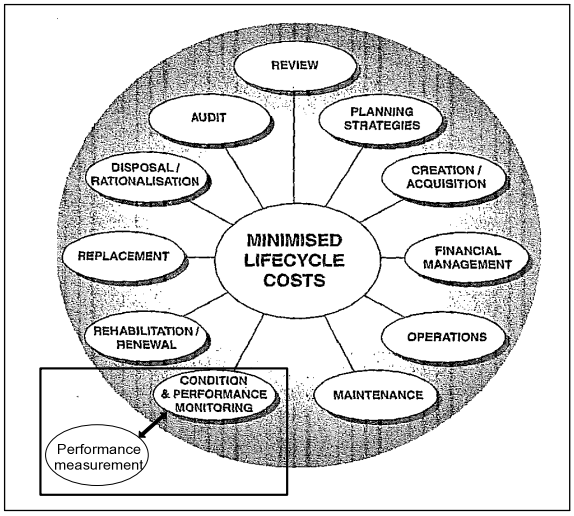

Fig. 7. Life cycle asset management interconnection with performance measurement

In a life cycle asset management approach the implementation of effective and the successful contracting out of road network maintenance activities relies on the use of performance measures to deal with changing circumstances. Minimum requirements and service levels can be defined through performance measures and these can be used by performance based dynamic contracting mechanism to define and measure the desired performance of contractors.

Performance, cost, value and price are front and centre in most transportation agencies for decision making. Performance measures work best as targets for cost minimization and value maximization in performance based contracting mechanisms. The performance of a road network can be directly tied to the system of transportation by value on one side and cost on the other side.

Transportation agencies are now expected to meet service level targets at reduced cost and explore the value of distinctive aspects as a driving force behind performance measurement. Value can be explored from different point of view, the psychological value is given by the architecture (form), the economical value is given by the function (capacity and quantity) and the technological value is given by quality [16].

Dynamic contracting mechanism can provide important inputs to set values (architecture quality and quantity) and provide a price based payment mechanism that helps parties to operate and maintain in an environment where there is much greater emphasis on goals and objectives for road network system under performance measurement.

VI. DISCUSSION AND CONCLUSION

The lack of a coherent process between owners and contractors, lack of innovation, focus on lowest cost and fixed

contracts reduces outsourcing initiatives and further implementation of contracting mechanisms.

The development towards the road asset management system at the moment in the Netherlands, requires dealing with the dynamic circumstances of the road network system. The provisional framework dynamic contracting for the Dutch road network contracting mechanism is meant to investigate the changing circumstances during the life cycle of a project, based on dynamic value cost calculations and life cycle performance measurement. In addition, the research is aimed at the further development of proper relationships between road infrastructure contracting procedures and social benefit that include effective arrangements for outsourcing maintenance contracts.

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