**Public-Private Partnerships as Collaborative Projects: testing the theory on cases from EU and Russia***

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**ABSTRACT**

How do public-private partnerships (PPP) differ from traditional public procurement and what role should governments play in them? This paper views PPPs as collaborative projects with imperfect information between parties. Typical public procurement contracts tackle asymmetric information problems, yet limit feasibility of projects: some are not profitable enough to ensure private party participation. Partnership improves feasibility; this justifies PPPs as a form of public good provision, and demonstrates how they differ from procurement. Four UK and Russian cases of PPP projects are analysed within the above framework, focusing on types of contracts, contributions of both partners, and specific partnership elements.

**Keywords**: public-private partnerships, public finance, contracting

*This work has been funded by the Russian Academic Excellence Project '5-100'

## 1. Introduction

Public-private partnerships (PPP) are a popular form of public good provision jointly by government (municipal) bodies and private entrepreneurs. Opinions on the societal role of PPP range from extremely positive (Lattemann et al., 2009) through moderately critical (Regan et al., 2011) to explicitly negative (Coulson, 2005; Siemiatycki, 2011), see also a discussion of various views on the public value of partnerships in Reynaers and De Graaf (2014). A review of approaches to and experiences with PPP is in Hodge and Greve (2007). PPPs are usually seen as an alternative to outsourcing (contracting out), privatization or public provision of public goods (Joha and Janssen, 2010, Stiglitz, 2002). Yet, as emphasized by Stiglitz (2002), one question is what role government should play in the partnerships. Of equal importance is how to contractually combine the contributions from the government and the private party. In practice, various types of contracts are in use. For example, in PPPs that have been formed to construct and renovate public buildings in The Netherlands, private partners are paid upon delivery of services (CMS, 2010)[1], based on their actual inputs. In Finland the E75 and E18 roads were built by PPPs on concession contracts with a fixed and irrevocable proportion of gross payment for services coming after the roads are put in use (CEDR, 2009)[2]. Therefore the question in this paper is twofold: how should public and private contributions be optimally combined in one collaborative contract enabling such a partnership, and what does the "partnership" element add on top of standard cooperation?

Much formal analysis of PPP usually resorts to contract theory. For example, one significant strand of literature investigates whether some or all tasks within one, typically infrastructure, project should be *delegated* to a single private partner (Bennett and Iossa, 2006; Martimort and Pouyet, 2008; Maskin and Tirole, 2008; Chen and Chiu, 2010). This "bundling" of consecutive tasks creates incentives for the private partner to perform well during the earlier stages of the project as this influences the outcomes at later stages, affecting the same private partner. At the same time, this approach “unbundles” contributions of the public partner from the project, and ignores benefits potentially arising through close collaboration. Suggesting an alternative approach, this paper considers PPP and the relevant types of contracts from the perspective of *collaborative* projects under asymmetric information (e.g. Roels et al., 2010; Kim and Netessine, 2013). Parties do not observe each other’s contributions; contracts serve to ensure appropriate incentives to contribute to the project, however contributions may need to be verified, which is costly. These verification and project management costs in standard contracts often impede the implementation of some projects. Are partnerships any different?

Although the interpretation of the term "partnership" varies in the literature (and across disciplines), most authors agree that a partnership involves "the closest possible cooperation" (this definition of a "partnership principle" is extensively used in the EU integration policy documents, see e.g. Allen et al., 2005, p.218; Dahl et al., 2014), agreement on objectives (Brinkerhoff, 2002) and different degrees of formality, "ranging from informal, oral understandings to formal agreements" (Erhard and Brigham, 2006, p.4). Bajwa et al. (2017) emphasize interdependencies that arise in a PPP and the role they play for the successful delivery of the project. The partnership element in a project may ensure facilitation of co-production through improved communication and knowledge spillovers, as well as potentially bringing other benefits to the private partner, such as reputational gain. For example, Roberts and Siemiatycki (2015) advance the argument that a partnership delivers deeper cooperation and thus improved performance. This outcome may serve to improve the feasibility of projects, especially of those that cannot be implemented under standard contract terms. From within this framework one derives optimal types of contracts and conditions to form a successful PPP.

To validate the above proposed view of PPP as collaborative projects with a partnership element, and to test whether this theoretical framework explains the actual choice of contractual arrangements, this paper further investigates four PPP cases, focusing on the combination of public and private resources, information frictions, and types of contracts chosen to enable the partnership in each of the cases. The analysis also highlights the real-life provisions that distinguish the partnerships from other types of cooperation. Given that data on contract types and exact inputs of public and private partners in a PPP are not always disclosed, quantitative analysis is not really feasible, while a case study approach has the benefit of combining and analysing data from various available sources. Departing from the traditional infrastructure and building examples of PPP, this paper presents cases in waste management and traffic control. The cases selected, are from either an economy with a rather well-developed PPP sector and extensive experiences of collaboration between the public and the private sectors (the United Kingdom, UK) or an economy where this sector and relevant experiences are still very much emerging (the Russian Federation, RF). The first PFIs were introduced in the UK in 1992, with 641 contracts having been signed by 2009 (Hellowell, 2010), while in Russia PPPs started in 2005, when the Law on Concessions was adopted, with only 53 projects reported by 2012 (Yarmalchuk, 2012). However, the Russian PPP sector continues to undergo rapid development: 68 regional Laws on PPP were introduced by the end of 2015, allowing for a variety of partnerships and selection procedures. While 1285 projects have been listed in the register of the RF unified information system of public-private partnerships by the time of writing of this paper.[3] A recent PPP development ranking of Russian regions[4] estimates that 73% of PPPs in Russia run as a concession project, 17.5% adopt alternative forms allowed by regional PPP laws, and the remainder are mainly through the lease of public assets. Russian PPPs are predominantly in the utilities sector (33.1%), social services (28%), energy (27.8%) and transportation (10.9%). For more details on the Russian PPP sector see, for example, Mouraviev et al. (2012) and Yarmalchuk (2012).

The main theoretical conclusion of this paper is that PPPs are only justified for projects where the verification costs of the actual contribution of each party is high, and which have high sensitivity to those inputs as any deviation from the plan may significantly impact the outcome. If the verification of inputs is too expensive, a concession approach becomes the optimal PPP arrangement. Otherwise, a PPP should either pay the private partner stage by stage for inputs provided, or make a bulk payment once the project is completed and approved. Despite different institutional environments in the UK and RF, similar arrangements are in use in both countries, and the proposed theoretical framework successfully explains their application, as evidenced by the cases considered in this paper. These cases, chosen to be representative, expose the main components of the model, i.e. the contributions of the parties, the difficulty of establishing their actual inputs or the impossibility to credibly observe them (especially if these are intangible, like knowledge and expertise, or dispersed in space and time, like materials used to construct a road segment in remote and hard-to-reach areas), the sensitivity of the outcome to those inputs, and, ultimately, the type of the contract used to run the PPP. The latter is then compared with what would be optimal from the perspective of the theoretical model developed here.

## 2. Theoretical framework

### 2.1. Collaboration and partnership principle

Collaboration involves the consolidation of resources of the public and private party and the coordination of their actions when working on a project. Consolidation is justified when parties have comparative advantages in the provision of various resources, where each party should supply the resource that it can provide at a lower cost. Contributions to PPPs do not need to be limited to labour, capital and materials; additionally, the private party provides valuable managerial skills ensuring efficiency (a review of literature on advantages of private businesses as compared to public ones is in Megginson and Netter, 2001; in a later work, Bartel and Harrison, 2005, explicitly show that in comparable conditions performance of public sector enterprises is below that of their private-sector peers.) The most common resources supplied by the public partner include land, access to funding, and human capital that brings in specialized knowledge and expertise (Besley and Ghatak, 2001) as well as administrative experience and skills (Mahalingam et al., 2011), particularly in the area of reducing compliance and red-tape costs (Vinogradov et al., 2014).

On top of the consolidation of resources, a PPP is based on a *partnership principle* where partners mutually agree on their objectives and rationally divide resource provision based on their respective comparative strengths (Brinkerhoff, 2002). Hodge and Greve (2007) note that the mutuality, i.e. interdependence and equality in decision-making as well as equal benefits to parties, constitute an important aspect of partnerships. Such a mutual agreement on objectives would also involve optimal sharing of risks, often seen as a crucial element of a PPP (e.g. van Ham and Koppenjan, 2001; Koppenjan and Enserink, 2009). To date, however, the partnership element of PPP is neither clearly defined nor exhaustively discussed in the PPP literature, although some definitions of PPP explicitly mention true partnership as a criterion (e.g. European Commission, 2003). In corporate finance a partnership is known as an association "to conduct a noncorporate business", as in Erhardt and Brigham (2006, p.4). They elaborate on this definition further to stress that "partnerships may operate under different degrees of formality, ranging from informal, oral understandings to formal agreements filed with the secretary of the state in which the partnership was formed. The major advantage of a partnership is its low cost and ease of formation. The disadvantages are... (1) unlimited liability, (2) limited life of the organization, (3) difficulty transferring ownership, and (4) difficulty raising large amounts of capital.... under partnership law, each partner is liable for the business's debts". This is in line with the "partnership principle" advanced here, as unlimited liability of both partners creates incentives to care about the ability of the other partner to meet obligations. Yet when the "other partner" is the state, "unlimited liability" does not seem to work the same way. Therefore the model in the current paper explicitly requires that both partners are concerned about the overall success of the project.

## 2.2. Projects and contracts

This section is based on results formally derived in the working paper version of this article, see Vinogradov and Shadrina (2016); similar results for collaborative services are in Roels et al. (2010). A more detailed non-technical exposition of the framework with a focus on the institutional setting is in Vinogradov et al. (2014).

A consolidated project is characterized by the inputs (contributions) of the two parties and by the *sensitivity*[5] of the project to the parties' inputs. As an illustration, using lower quality building materials would require more frequent repair, and result in a higher maintenance cost of for example a road or other infrastructure objects, thus lowering their social value; these projects may be referred to as sensitive to the private party input. In addition, they are also sensitive to the input of the public party, which usually contributes at the planning and design stage. The sensitivity to the public input in this type of case can be higher than the sensitivity to the private one if, for instance, a road is planned without a proper account of social needs (wrong place or wrong capacity). Real-life examples of project sensitivity in waste management and traffic control can be found in Section 3.

Collaboration is advantageous as it brings cost-efficiency, yet it may also be costly due to asymmetric information if the parties do not freely observe each other's inputs. To give an example, a commissioning authority may be unaware of the exact number of workers employed or of the amount of materials used to construct a bridge, yet can obtain this information at some cost, for instance, through monitoring. Even if individual inputs are observed by the two parties, it is important that they are also verifiable when it comes to dispute resolutions. A project may fail due to the insufficient involvement of the public authority, yet either the private contractor will have to prove this in a court of law, or the public party will have to provide the evidence of appropriate involvement, requiring information verification costs in both cases. A similar situation occurs if the insufficient contribution is on the private side.

If a party provides less resource than contractually agreed, it is subject to penalties. Penalties can be monetary or non-pecuniary, associated with the loss of reputation and foregone future profit opportunities. For the private partner the penalty may include the value of their physical assets (bankruptcy value). The harshest penalty that can be imposed on a public partner is the exhaustion of their reserves and the dismissal of the relevant public managers. An example of a monetary penalty paid by a public partner is £30m paid by the Norfolk County Council to the Cory Wheelabrator Consortium for abandoning the Willows incinerator project at King's Lynn in the UK.[6] In terms of the framework adopted in this paper, the public party delivered less resource than agreed, which caused the failure of the project. The specific resource in question here is the approval of the project and securing the state funding for it (the main reason for abandoning the project were 92% local citizens voting against the project and the subsequent withdrawal of the £169m government grant). The penalty imposed on the council entails £19m from current reserves and £11m from future savings, implying a longer lasting burden for other local projects and reputational damage.

A contract between a public and private party specifies their respective inputs, the remuneration due the private partner, the liabilities of the parties (in particular, penalties), and, in the framework used here, the type of reporting on costs and contributions (input verification). Even if the mode of information verification is not clearly specified in the contract, one can associate it with parties' beliefs in regard to which of them will *actually* be monitored or should credibly report on inputs provided. In some institutional settings it is the private party that is more likely to have to provide evidence of meeting the terms of the contract, therefore if the contract is silent on this issue, it implicitly assumes the verification of the private party's input. Three types of contract are conceivable: those where only public input or private input is verified respectively, or where no input verification is conducted. The verification of both parties' inputs is unnecessary because knowing the outcome of the project and the credibly verified input of one party should suffice to establish whether the other party underprovides.[7]

The public partner designs the contract with an objective to maximise the project's social value, minus the costs of its provision and the related verification costs. Verification is only needed for the actual input and not for the cost. The private party's remuneration for their input is established through a *price revelation mechanism*, such as a bidding/auction phase or a tendering procedure. This ensures not only that the most cost-efficient private partner is chosen but also that this partner reveals the lowest payoff they would accept for the provision of these resources. A contract with the verification of the private party's input will specify that the private partner is only paid once inputs are confirmed. This approach is referred to as an *input-contingent* contract (IC-contract); it encompasses agreements where the private party is paid either on an hourly basis or for a specified contribution to the overall project, yet not contingent on the success of the project as a whole.

If the contract stipulates it is the contribution of the public partner that is to be verified, the private partner is paid (as determined by the bidding phase) only if the project is successfully completed. This is because the exact contribution of the private partner cannot be credibly established; yet the success of the project (achieving the target value) implies agreed resources were delivered in full, and hence payment is due. If the project fails, and it is established that the public partner delivered in line with the agreement, this implies that the private partner failed to meet the terms of the contract, and penalties are imposed. Alternatively, if the public party failed to deliver, it is accordingly penalised in favour of the private party. This type of contract is referred to as *output-contingent* (OC-contract).

An alternative to the two types of contracts above that verify contributions of the parties, is a contract that creates incentives for the private partner to properly contribute to the project without actually verifying their inputs. This can be achieved by making the remuneration dependent on the value that the project generates. Theoretically, contracts of this sort (*performance-based*, PB-contracts) are justified in microeconomics (e.g. Bhattacharya and

Lafontaine, 1995; Kim and Wang, 1998) for the cases where, as in the context of this study, each party has an incentive to minimise their inputs and let their counterpart bear the costs. Practically, this type of concession approach is a good example often used in PPP: the private party operates an infrastructure object and derives profit from payments by the end users or by the government, proportional to the actual usage of that object. In this case, the higher the social value of the object, the more intensively it is used, the higher is the payoff to the private party.

A project is *feasible* if both parties agree to implement it by entering one of the above contractual agreements. The optimal contract is chosen by comparing the total surplus generated by the project under different contractual provisions. In the input- and output-contingent contracts input verification raises the effective cost of resources. It is therefore necessary to compare the cost *with* and *without* verification. An important parameter for this comparison is the verification cost *relative* to the pure provision cost, i.e. by how much more expensive (%) in total would be a particular resource if one has to monitor its provision. This is what this study understands as a *verification cost* throughout the analysis. For example, a complex bridge incurs higher costs of resources (per unit) than a road because a bridge would involve unique solutions, while constructing a road involves a repetition of more standard techniques at each segment of the road. At the same time, it is easier to verify the quality of the bridge and the resources actually used by parties, as it is one localised object, while it is more expensive to monitor the actual provision of resources for each mile of a road. For these reasons, the verification cost (relative to the provision cost) is expected to be lower for the bridge and higher for the road. Even if resources of both parties have identical provision and verification costs, different contracts imply different *effective* cost. In the OC-contract it is the public input that is verified and therefore becomes more costly than the private input. In the IC-contract (private input verified) the private input will be more expensive when verification costs are taken into account. The sensitivity of the project to inputs determines then the type of the optimal contract: the OC-contract (public input verified) is preferred to the IC-contract (private input verified) if the project is less sensitive to the public input than to the private input, and vice versa. This is because choosing a contract that incurs verification cost for the input of the public party (OC-contract) reduces the optimal amount of this input (due to its higher overall cost compared to the contract with no verification of this input), which does affect the final value of the project, yet this impact is smaller if the project has lower sensitivity to this resource. In Figure 1, OC-contracts are shown optimal for projects with low sensitivity to public input and high sensitivity to private input (vice versa for IC-contracts).

Unlike IC and OC contracts, verification costs are not present in the PB-contract. There is a trade-off between paying for information verification but achieving maximum value out of the project, and saving on the verification cost but reducing the project's value (incentives without verification are weaker, hence the contribution of the parties within a PB-contract is lower than in the first-best case). If verification costs are high, a PB-contract would be preferable to both IC and OC. However this would only hold true if the sensitivity of the project to the inputs is rather low, otherwise even a small reduction in the input due to weaker incentives would lead to a severe loss of the value for the project. For this reason, PB-contracts cannot outperform IC and OC contracts at higher values of sensitivities. In Figure 1, therefore, PB-contracts are shown optimal only for projects with rather low sensitivity to inputs.

Not all projects are feasible even if contracts are optimally designed. One reason for this are verification costs. Projects with high sensitivity to both inputs and with relatively high verification costs are likely to be impractical because they become too costly with IC- and

OC-contracts, and generate a too low value with a PB-contract. Additionally projects may not be feasible due to the remuneration of the private partner. The latter can be broken down into the compensation for resources provided, which can be measured per unit of resources, and a lump-sum amount, which does not depend on the actual contribution. This lump-sum amount may be needed to cover the sunk costs of starting the project, costs unrelated to the inputs, as well as a premium for working with the government. The lump-sum part of the remuneration represents a *participation threshold* for the private partner: even if the required input is small, a private partner would not be interested in taking part in the project if the payoff is below their acceptable threshold. The value of the project may be insufficient to justify high payoffs to the private partner, thus making the project infeasible for the public partner. Note that these projects despite not being financially viable may still be socially desirable.

Finally, the partnership principle either brings extra benefits to the private partner, for which reason it can lower the participation threshold, or improves productivity of resources due to a deeper cooperation and thus saves on the production cost. Both improve the feasibility of projects. A reduction in the information and production cost come through the close cooperation and aligned objectives. Reputational gains, implicit guarantees and start-up assistance provided by the government may also contribute to a reduction in the participation threshold. PPP units designed to promote and develop partnerships with the private sector and aimed at assisting the projects are an example of institutional arrangements that reduce the participation threshold (OECD, 2010, offers a review of PPP units and their functions in OECD countries.)

Reduced participation threshold and lower information and production costs enable the implementation of projects that would be infeasible under standard contract conditions. This aspect of PPP is demonstrated in Figure 1, which summarizes the core of the theoretical framework used here. Infeasible projects are now those that cannot be implemented even through PPP, while the area of PPP projects corresponds to those that would be infeasible under standard contractual conditions, without the partnership element, yet may be implemented through a PPP. This justifies PPPs as arrangements that outperform other forms of public good provision. IC-contracts are optimal for projects with higher sensitivity to the public input, OC-contracts for projects with higher sensitivity to private input, and PB-contracts outperform the two for projects with low sensitivity to both inputs. Because a PPP employs the same three types of contracts, they are shown in brackets. In Figure 1(a), verification costs and the participation threshold are small, for which reason the benefits from a PPP are rather small: establishing a PPP would enable implementation of a small number of specific projects that were not otherwise feasible. When, however, information costs and participation threshold are high, establishing a PPP can be highly beneficial for a large number of otherwise infeasible projects, as in Figure 1 (b).

[Insert Figure 1 around here]

### 2.3. Implications for optimal PPP arrangements

The choice of the optimal contract for a PPP depends simultaneously on the project parameters (such as its sensitivity to inputs, and costs of verification of those inputs) and on exogenous factors embedded in the participation threshold of the private partner. In particular, the participation threshold depends on risks for the project triggered by actors or circumstances related or not to either of the parties (for example, changes in preferences of the public that might affect the value of the project). Participation thresholds cannot be observed directly, yet one should be able to observe benefits arising from the partnership element affecting thresholds in real-life cases.

**Implication 1:** A PPP is optimal only if the input verification costs and the participation threshold are relatively high; a PPP has a clearly demonstrable partnership element benefiting both parties beyond cooperation achievable in standard contracts.

The infeasibility argument underlines that when the sensitivity of the project to inputs is small, parties can reduce the employment of resources that are too costly to verify, without a significant impact on the project value. For this reason, projects with relatively high sensitivity to both inputs can become infeasible, this is where a PPP can help.

**Implication 2:** A PPP is optimal only for projects with relatively high sensitivity to inputs of either or both parties.

As demonstrated in Figure 1, if verification costs for both inputs are equally small, a PB contract is unlikely to be optimal for a PPP because a better arrangement can be achieved through an IC or OC contract.

**Implication 3:** A PPP through a PB-contract (concession) is optimal only if input verification costs are high.

The choice between the IC and OC contracts depends on the relative verification costs for the inputs. Higher verification cost for the input of private partner makes an IC-contract (with a stage-by-stage verification of the private input) less cost-efficient, and therefore the optimal contract for the project is likely to be output-contingent. Similarly, higher verification costs for the input of the public partner makes the OC-contract less cost-efficient and more likely that the project should run under an IC-contract, as shown in Figure 2. For this reason, if a PPP is being formed, in most cases it should resort to an OC-type of arrangement if private input is more costly to verify, except for very high sensitivities to private input (Figure 3a), or to an IC-arrangement if it is the public input that is more costly to verify, except for very high sensitivities to the public input (Figure 3b). If both are too costly, a concession (PB-contract) is optimal, as above.

**Implication 4:** A PPP through an IC-contract is more likely for projects with more expensive verification of public input; a PPP through an OC-contract is more likely for projects with more expensive verification of private input.

[Insert Figure 2 around here]

[Insert Figure 3 around here]

## 3. Cases

The above three types of collaborative contracts between the public and the private partners are quite common in practice. This framework explains examples of government buildings in the Netherlands (IC-type PPP contract) and roads construction in Finland (concession, PB-type contract) from the Introduction. Note that due to the economies of scale, in large projects costs per unit are typically lower than in smaller projects. A building exemplifies a rather unique project of a smaller size than, for example, a highway. In a building project, the input of the private partner can be relatively easily verified: the construction site is accessible, usually in an urban location, for which reason regular monitoring is not problematic. Architecturally, large buildings, especially in a central location, are rather unique, which implies relatively high production costs per unit of input. Therefore verification costs relative to the provision costs tend to be low, and Implication 3 rules PB-contracts out. Implication 4 suggests that an IC-contract is optimal for these types of building projects, as public input is less specific, and the sensitivity of the outcome to it is rather low. In contrast, large-scale projects like motorways offer opportunities for a reduction in costs per unit through the economy of scale argument, and in particular through a rather routinized repetition of standard actions at each segment of the road. However the length of the project site makes private partner's inputs less observable, suggesting higher input verification costs. As predicted by Implication 3, concession (PB Contract) is more likely to be optimal in this case. The same logic applies to the cases below.

### 3.1. Performance-based contracts in waste management

All cases are presented as a brief summary, sketching out the main building blocks of the theoretical framework, such as the contributions and liabilities of the parties, assessment of the sensitivity of the project to these contributions, the theoretically optimal and the actual contracts. Special emphasis is placed on the partnership elements embedded in the relationship between the parties. The cases also provide information on whether the project is successful or not, where available. Each case is accompanied with a list of case-specific references to original sources of data (see footnotes to individual case subheadings).

#### Case A: Energy From Waste project in Suffolk, UK[8]

**Description**: 25-year, £1-billion private finance initiative (PFI) waste management contract between Suffolk County Council and SITA UK. Includes £185-million incinerator in Great Blakenham (Suffolk, UK), a combined heat and power (CHP) plant, with the capacity to burn up to 269,000 tonnes of residual waste a year and generate enough electricity for 30,000 homes. [1]

**Public party contribution**: Provision of the Great Blakenham site (in the ownership of the

Suffolk Council) on a lease to the private partner (at a peppercorn rent) for the duration of the project, which will revert to Council ownership on expiry of the contract or earlier termination [3]. Minimum guaranteed tonnage of waste to be processed (170,000 tonnes a year). Government grant of about £200 million over 25 years, to contribute towards the running costs [2].

**Private party contribution**: finance, technology, building facilities, management. £180 million Incinerator funded by SITA UK; at the end of the contract, the facility will be owned by Suffolk County Council [2]. Private party outsourced activities to other subcontractors, for example, architecture and design of the building were outsourced to Grimshaw.

**Liabilities of the public party**: payments for an insufficient waste delivery; penalty if project plans withdrawn. Credibility of penalties is evidenced by a similar project in nearby Norfolk, initiated under the same conditions (and subject to the same government regulation), that has been withdrawn by the public party and resulted in penalties paid to the private partner (see example in Section 2.2). Minutes from Suffolk council meetings evidence discussions of the logistic schemes to achieve targets on waste delivery. The risk, of not meeting the waste volume target, is confirmed by estimates that "UK's residual waste treatment capacity will exceed supply in 2017/18" [1].

**Liabilities of the private party**: penalties for broken deadlines, failure to meet standards; business risks, except for the risk of insufficient waste delivery.

**Sensitivity to contributions**: First phase of the project (plant construction) is more sensitive to the contribution of the private party. The second phase (waste processing) is equally sensitive to contributions of both parties, as energy generation depends on the waste collection, as well as on the technology implemented and the quality of materials used in the construction of the waste processing facility.

**Optimal contract**: PB-contract, because project sensitivities to both contributions are equally high. Information costs are high (e.g. verification of the technology employed requires specialized knowledge). If the first phase (plant construction) was unbundled from the second phase, a fixed-fee output-contingent contract would be optimal for the first phase as it is highly sensitive to the contribution of the private partner, and the information cost (verification of the quality of the plant) is high. Due to the high information costs at the first stage, bundling it with the second stage is optimal, as it removes at least one information verification stage, and introduces incentives for the operator to ensure the necessary quality of the facility.

**Actual contract**: PB (concession). The private party derives profits from waste processing fees, depending on the amount of waste processed, as well as from energy generation. The public party shares profit from energy generation (if it exceeds target).

**Partnership element**: close co-operation, as evidenced by the minutes of the Council's Scrutiny committee [4]. Assistance from the public party evidenced by the record-breaking short project approval time. The Council and the Community Liaison Group established by the Private Partner, jointly held meetings with the local community to update on progress and address any issues arising. Although identification of the construction site is usually in the remit of the private partner [5], in this case the site was suggested by the Council from the beginning (and accepted by all four bidders at the procurement stage) [3]. The council site provision reduces risk of proposal being rejected on the basis of suboptimal choice of site (translates in the reduced participation threshold in the model).

**Evidence of success**: The plant opened on time and on budget [1]. Architectural award for the building. Civil Engineering award for the overall project. [2] Successful operation scheme including accommodating extra waste delivered from Norfolk after closure of several sites there.

Average electricity generation 570 MWh per day (daily data available from http://www.suffolkefw.co.uk); this exceeds the predicted energy generation of 225 MWh per day (converted from a figure of 80 000 MWh a year, [6]).

**Other remarks**: the ownership of the facilities is transferred to the public party after 25 years; associated risks (worn out facility, amortization costs, modernization needs) are on the public party. Budget forecasting does not go beyond 25 years, and does not consider these costs.

**Case B: Waste processing in Krasnokamsk, Perm Krai, Russia[9]**

**Description**: Solid household waste (SHW) processing at Bekryata site (Krasnokamsk, Perm Krai[10], Russia). From 2008, the Bekryata landfill site is under the management of the private partner «Bumatika», selected through a competitive procurement procedure. The initial contract was for 10 years. The waste management scheme includes a waste sorting facility, launched in 2008 (the only one in Perm Krai at that time) and fully operating today, with a capacity of 30 tonnes of SHW, capable of separating SHW into 18 fractions. Estimated investment value – RUR 38,5m (approximately £1m in 2008). Total planned investment – RUR 100m. The size of the site –16,7ha. Apart from the sorting facility, the operator introduced modern technologies and equipment for waste compaction and ground densification, reducing water pollution and simplifying future re-cultivation [1, 2]. In November 2013, Bumatika launched the second sorting facility, making it available to local university researchers for experimental studies in waste processing. Altogether, the project includes collection, transportation, storage, sorting and processing of SHW [3, 4].

**Public party contribution**: land (at a peppercorn rent), monopoly waste processing rights in the Krasnokamsk area (where the site is located), red-tape reduction, monitoring of the ecological situation in the region.

**Private party contribution**: finance, technology, facilities, maintenance, management. [5, 6]

**Liabilities of the public party**: no evidence of formal liabilities (penalty sanctions) of the public party. Legal sanctions for improper usage of public (municipal) assets if property rights are not clearly defined. Evidenced by court proceedings investigating the property rights and procedural regularities of setting the rental price in this case [7].

**Liabilities of the private party**: regulatory sanctions if standards not met, business risks; penalty if project is not delivered; the public party has the right to terminate the contract.

**Sensitivity to contributions**: the project is sensitive both to the private and to the public contribution. The private contribution ensures the quality of facilities, including environmental aspects, and partly the waste collection (apart from Bumatika, there are other collectors in the region who deliver waste to the processing facilities of Bumatika). The public contribution affects the amount of waste collected and processed [5, 8]. Unresolved issues with property rights and lease agreement delayed the launch of the facilities [10].

**Optimal contract**: PB-contract, because the sensitivity to both contributions is comparable and rather high. Information costs are relatively high (e.g. verification of timely waste collection).

**Actual contract**: PB-type, similar to concession. The private party derives profits from the waste processing fees, paid by other waste collecting companies, who are paid by households for the collection of waste. Additional profit is derived from sales of recyclable elements of the waste. [11, 12].

**Partnership element**: Assistance from the local administration in promoting separation and collection of waste: subsidies to businesses that separate waste, popularisation of waste separation. The private partner confirms the local administration is interested in and contributes to achieving the objective of improved waste management in the region [9].

**Evidence of success**: The project is still running. A second plant was launched in 2013. RUR 168m (£2.5m) reported revenue and RUR 2.4m (£34 000) net profit in 2013 [13].

**Other remarks**: the lease agreement between Bumatika and the local authority expires in 2019. From 2014-15 there is a surge in the competition in the market for SHW processing in Perm Krai. This creates additional business risks. In 2015 Bumatika has been reportedly acquired by Eco-Systems (Moscow), a company that aims at a consolidation of smaller SHW processing enterprises in the Perm Krai [13].

### 3.2. Fixed-fee contracts in traffic and road safety management[11]

**Case C. Intelligent Traffic Systems in Essex (UK)**

**Description**: As of 2008, Essex had 7500 km of roads and 785,000 registered cars, travelling over 11 million vehicle kilometres annually. Traffic levels were estimated to grow by 2% per year. The county's objectives were to improve the reliability of journey times for car users (increase journey time reliability to 95%) and reduce average journey times (reduce journey times by 1% across the board) [5]. To achieve these objectives, a partnership contract SA2000 between Siemens/Atkins and the Essex County Council (ECC) was signed in 2006 for the period until 2013 [1]. Although formally this contract was announced as commencing in 2006, the actual start of the partnership dates back to 2000, when an initial contract with a total value of £7m was signed until 2013. Interruption and refreshment of the contract in 2006 is due to the programme restructuring on the public side [2]. SA2000 manages the design, supply, installation, maintenance and operation of Intelligent Transport Systems (ITS) in Essex and is responsible for keeping traffic moving. [3]

**Public party contribution**: At the *pre-tender stage*: funding, specification of needs: "…the development of the new contracts [needs to be] properly resourced and evaluated prior to going to tender. It is proposed, therefore, to establish a dedicated multi disciplinary team of staff to deliver the new contracts … some external resource will be required to support internal staff and it is proposed to secure experts from the industry to both provide advice and guidance, and also a resource to meet workload demands. This can be met from existing budgets. The intention is that that the wider industry and our existing partners will also be engaged in this process." [7]

At the *post-tender stage*: the county operates Essex Traffic Control Centre, involving Essex Police, Highways Agency, Regional and National Traffic Control Centre as stakeholders. The Centre is the main focal point for the Intelligent Traffic system and its congestion management: (1) acts as the control room for monitoring the network and implementing intervention strategies in response to planned and unplanned incidents, and (2) provides travel information and advice to the public relating to journey planning. Example of intervention includes changing timings on signal controlled junctions when they "lock up" due to heavy volumes of traffic. [5]

**Private party contribution**: Technology, installation, maintenance of equipment, data collection and processing.

**Liabilities of the public party**: n/a.

**Liabilities of the private party**: the contract can be terminated, as exemplified by the review of the original contract of 2000 in 2006 with a note that despite a good partnership with contractors, there was need for improved contract control and better financial management because "the added value expected from the "partnership" has not materialised to the extent expected" [7].

**Sensitivity to contributions**: High sensitivity to private input (equipment needs to function correctly). High sensitivity to specifications of needs by the public party at the pre-tendering (wrong specifications result in underperformance) and post-tendering stages (the operation of the traffic control centre is crucial for smooth traffic).

**Optimal contract**: fixed fee IC-type. The input of the private party (equipment installed and working) is verifiable at a relatively low cost. The input of the public party (Traffic control centre) to the overall objective of improving traffic and reducing accidents is less visible despite website with live data, radio broadcasting, as it also involves proper and quick response to congestions and accidents, which are more difficult to verify.

**Actual contract**: IC-contract: "the payment mechanism is a combination of actual cost, tendered rates and time" [7].

**Partnership element**: long-term relationship, involvement of the private party at the tender preparation stage (see the pre-tender public party contribution above), increased involvement of the public party at the post-tendering stage. "Siemens and Atkins work with the council to develop a strategic plan to develop such technologies". Contract has not been terminated despite programme restructuring. New "retrofit" programme to replace traffic signals with Siemens LED technology started in 2010 as a sign of continuing relationship [4]. Additional stimulus for the public party (ECC) through the Local Area Agreement (LAA) with the Department for Transport in 2006 to deliver improved journey time reliability across the Essex road network. This agreement included an element of pump-priming and, on successful achievement of the targets, significant reward funding of nearly £3m [5]. Maintenance cost on SA2000 contract reduced through on-road advertising by an additional agreement with Siemens [6]. "To ensure a strong partnership" regular meetings between the parties take place [7].

**Evidence of success**: 100% success against Operational Performance Indicators (OPIs) and Key Performance Indicators (KPIs) in 2011/12, up 27% since 2010/11. The OPIs and KPIs measure various factors, such as: delivery to time and budget; reducing congestion; and lowering the incidents of people being killed or seriously injured on the county's roads [3].

**Other remarks**: The input of the public partner is unbundled from the private input; therefore the contract refers mainly to the contribution of the private partner. Generally, this creates risks of insufficient cooperation and low benefits from a partnership, which was the case at the first stage of the project, from 2000 to 2006. These risks were remedied by the developed relationship and improved incentives for the public partner.

**Case D. Traffic and road safety management in Tula Region (Russia)** [12]

**Description**: the local authority in the city of Tula has joined with a private partner to develop, install, and service speed and red light cameras on roads. The objective of the project is to improve safety on roads by registering violations of the highway code. Through appropriate penalties on drivers, this should lead to less accidents and injuries. The project is for the period of 2014-2020, with a funding of RUR 475m (approximately £8m in 2014). The Regional Ministry for Transportation and Roads provides open access to all relevant documentation, from the call for proposals, tendering documentation to the protocols of the meetings to select the private partner. [1]

**Public party contribution**: Identification of locations, putting in force legislative acts necessary to implement this project, coordination of the interaction of all parties involved, financing the Operator (a special entity appointed to collaborate with and monitor the private party) [1]. The police department is responsible for the identification of drivers who violate the Code, and imposing penalties on them.

**Private party contribution**: Finance, design, construction works, supply and installation of the equipment, servicing and maintenance [1].

**Liabilities of the public party**: “as specified by applicable laws” [1].

**Liabilities of the private party**: Penalties: violation of the agreed overall deadline or termination of the agreement is fined per month of delay at a rate of 0.01% of the maximum amount of investment; delays with intermediate targets fined at RUR 30 000 (approximately £500) per day [1].

**Sensitivity to contributions**: The project is sensitive to the quality of equipment supplied and its proper installation (private party contribution), which depends on the timely approval of connections to electricity lines, coordination with municipalities and other parties involved (public party contribution). The overall objectives (safety on roads) are even more sensitive to the public input as failing to properly identify and impose fines on drivers violating the Code would significantly reduce the effectiveness of the system for the safety on roads.

**Optimal contract**: IC-contract. The input of the private party (cameras installed and working) is verifiable at a lower cost than the input of the public party (using cameras to penalize speeding and dangerous manoeuvring on roads), IC-contract is also optimal even for higher levels of sensitivity of the project to the public input.

**Actual contract**: Fixed-fee input-contingent (IC). The public party uses the system on lease from the private partner, with an option to purchase the system from the private party at the end of the lease agreement. If the system has to be dismantled due to road construction/extension/maintenance works, all expenses of the private party are paid in full.

**Partnership element**: close cooperation. A special entity (Operator) is created to ensure day-to-day communication and decision-making. The parties agree to form a Commission to coordinate activities.

**Evidence of success**: The system has operated since 2014 with 33 elements running and 55 installed [2]. By 2015 all 90 elements were running [3]. In 2015, the Minister reported a reduction of the number of accidents by 12% compared with 2014, which includes 24 fewer people killed and 329 fewer people injured in traffic accidents [4].

**Other remarks**: Similarly to the previous case of Intelligent Traffic Systems in Essex (UK), the delivery of the system is unbundled from the public input (identification and prosecution of violations). The risks of insufficient cooperation are partly remedied by explicitly introducing an Operator for day-to-day decision-making and agreeing to form a Commission for regular meetings. At the same time, the lease agreement contains the buy-out arrangement as an option for the public partner, which might have a positive effect on incentives for both parties. On the one hand, it creates risks for the private partner and incentives to raise the lease payments in order to lower the buy-out price. On the other hand, the private party is incentivized to demonstrate high quality and usefulness of the system, to ensure the buy-out option is realised by the public party, which, in turn has incentives for closer cooperation and monitoring under higher lease payments.

## 4. Conclusions

This paper considers PPPs from the perspective of collaboration between the public and the private sector. This framework extends the traditional approach where optimal arrangements are designed to delegate provision of public services to the private sector. The four case studies confirm that such collaboration indeed takes place, both in a PPP sector with a long history and experience (UK), and in an emerging PPP sector (Russia). Moreover, in both sectors similar projects appear to be arranged through similar contracts, suggesting that the suggested framework is robust to country-specific variations in institutional systems.

The framework developed in this paper explains why some PPPs are formed through fixed-fee contracts, and others through concessions. The crucial elements for the rational choice of the contract are the project sensitivity to inputs and the costs of verification of the actual delivery of those inputs by either party. The cases in this paper offer a qualitative assessment of these parameters. To further test quantitatively the framework used in this paper, one would need to collect data on types of contracts actually used to form a PPP and to quantify the above key parameters. Unfortunately, none of the existing sources seems rich enough to provide this data. Specifically, the data on the actual contracts between the public and the private parties are only available sporadically. However, given the normative implications of this type of analysis, such a quantitative study would be a challenging but desirable direction of further research.

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[1] Examples include the renovation of the Ministry of Finance in The Hague, new buildings for Penal Institution Zaanstad, for Soesterberg military museum, for the Innovation Management Group and Groningen Tax and Customs Administration, and for the Supreme Court of the Netherlands.

[2] As the operator reports, "the owner of the highway, the Skanska ID-led special purpose company Tieyhtiö Nelostie Oy, is paid by the authorities depending partly on user numbers" - http://group.skanska.com/projects/57385/E75-Highway.

[3] http://www.pppi.ru/projects

[4] PPP Development Center, http://pppcenter.ru/en/.

[5] Sensitivity describes by how much the generated social value changes in response to a variation in the input of either party. In microeconomics, a traditional measure of sensitivity would be factor elasticity of the output.

[6]See, e.g. the BBC report "King's Lynn incinerator: £500m scheme set to be scrapped" of 31 March 2014: http://www.bbc.co.uk/news/uk-england-norfolk-26820542.

[7] This emphasises, in particular, that mistrust between the parties, which makes them believe that there is a need to monitor actions of each other, leads to a suboptimal outcome, as in an equilibrium less resources will be provided in total, yielding a lower value of the project. For this reason, the benefits from a partnership in the framework employed in this paper would only become larger, as it is assumed that improved communication in a partnership contributes to developing more trust between the partners.

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