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CONSIDERATION OF RISK IN PPP-PROJECTS

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Abstract. Risk management has become a core competence for companies operating in construction services. In particular regarding Real Estate Development and Construction Management the fundamental knowledge and the dedicated application of risk assessment turn out to be critical. Construction Management deals with a multitude of local and temporal issues which are unknown or only given by statistical evaluation while conducting a unique construction project within a very tight frame of budget and time. Real Estate projects focus on the predictability of profitable operation for a fairly long period in advance and are therefore subject to many more and more voluminous uncertainties. With PPP-projects a more or less complete federal task is awarded to a private company. Its extent varies but comprises at least design, construction and operation of a real estate project, e.g. a toll road, bridge, tunnel or other infrastructural object. Durations of such contracts often extend to some 20 to 30 years.

In this article the applicability of traditional means of risk management is investigated for the use on PPP-projects and limits of risk consequences are pointed out. Finally we come to the conclusion, that the resulting unavertable risks tend to exceed every surcharge that could be successfully placed on a market.

Keywords: PPP-projects, risk management, risk evaluation, operation planning, financial planning.

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1. Introduction

Public Private Partnerships (PPP) is a widely discussed cooperation form between the public and the private sector in infrastructure projects, not only in Germany but all over Europe and the world. Many reports, handbooks and task groups besides comprehensive studies (see e.g. Tanga *et al.* 2010; Kea *et al.* 2010) are addressing PPP and pointing out the need of research.

Its early development was primarily driven by the need for new investing and financing possibilities furthermore aiming at better efficiency of the public sector. PPP is in its broadest sense "any form of cooperation between public and private sectors for the funding, construction, renovation, management or maintenance of an infrastructure or the provision of a service." (Commission of the European Communities 2004). In Germany PPP is described by the Federal Ministry of Transport, Building and Urban Affairs (BMVBS) as a "long-termed, contractually regulated cooperation between the public authority and the private industry in the fulfilment of public tasks." (BMVBS 2003a). Two characteristic issues are determined by the Bundesverband Public Private Partnership (BPPP):

- Transfer of services: The project covers a long-term transfer of a (so far) public service to a private part,
- Transfer of risks: The private service provider takes over risks which would be with the public part if procured conventionally (Proll, Drey 2006; Jin, Zhang 2011; Xua *et al.* 2010; Binga *et al.* 2005).

This leads inevitably to the research question of how risks in PPP-projects could generally be reduced or avoided by transferring them to other parties, who are willing to take them, i.e. are capable to treat them more advantageously than the original owner.

2. Structures and properties of PPP-projects

2.1. PPP typology

The schemes of how PPP-projects would be defined vary with different countries respectively local naming conventions. Some examples of different structures and types to deliver projects as PPP are listed in Table 1.

Table 1. Examples of types project delivery in PPP (International Monetary Fund 2004)

Types	Descriptions
Build-own-operate (BOO), Build-develop-operate (BDO), Design-construct-manage-finance (DCMF).	The private sector designs, builds, owns, develops, operates and man-ages an asset with no obligation to transfer ownership to the government. These are variants of design-build-finance-operate (DBFO) schemes.
Buy-build-operate (BBO), Lease-develop-operate (LDO), Wrap-around addition (WAA).	The private sector buys or leases an existing asset from the government, renovates, modernizes, and/or expands it, then operates the asset, again with no obligation to transfer ownership back to the government.
Build-operate-transfer (BOT), Build-own-operate-transfer (BOOT), Build-rent-own-transfer (BROT), Build-lease-operate-transfer (BLOT), Build-transfer-operate (BTO).	The private sector designs and builds an asset, operates it, transfers it to the government when the operating contract ends, or at some other specified time. The private partner may subsequently rent or lease the asset from the government.

The roles of different stakeholders and their specific influence on defining, awarding and executing PPP-projects are numerous and multifaceted. They are in more detail pointed out e.g. in the Public-Private Partnership Handbook of the Asian Development Bank (2007).

2.2. PPP in infrastructure

PPP has been used in many different infrastructure projects from power generation and distribution via hospitals, schools, airports and prisons, railways, roads and highways to stadiums and telecommunication facilities.

Public infrastructure can be classified into economic infrastructure like roads, water infrastructure and airports for the daily economic activity and social infrastructure like housing, hospitals and libraries for the benefit of the society.

Economic infrastructure normally involves the user pay principle. Fees collected from the final user would refinance the private sectors investment whereas otherwise typically social infrastructure is availability-based which involves service investment by the government.

Characteristics and features of public infrastructure with respect to PPP in more detail were investigated by Grimsley and Lewis (2004, 2005):

- General availability of network services providing the necessary links for economic activities.
- Infrastructure provides public goods where the benefits are shared by the whole community.
- Network externalities are possible where benefits and costs are transferred to third parties.
- Infrastructure possibly gives rise to natural monopolies which implies the principal sense of being a public task.
- Infrastructure usually involves fairly large capital investment in comparison to running operational cost.

2.3. Characteristics of PPP-contracts

The general aspects of an overall solution of the task and appropriately dividing of risks are a central part of the definition of PPP. Only by considering overall solutions over the entire lifecycle of the project somehow improved total economy of the project can be expected.

Thus the tender of a PPP project focusses on functions, results and output to be achieved, in particular a service to be maintained, probably as a set of requirements to be fulfilled, rather than specifying processes, materials and procedures. This is meant

to make use of the full know-how of the private industry partner for the development and the completion of functional public tasks.

The definition also requires dividing and sharing of specific risks. Sensibly, risks are in general to be assigned to the party who would best handle or influence the risk. I.e. risks are ideally located within the proper field of competence (e.g. Binga *et al.* 2005). The division of risks is made from an economical point of view, thus the party to optimally handle a risk would be named the Cheapest Cost Avoider. In order to find appropriate assignments of risks thus all involved parties need to know, prove and clarify their core competences and core areas which is in no way trivial (Erhvervs- og Byggestyrelsen 2005; BMVBS 2003a; Jin, Zhang 2011).

Contracts cover the mechanisms of payment on the basis of the services to be delivered and the required quality as well as on risk issues, investment costs and operation. Including in particular the operation phase contract durations come up to 20–30 years. Since the specifications of demands have been given by defining functions the private part is given widely freedom to decide details of the project whereas the public part submits themselves to strong limitations (Erhvervs- og Byggestyrelsen 2005). In order to assure the requested services controlling measures like Service Level Agreements and Key Performance Indicators need to be implemented and integrated into the contracts (Vocke 2007).

Decisions to offer PPP contracts for a public task need to be founded on a very clear understanding of advantages over traditional contract types. An analysis of the net product of a PPP project in comparison to a traditional project needs to consider all costs, risks and profits over the total lifetime (Cruza, Marquesb 2013; Meddaa *et al.* 2013). The Public Sector Comparator (PSC) given e.g. by the Finanzministerium of Nordrhein-Westfalen 2003) is used as a set of standardized parameters comparing PPP details to conventional submission in order to point out clear benefits.

Finally as a PPP projects cover long periods of time, it is stated that the parties involved need to operate on a high level of trust and respect towards each other ("Partnering") (e.g. Deutsches Institut für Urbanistik 2008; BMVBS 2003b; Ng *et al.* 2013; De Schepper *et al.* 2014).

2.4. Transfer of service

The main idea of PPP projects is to award different parts like design, construction, operation and financing of a complete public task to a private company in order to gain benefits from the therewith expected close interactivity between the otherwise widely separated elements. Different levels of implementation are common and denoted as Transfer of Service in Fig.1 (Erhvervs- og Byggestyrelsen 2005).

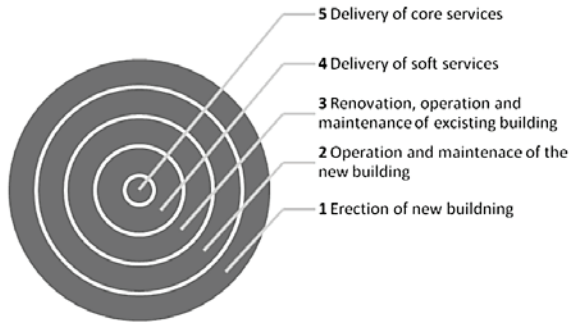

Fig. 1. Transfer of service (Source: Erhvervs- og Byggestyrelsen 2005)

Usually a PPP project includes at least levels 1 and 2, i.e. construction, maintenance and operation. Possibly redevelopment, i.e. renovation, operation and maintenance, would be included as this strongly affects optimal operation. Level 4 and 5 contain soft services, e.g. canteen activities, guarding, cleaning etc. Level 5 would finally include the core services being the actual public duty and rarely to be contracted out. This would be e.g. teaching at a school, caring at a nursing home or operation of transport or the administrative tasks at a town hall (Erhvervs- og Byggestyrelsen 2005).

Different from this approach tasks are distinguished into object related services and functional services were the first serves to operate the facility (comparable to Level 4) with everything required to operate the core functions actually being the governmental task to be fulfilled (Level 5). This structure regularly maps the legal situation e.g. in Germany where the object itself can be rented easily yet the responsibility for the public task cannot be awarded (Zimmermann, Eber 2006).

2.5. Public sector comparator

PPP contracts will only be advantageous if they represent the most suitable form of public private collaboration for a specific task. Therefore the situation is subjected to a systematic evaluation based on a model estimating the cost-effectiveness of a PPP solution compared to a traditional executed project (e.g. Tsamboulasa *et al.* 2013). In Germany the government formulates this request not as law where only the selection of the most profitable solution is required but as a four step guidance (Federal State Nordrhein-Westfalen 2006) published for each state. There the application and details of the Public Sector Comparator (PSC) are described and can thus be used as well accepted justification of decisions. The PSC so far serves as a tool for assessment and benchmarking of a project regarding overall cost-efficiency (Erhvervs- og Byggestyrelse 2004). Basically the PSC provides a fictitious profitability value of a PPP-version in comparison to a traditional project delivery system on the basis of multiple prime contracts (Initiative D21 2003). According to Federal State Nordrhein-Westfalen (2006) this is generated "<…> considering all direct and indirect costs and relevant quantified risks on the basis of well-defined standards of products and quality as wells scope of time".

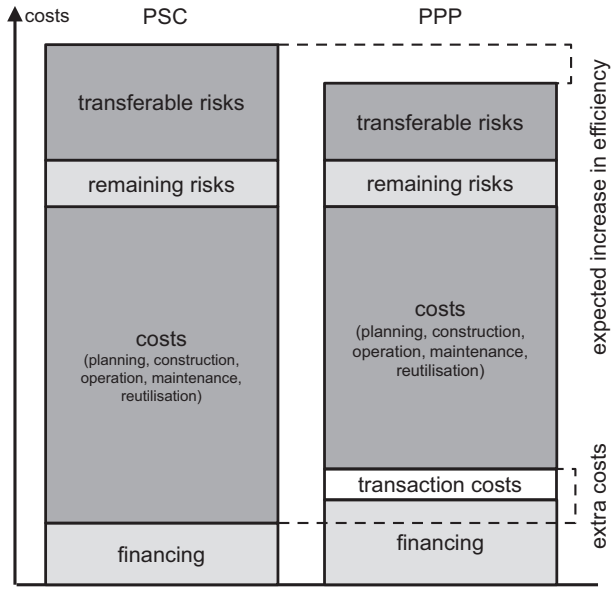

Fig. 2. PSC-elements and expected profit
(Source: Finanzministerium des Landes Nordrhein-Westfalen 2003)

Fundamental parameters of the PSC are investment costs, financing costs, operating costs, transaction costs and risk costs. Taking into account the long term orientation of PPP projects, besides the direct economic consequences, the societal and operational opportunities of a PPP model (Erhvervs- og Byggestyrelse 2004; Ng *et al.* 2013) need to be elaborated too.

Authors of Initiative D21 (2003) and Bundesrechnungshof… (2011) name the elaboration of a useful PSC a 'challenge' and demand it to be constructed by a 'team of experts' in particular because aspects need to be evaluated which are normally not quantified. This clearly focusses on the estimation of risks.

Obviously (see Fig. 2) despite rising financing costs and additional transaction costs with PPP projects some compensation is expected by reduced construction and operation costs. Actual profitability is taken from a strong decrease of transferable risks.

In order to elaborate these critical values a respective software tool was developed by the ÖPP Deutschland AG as a 'standardized model for profitability analysis' (ÖPP Deutschland AG 2014). ÖPP was founded in 2008 under surveillance of the German Ministry of Traffic, Construction and Town Development as an independent consultant for the public authorities, who also holds the majority.

2.6. Risk allocation

Risks can always be taken as chances as well as hazardous (e.g. Zimmermann *et al.* 2008; Zimmermann, Eber 2011). In particular in PPP, where the majority of production and operation are with the private part, the chances of using the private know-how are obvious. The assignment of existing risks to partners becomes thus highly critical and is subject to very tedious considerations (e.g. Xua *et al.* 2010). For the private part e.g. the German VOB/A (Deutsches Institut für Normung 2012) allows for no offer of undeterminable risks. Therefore a distinction is made for transferable and not transferable risks (Oberste Baubehörde im Bayerischen Staatsministerium des Innern 2006). In contrast to this situation it is said that in PPP projects where risk understanding is more comprehensive no too detailed but a more universal risk management perspective is required (Federal State Nordrhein-Westfalen 2006). The transfer of risk cannot be considered without taking the respective financial compensation into account. According to the Oberste Baubehörde im Bayerischen Staatsministerium des Innern (2006) this is to be calculated on the basis of probability of occurrence of the risk and the related possible extent of damage. Some examples are given in Table 2.

Table 2. Example of risks in PPP-projects, based on Initiative D21 (2003)

Production Risks	Operation Risks	Transfer Risks
Performance assessment	Financing risk	Utilisation risk
Quantity assessment risk	Risk of change in interest rates	Flexibility (Alternative applications)
Risks of building permission	Maintenance risk	
Delivery risk	Risk of claims on the guarantee	
Price and interest rate variation risk	Risk of destruction or deterioration and of price variation	
Soil and Ground risk	Risk of 3. party interference	

2.7. Financing

One of the main attractions of running PPP is the possibility of developing infrastructure projects without adding strain to the public finance. Hence, PPP arrangements will always involve private sector finances. The typical structure of a PPP normally involves a special purpose vehicle SPV (OECD 2008; Smyth, Edkins 2007). This acts as an intermediary to deal with different stakeholders e.g. the government, public users, private companies and financial institutions.

Since the public sector transfers substantial risks and obligations to the private sector, the total of operation and funding becomes the responsibility of the private sector. Two specific modes of financing are most important, the project financing and the forfaiting model as shown in Table 3.

Table 3. Primary financing models for PPP- projects, based on Züblin AG, DYWIDAG Bau GmbH (2007)

Characteristics	Project Financing	Forfaiting model
Risk assessment	The bank proves and assesses the risk structure via due diligence	Risk of evaluating the quality of the building is with the public part. The bank only proves the financing
Financing costs	Higher financing costs due to Cash-flow credit ranking. Higher transaction costs	Low financing costs due to public-like creditworthiness. No equity required
Security	Unlimited deduction possibilities, also toward the production costs. Higher liquidity. Optimized risk structure	Limited deduction possibilities

Project financing assigns the financial risk to the project association which has to provide all securities and is thus subjected to less advantageous financing conditions. In contrast, the forfaiting model transfers all claims completely to the interaction of the financing institutes and the public sector. Therefore financing conditions become comparable to the communal situation which actually locates the risk again with the principal.

3. Exemplary situations and conditions

Some experience was gathered during recent years, but due to the long duration of PPP-projects obviously no final results are available. Nevertheless in Germany several projects (Table 4) are in progress with fairly promising efficiency values:

Table 4. Positive PSC estimations (Source: BMVBS, DSGV 2009)

State	PPP Project	Vol [Mio. €]	VAS	Estim. incr. in eff. at VAS
BY	School and Sports Hall	24,80	May 07	10.00%
BY	Fürst-Wrede-Casern	60,00	Apr 08	17.40%
HE	Agency for Land Management Büdingen	12,00	Dec 07	10.00%
HE	4 Schools	106,00	Aug 07	15.00%
HE	Educational Center Ostend	42,00	Jul 03	21.00%
HE	Center of Finance Kassel	37,00	Nov 06	12.00%
HE	Agency for Land Management Korbach	6,30	Oct 07	13.00%
HE	Schools	102,00	Nov 04	18.10%
HE	Schools	110,00	Mar 04	18.50%
HE	Agency for Land Management Limburg	13,00	Oct 07	1200%
HE	2 Schools	27,00	Jan 07	10.00%
HE	Center of Administration and Justice	128,00	Mar 07	14.00%
HE	Thermal Bath	22,00	Jan 02	12.00%
HH	HafenCity Primary School	17,40	May 07	12.00%
HH	Elbphilharmonie	180,00	Mar 07	24.00%
MV	Gymnasium	7,80	Jul 07	15.60%
MV	Congress Hall	23,25	Mar 07	32.00%
NDS	Schools	8,40	Aug 05	18.40%

Recently the Bundesrechnungshof has analysed some projects, given in Table 5. Obviously the primary estimations based on PSC have been rather positive but would not reliably hold. Some of them have been evaluated fairly precisely judged by the given return estimation and turned out to earn dramatically less than expected. Some other examples are described only by rather coarse estimations and therefore cannot be measured finally. Very few projects seem to work fine and thus serve as showcase. Not a single one seems to earn profits comparable to the optimistic efficiencies.

Table 5. Results from some PPP examples (Source: Bundesrechnungshof… 2011)

State	PPP Project	Dur.[y]	PPP-return estim.	final
BB	Ministry of Finance	30	2.00%	–6.50%
BW	Correctional Facility Heidelberg	15	9.95%	9.66%
BW	Correctional Facility Offenburg	20	1.94%	1.67%
BW	Dual Academy Heidenheim	20	–0.54%	–0.54%
BW	University Aalen	20	3.26%	3.40%
BY	State Road 2309	25	max 8%	not validated
BY	State Road 2580	25	max 2%	not validated
HH	Katharinen-School	25	25.76%	not validated
HH	Hamburg Schoolbuilding (ÖÖP)	25	11.02%	4.83%
NI	Correctional Facility Bremervörde	25	5.68%	not validated
RP	South Bath Trier	25	4.00%	–21.50%
ST	Schools in Halle	25	1–35%	not validated
ST	Schools in Magdeburg	20	11.00%	not validated
ST	Correctional Facility Burg	25	12.00%	not validated
TH	Land Road Saale-Holzland	30	1.80%	not validated

This inconsistency can easily be traced back to the relevant input data of the PSC model. As already pointed out this requires the competence of experts to be worked out because numerous required data cannot be calculated but need to be arbitrarily estimated on the basis of the available expertise (see Fig. 3). Values as far as they can be precisely evaluated are to be entered to the model but additionally variations of these are introduced by the users' opinion. Best and worst case scenarios are defined by just varying investment costs, operation costs and maintenance costs as a share of the basic case. Thus even if the basis case would have been evaluated correctly, factors distort the situation. Moreover the introduction of factors proves the fact that the evaluation does not reflect the correct scenario and thus needs to be modified. The mere shifting of risk issues by a freely defined percentage from one partner to the other is arbitrary and provides starkly different results.

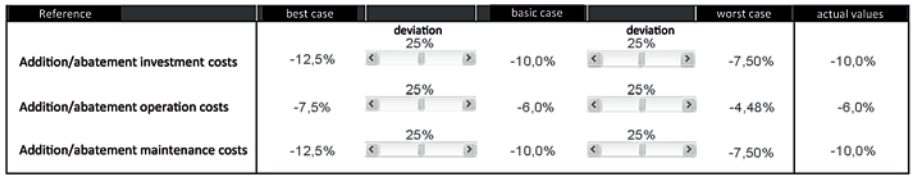

Fig. 3. PSC-Screenshot from the standard-model (Source: ÖPP Deutschland AG 2014)

Over all, correct evaluation comes to be the task of estimating risks appropriately before assigning them. As stated by the Oberste Baubehörde im Bayerischen Staatsministerium des Innern (2006) this is to be done by estimating probabilities of occurring and deriving respective possible damage values.

4. Considering risk and risk management in PPP-projects

The so far proposed methods to quantify risks are based on the probability of occurrence and the possibly induced hazard. Introducing subjective estimations for these and taking them into account in tendering causes highly unrealistic price settings respectively risk surcharges which are in no way compatible with reasonable market pricing. Consequently such considerations are widely ignored against better judgement.

In terms of decision theory the considered uncertainties (see Table 2) are not risks. In some cases the situation is given and only the knowledge lacks but could be retrieved e.g. by appropriate investigation. In other cases objectively given probabilities are actually required but "true uncertainties" arise from subjectively acquired estimations. Deviations from these can principally not be quantified even if based on experts' opinions as widely proposed. Yet presenting therewith generated probabilities connotes an unsubstantiated precision and thus leads to erroneous consequences. Experts' opinions are in this context no more substantial than a single measurement and this only if the expert has in fact experienced at least one completely matching project.

An inevitable precondition for any probability based risk analysis is the existence of sufficient information taken from the past and describing objects of adequate equivalence or at least similarity. In contrast to e.g. insurance business this is not possible in operative construction or real estate management, not to speak of the operation of infrastructure. Fairly heterogeneous circumstances would lead to a multitude of risk classes comprising only very few samples. Thus probabilities derived from such turn out to be highly imprecise and allow for no reliable prediction of results. In the case of PPP projects in fact there are no closed projects available. Due to the inherent long duration of such projects none of them can be analysed as successfully finished.

Collecting worldwide well-based data in order to form a reliable database might offer a set of projects, yet due to the multitude of key parameters for projects the number of required classes is high and therefore comprises only very few comparable projects

(Konchar, Sanvido 1998). Even if restricted to Construction Management such parameters would range from the type of building defined by geometrical aspects, materials, location, soil properties etc. to the applied project delivery systems, a variety of investor personalities and behaviour and contract types, as well as of neighbours, authorities, employees and contractors. Even two absolutely identical buildings are likely to result in completely different risk estimations. Table 6 denotes exemplarily some classification parameters.

Table 6. Exemplary object and organization related parameters for defining classes in construction projects (Source: Zimmermann *et al.* 2014)

Parameters of Object	
Real Estate	**Building**
Location, shape, soil chacteristics, etc.	Shape, materials, standards, count and type of elementes etc.
Parameters of Organisation	
Principal	**Executing company**
Principal: public/sector/private, competence, personality of responsibles, etc.	Legal form, range of production, size of company, structure of company, core competence, type of service/production, etc.
Planning of design	**Planning of organisation**
Design, structural planning, building services, etc.	Controlling, supervising, hierarchical organisation and workflow, planning of production, scheduling, planning of terms, etc.
Delivery system	**Contract and remuneration**
Multiple prime, general contractor, general planner, etc.	Unit price contract, lumpsum contract, GMP, etc.
Stakeholders (external)	**Terms and deadlines**
Adjacent owners, authorites, citizens' intiatives, public etc.	Contractual terms, season of year etc.

If a project not only comprises development and construction but is per PPP extended to operation for a long period of time, financing, maintaining and possibly redeveloping, risk assessment becomes more complex. An additional set of parameters needs to be observed, which further distinguishes projects and impedes successful comparison to an existing PPP-project. Thus the small multitude of available projects would have to be allocated to a much larger count of classes. Some possible parameters regarding the operation of a general PPP-project are listed in Table 7. They are not to be understood as a variable-like set but as a number of aspects where variables would be taken from.

Table 7. Exemplary object and organization related parameters for defining classes in construction projects regarding operation (Source: Zimmermann *et al.* 2014)

Parameters of operation	
Principal	**Operating company**
Public authority, political circumstances, stability, market situation, legal certainty	Knowledge and competence to operate, longterm development
KPI (Key performance indicators)	**Planning of organisation**
Degree of functionality, valuation, benchmarking, grade of violation, penalties etc.	Operation structures, internal controlling, benchmarking, longterm operability
Financing	**Contract and remuneration**
Guarantees, rate of interest, volume, bonds and securíty, involved parties, governmental and institutional and private participants etc.	Fees, concession, guarantees, penalties, adaptivity to market changes etc.
Stakeholder (extern)	**Terms and deadlines**
Users, operational authorities, financing institutes, public, operational subcontractors, environmental groups, adjacent owners etc.	Duration, guarantees, flexibility of terms, closing and terminating conditions etc.

Appropriate handling such a multiplicity of classes is provided by insurance mathematics, in particular as of how the sample size of a class influences the precision of the predictability of future occurrence of a risk (e.g. Zimmermann *et al.* 2014). The additional uncertainty of an otherwise well-defined average value becomes a multiple of the standard deviation depending on the required level of confidence. This is plotted for low numbers of samples in Fig. 4a/b. It must be conceded that the number of samples in PPP is in fact zero which leads to infinite uncertainty.

α	0,1	0,05	0,025	0,01	0,005	0,003	0,002	0,001
N=2	4,46	8,98	18,00	45,01	90,03	150,05	225,08	450,16
N=3	1,69	2,48	3,58	5,73	8,13	10,52	12,89	18,24
N=4	1,18	1,59	2,09	2,92	3,73	4,45	5,11	6,46
N=5	0,95	1,24	1,56	2,06	2,50	2,88	3,21	3,85
...	...	...	...	...	...	...	...	...
N=1000	0,05	0,06	0,07	0,08	0,09	0,09	0,10	0,10

Fig. 4a. Reduction of uncertainty of standard deviation with increasing number of samples (Source: Zimmermann *et al.* 2014)

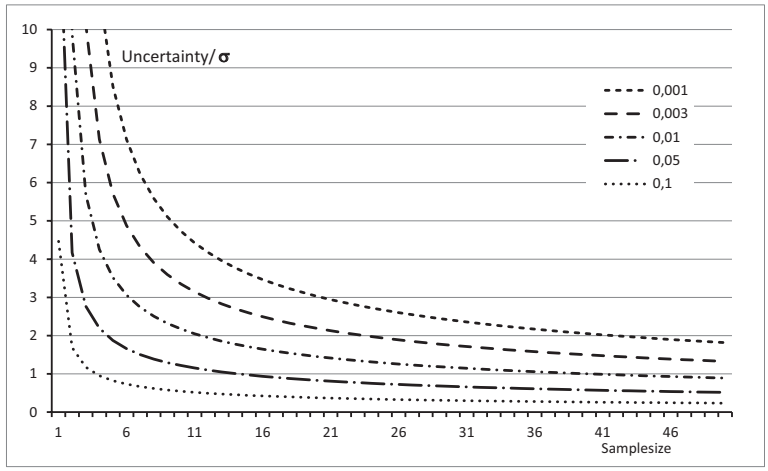

Fig. 4b. Reduction of uncertainty of standard deviation with increasing number of samples (Source: Zimmermann *et al.* 2014)

This development might in general cases be compensated by cumulating a certain volume of identical risks which balance each other. Such is certainly valid to some degree in serial production business. Yet as is clearly visible from Tables 6 and 7, since parameters differ so much, no compensation can be expected from strongly differing risk issues. A combination of these two effects is plotted in Fig. 5.

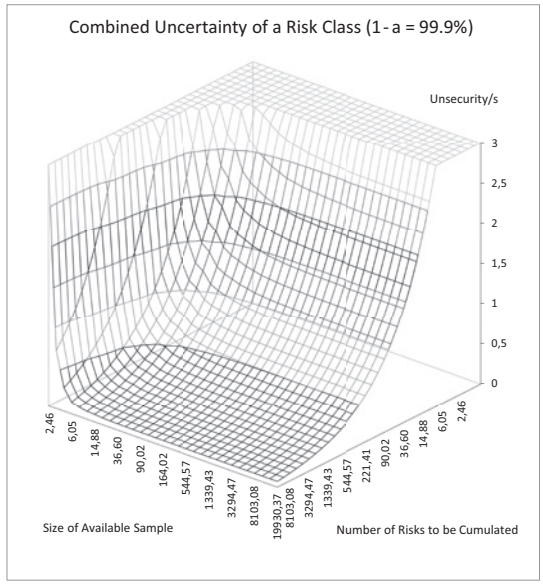

Fig. 5. Combined plot of uncertainty with respect to the number of samples and cumulation of cases for $1-\alpha=99.9\%$ (Source: Zimmermann *et al.* 2014)

Obviously risks in PPP projects are located to the back end of the plot and lead to absolutely unquantifiable values, which can in no way lead to affordable risk surcharges on an offer.

Incidentally it needs to be noted, that such considerations are based on the assumption of Gaussian distributed occurrence of risks. Precondition therefore is a multitude of numerous influences on the risk issue which are all small and independent of each other. Yet handling a PPP project as a strongly interacting network of elements, social groups, companies, authorities, personalities, conditions and restrictions, laws and regulations etc. such distributions can hardly be assumed.

5. Conclusions

On the background of the characteristics of PPP-projects the overall reasonableness is obviously given by the appropriate treatment of uncertain issues. Hence this turns out to be the gist in making a reliable offer for conducting the task to be awarded. Only then the bidding would reflect the explicit evaluation of the transferred risks and the price to be paid for taking them.

Simply according to their definition such projects always include at least conception, construction and operation tasks and are spanning some 10 to 30 years of time. Hence, the multitude and the variety of relevant aspects can be rated. Each of these is clearly not calculable but subject to uncertainty, be it because proper investigation is not affordable or possible or explicit values cannot be retrieved principally. Thus, knowledge needs to be replaced by estimation. The only sensible basis for estimations would be experience from successfully closed comparable projects. Statistics allows for the precise evaluation of average values and for specifying the certainty of so based predictions. Yet if true counts of comparable projects are taken into account, the calculated confidence intervals reach absolutely inacceptable levels. The main reason is the sheer number of key parameters distinguishing the projects pairwise and therefore leading to too many classes with too few samples. Actually in most cases not a single one exists.

To approach this situation the elaboration of experts is said to be required. Yet, experts are not expected to replace values by opinions and assumptions which would be in no way helpful. The one and only help that can be offered by experts is their capability to analyse complex situations. Combinations of parameters which are too complicatedly forming the inaccessible risk issue of a PPP-project would be separated by the experts' knowledge. Thus smaller independent risk is-sues could be identified which might be computable. Unfortunately even smaller issues are not accessible as can be seen in risk management of just construction projects. Furthermore a project cannot be concatenated from independent small issues since it inherently comprises the high count of elements as well as the most complex set of interaction of these. Therefore in particular risks are not at all independent and thus all the calculations based on this precondition become obsolete.

Evidently there is no way to calculate or estimate risks in projects as large and complex as PPP-projects and if so the results would, taken seriously, never lead to compensations compatible with the markets. Thus we conclude that appropriately and seriously elaborated risk management for PPP-projects will principally assign only very minor risks to the private part. The main risk volume will always remain with the public side since no profitable risk limiting solution exists which would be obligatory for a private companies' offer.

The mentioned report of the Bundesrechnungshof proves this understanding without any doubt.

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