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Governance and innovation through partnerships

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COMPLEX PERFORMANCE IN CONSTRUCTION

GOVERNANCE AND INNOVATION THROUGH PARTNERSHIPS

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Preface

This report summarises the results from work undertaken in the international collaborative project “Procuring and Operating Complex Products and Systems in Construction” (POCOPSC).

The research project was formulated and funded within the call for tenders “Value driven processes for construction and operation of buildings” issued in May 2009.

POCOPSC was carried out in the period 2010-2014. The project was executed in collaboration between CSTB (Centre Scientifique et Technique du Bâtiment) and SBi/AAU (the Danish Building Research Institute/Aalborg University).

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Introduction

The construction industry is often criticized for its inability to innovate, to improve its practices and to provide value for its clients (Egan, 1998).

To fulfil the expectations of demanding clients, new project-delivery configurations have been developed. Approaches focusing on performance-based building or new procurement process such as new forms of private-public partnerships are considered as solutions improving the overall performance of the industry.

The main objective of this project has been to understand how the development of integrated solutions in construction led to distinct configuration of actors and structures. Furthermore, the project analyses whether these changes modified project processes and contributed to the delivery of new value to the end users.

In this report we argue that an understanding of the coupling between new values for clients and new project-delivery configurations can benefit from including the notation of Complex Products and Systems (CoPS) to weight the systemic and contextual factors in which the formation and stabilization of the coupling between values and new project-delivery methods takes place.

Purpose of the study

According to Goodier et al. (2008: 109), there is an increasing move away from product delivery towards delivery to satisfy clients' needs through service provision. This shift, which is argued to be well established in sectors such as aerospace, defence and manufacturing procurement, is now becoming more important in the construction industry as well – a statement to which the proliferation of e.g. PPP/PFI schemes in most European countries bears witness. This move has also been the target of the European Union, which in the Lead Market Initiative for Europe seeks among other things to promote sustainable solutions in building and construction works, and to help foster market uptake of innovative products and services by means of improved public procurement practices.

The move towards sustainable solutions and service provision in construction is not, however, a straightforward task. As is argued by the European Commission (EC, 2010):

> *"The plethora and mismatch of building regulations at EU and national levels leads to considerable administrative burdens and - given that the business structure is predominantly local - to a very fragmented sustainable construction market." (EC, 2010).*

Furthermore it is argued that, although many technical solutions are already available, demand remains highly fragmented. Despite the fact that 40% of demand for construction works comes from the public sector, decision-makers are said to be unaware of the scope for adopting so-called innovation-oriented solutions. This ignorance is the result of a perceived lack of knowledge on possibilities for procurement that could facilitate demand for innovation-oriented solutions (EC, 2010).

To address and redress this issue, the POCOPSC project consortium has set out to examine this "*…increasing move away from product delivery towards the delivery of clients' needs through service provision*" (Goodier et al.

2006: 109) and the development of integrated solutions (Brady et al., 2005) in construction. In doing so, the project consortium has analysed how complex products and systems (CoPS) are procured and operated in Danish and French construction business systems.

To meet this goal, three inter-related issues in the study of different project delivery forms have been scrutinised in the project. These are:

1 *How new types of partnerships develop new innovation structures and what impact this has on the construction sector.*

New configurations of partnerships in the construction sector occur as part of the innovation by the sector itself in its transition to social agendas such as energy and climate-adapted building etc. This addresses the issue on where and how different configurations of various public-private partnerships come into being in the construction sector, how new innovative structures are taken into use in construction projects and what types of feedback processes that have been established as part of the innovation.

2 *How (and which) governance mechanisms are put in place to deal with the new project delivery processes and procurement procedures.*

New configurations will require new governance mechanisms, considering traditional contractual control as well as relational coherence (Clegg et al., 2002). As e.g. Teubner (2006: 51) argues, today we face a “contractual gap” in that the contract can no longer be seen as "the consensual exchange relation of two legal subjects to which the judge grants legal force.” Rather, the contract should be understood as a polycontextual relation that simultaneously has to address legal, economic and productive acts in accordance with the intrinsic logic of the specific context. Thus, to reduce hazards of opportunism and deploy safeguards for every possible future contingency, formal control based on detailed and complex contracts is insufficient as the contract can never stipulate every potential contingency. Conversely, the relational perspective focuses on the role of trust and promotes solidarity and information exchange.

3 *How changes in public and private procurement procedures are reflected in performance processes and delivering new value to the end users.*

Any way of working, from traditional turn-key contracting to crafts-based project delivery, requires a distinct configuration of actors and structures (institutional and regulatory) that is inscribed with a certain value-rationality; a certain quality of project delivery that is seen as more or less valuable than alternatives made possible by other configurations. In terms of value, the construction industry has been dominated by cost issues for many years. But recent changes in public and private procurements are modifying performance processes and bringing new value to the end users.

Theoretical approach

In the design of our theoretical framework, we draw on two fields of research that address the various relations between actors in the construction sector.

Both CoPS studies and the STS approach (Science and Technology Studies) elaborate 1) the project-based nature of the construction sector theoretically and empirically 2) the importance of relationships between companies that provide complex products, and 3) the interplay between the project and the infrastructure surrounding the project such as legislation, institutions, research, etc. The two research approaches pursue divergent objectives, as reflected in divergent research agendas. The CoPS approach is primarily business-oriented and aims to enhance the quality of project-based companies' innovation processes. The STS approach is a critical and alternative perspective of the perception of technological development as deterministic, and it aims to enhance the understanding of technology development as a social process by showing how technical objects and social relations are bonded together and how actors and technology are co-produced (Bijker, 1995; Harty, 2005).

Several business sectors are concerned with CoPS. "*CoPS are defined as high-cost, engineering-intensive products, systems, networks and constructs*" (Hobday, 1998: 690). The aims are to understand CoPS as an analytical category and how CoPS as an analytical category can be applied in construction. STS is used as a critical and constructive perspective to strengthen the analysis.

Readers guideline

The report is structured in four major parts. **Part one** introduces the main characteristics of CoPS and methodological foundations and implications. **Part two** addresses three separate themes that each highlights different aspects of CoPS: 1) Innovation in CoPS, 2) Governance issues in CoPS and 3) Measuring performance in CoPS, Each theme relates to one research question and is the starting point for the development of analytical focus points. **Part three** is the case section. In the case section six cases are included, three Danish cases and three French cases. The cases illustrate how CoPS are procured and operated within Danish and French construction business systems and illustrate different public-private partnerships and integrated solutions. The case studies concern private as well as public projects, where the client is also the building user. Different configurations have been explored such as ESCO, conventional procurement based on performance criteria, partnership between a public client and a building component supplier, and PPP. The French cases focus mainly on PPP projects due to the growing interest of these procurement systems since 2004.

Since improving building energy performance is perceived as a central part of the solution to climate change in the EU, and since different strategies at EU level as well as at national level have been developed to cope with the challenges, this aspect influences all the cases in different ways. Energy strategies reflected in EU directives and the various national Building Regulations have changed character, reflecting differences in the understanding of the problem and possible solutions, relevant actors and governance structures. Overall, one can describe the evolution as a shift from prescriptive regulation to performance-based regulation. Each case addresses with this challenge in different ways. **Part four** is the concluding section. The findings in the six cases are summarized schematically followed by a discussion structured by the three research questions.

CoPS as an analytical category

The focus on CoPS is motivated by the fact that in the academic literature CoPS constitutes a relatively well-grounded perspective on the systemic character of innovation in construction. As Harty argues:

> *"A growing literature on complex products and systems […] initially looks interesting for those interested in construction organization, and it reveals a mismatch between a high amount of innovation and learning at a project level, where many novel problems are encountered and solved, and the capture and translation of this into a reusable organizational resource." (Harty, 2005: 514).*

Harty (2005) argues that the literature "initially" looks interesting and this has much to do with (i) the rather weak conceptualisation of how to bridge the gap between firm and project; and (ii) that most CoPS cases are confined within a single organisation and do not consider cases of inter-firm collaboration in which ownership and control of activities are not clearly delineated.

This problem of weak conceptualisation of the mechanisms at play in the intersection between project and firm, in specificity and heterogeneous entities in general, is not just a problem in the CoPS literature. We also encounter this issue in the related area of innovation systems study. As Broström (2008) has argued

> *"…the approach [systems of innovation approach] has remained a general framework rather than evolved into an analytical tool for the study of the dynamics of innovation activities." (Broström, 2008: 1).*

Before addressing the wider analytical and methodological issues in the study of CoPS, we will briefly highlight the main characteristics of CoPS when observed as an analytical framework.

CoPS as an analytical category

In the following, we will start our elaboration of CoPS as an analytical category by referring to the seminal work undertaken by the Complex Product Systems Innovation Centre (cf. Hobday, 1996; 1998a; Barlow, 2000).

Level of analysis: Complex product systems

Using CoPS as the analytical category in the study of construction activities places special emphasis on:

> *"…the elaborate nature of organisational dynamics [that] arises from the temporary nature of the inter-firm coalitions involved in the production of CoPS projects." (Barlow, 2000: 974).*

Before commencing the discussion of the essence and implications of this "elaborate nature of organisational dynamics", let us briefly review the defining characteristics of CoPS as argued by e.g. Barlow (2000) and Hobday (1998; 2000a).

First, the definition, which is the primary point-of-entry in discussions on CoPS:

> *"CoPS are defined as high cost, engineering-intensive products, systems, networks and constructs" (Hobday, 1998: 690).*

Sharpening this definition, the simplest way of illustrating the defining characteristics of CoPS is, according to Hobday (2000a: 794), to distinguish them from mass-produced goods. Thus, it is argued, there are at least three significant differences between CoPS and mass-produced goods:

1 CoPS are composed of many customised, interconnected elements, including control units, sub-systems and components. These are organised in a hierarchical manner and tailored for specific customers and/or markets.
2 CoPS tend to exhibit emergent properties during production, as unpredictable and unexpected events and interactions often occur during design, systems engineering and integration.
3 CoPS tend to be produced in projects or in small batches which allow for a high degree of direct user involvement, enabling business users to engage directly in the innovation process.

Further, Barlow (2000: 974) argues that "*The integration of a wide variety of knowledge and skills, and mastery of complex subsystems interfaces, are all crucial to the design and development of CoPS project*s" and that:

– It is not usually possible to test full-scale prototypes in CoPS projects, making simulation and modelling of great importance in front-end decision making, planning and execution.
– The importance of tacit knowledge and need for personal contact in problem solving places emphasis on continuous and contiguous project participation in the successful delivery of CoPS projects (Ibid., 2000).

As such, and at first glance, this might sound very much like the characteristics of the everyday large-scale construction project that very much is taken for granted within the construction management research area.

When this, however, is argued not to be the case, it rests primarily on the technology scope. Thus, even though the units of analysis of CoPS are (i) the project and (ii) its output, the creed “a project is a project is a project” does not hold true (Hobday, 1996: 1). Rather, with a somewhat circular argument, Hobday argued that complex product systems projects can be viewed as a specific sub-set of projects concerned with the development, manufacture and delivery of complex product systems.

Using the figure below on the scope of complex product systems, Hobday (1996: 2) argued that CoPS include all the high technology, high cost, complex, networks, infrastructural and engineering goods contained in categories A and B. At the same time it is stressed that some low technology systems (such as roadworks and simple building constructs) would not be included.

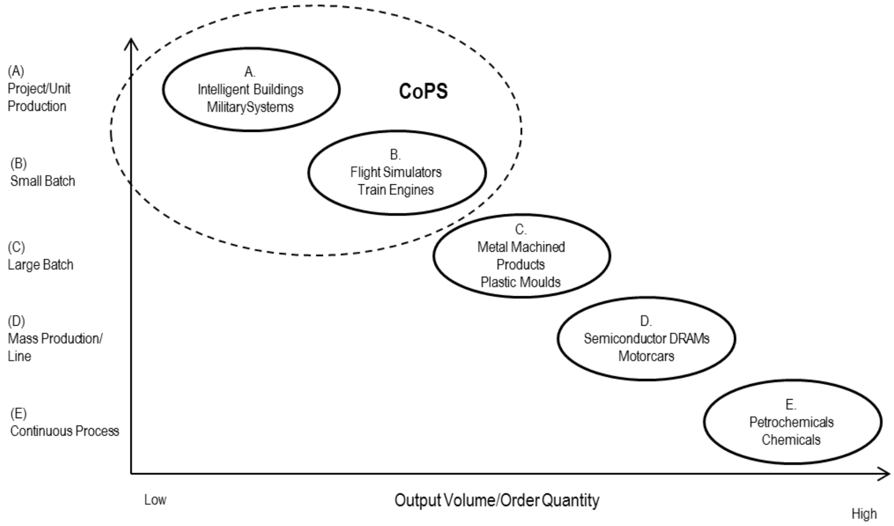

Figure 1. The scope of complex product systems (Hobday, 1996: 2).

This figure cannot stand alone, however. Hobday (1996: 3) thus argued that the classification "…*lacks any sense of the nature of the "product" or its technological novelty and uncertainty*." The reason for Hobday to stress this very aspect is arguably that he is speaking specifically from the point of innovation (and innovation management) theory, which hitherto had predominantly developed on the basis of studies of mass-production. Thus, in order to outline a new research agenda for a type of industrial output (being characterised exactly in terms of its task, technological uncertainty/novelty and complexity) that is increasingly of importance to the modern economy, a clearer delineation of these features is required.

Such a conceptualisation is offered by Shenhar (1994), who provided the following model illustrated in figure 2 below (cf. Shenhar (2001: 397-401) for a detailed description and explanation of the model).

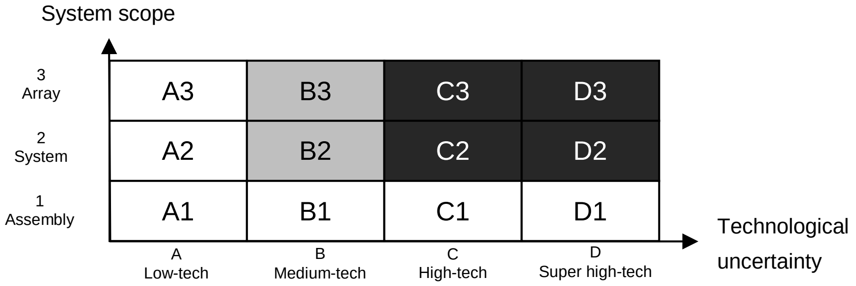

Figure 2. Two key dimensions of projects and products (Hobday, 1996: 2; Shenhar, 2001: 401).

According to this classification, Hobday (1996) argues that a CoPS would be located in groups C2, C3, D2 and D3, with a possible overlap with groups B2 and B3. Let us therefore look closer in at the dimensions and properties of these groups.

System boundaries: Technology

Technological uncertainty is associated with the degree of "*…using new (to the company) versus mature technology within the product or process produced*" (Shenhar, 2001: 397). Hobday (1996), on the other hand, removed the company from the equation. Thus, in shifting focus from the "firm" to the project and its output, Hobday operated with a rather non-situated technology perspective in which technological uncertainty at the level of the situated actor is replaced for technological novelty understood at a most generalised "industry" level in terms of R&D intensity.

System boundaries: Complexity

Second, system scope designates "*…the physical nature of the product and, in particular, the degree of hierarchy within a product or system*" (Hobday, 1996: 3). According to Shenhar (2001), system scope constitutes the complexity dimension of the framework.

Complexity is mainly seen from a technical angle by Hobday. However, complexity also encompasses financial and legal elements and varies according to contracting authorities.

According to the European Commission, "*a public contract is considered to be particularly complex where the contracting authorities:*

– *are not objectively able to define the technical means in accordance with Article 23(3)(b), (c) or (d), capable of satisfying their needs or objectives, and/or*
– *are not objectively able to specify the legal and/or financial make-up of a project."*

This financial complexity can be linked to *"projects involving complex and structured financing the financial and legal make-up of which cannot be defined in advance." (European Commission, 2005)*

Moreover, the capacity of the contracting authority has to be taken into account to justify the use of the competitive dialogue. According to Williams (1999), this complexity refers to uncertainty. Indeed, project complexity is characterised by two dimensions: structural complexity and uncertainty. Structural complexity (Baccarini, 1996) refers to the number of subsystems of a product / the number of specialties and their inter-relationships. Interdependencies intensify complexity since a change in one element will have an impact on the subsystem. Uncertainty can also be classified according two dimensions: the uncertainty in goals is linked to the difficulty of the users / clients to specify their requirements. This increases the risks of changes (i.e re-work). The uncertainty in methods is more due to a lack of experience on a similar project which requires modifying and refining the methods during the course of the project. For example, complexity will be stronger for small municipalities than for large one who can rely on specialized internal departments.

Originally, Hobday (1998), drawing on Shenhar (1994; 2001) operated with three levels of complexity: (i) assembly projects, (ii) system projects and (iii) array projects, where CoPS would fall into the system and array categories. Whereas an assembly was defined as a collection of parts formed into a single unit performing a limited function, a system should be seen as a more complex collection of interactive components within the boundaries of a single product, which perform a task. Finally, an array would be a very large, complex collection of systems, which act in unison to achieve a common goal. As such, Hobday (1996) argued that an array "*…would provide a major input to the formation of a large technical system as defined by Hughes (1983).*" (Hobday, 1996: 4).

The boundaries between CoPS and LTS (large technical systems), however, are not entirely clear from this delimitation alone. In an extended version of his previous papers (Hobday, 1996; 1998a), Hobday (1998b) therefore elaborated the two-dimensional framework accordingly (Figure 3 below):

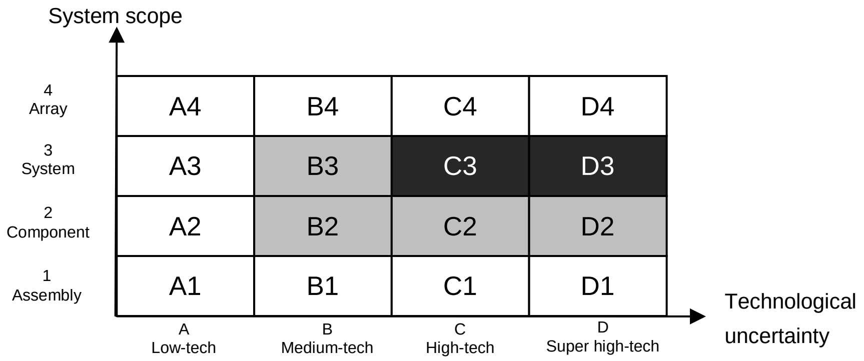

Figure 3. Two key dimensions of projects and products (Hobday, 1998b: 4).

Drawing explicitly on Hughes (1983), arrays are now abandoned as units or arenas of investigation in the analysis of innovation in CoPS on account of their evolutionary nature. As Hobday (1998b: 6) argued:

> *"Also, arrays comprised of combinations of systems would mostly be excluded from the definition, unless they were supplied under one definable project."*

Eventually, Hobday et al. (2005) replaced the notion of "array" with "large technical system" in describing their simple typology of technological systems, thus stressing the point that CoPS, in contrast to LTS, are centripetal rather than centrifugal and are endowed with certain ex-ante rather than ex-post qualities (cf. Geyer and Davis, 2000).

Further, from a perspective of systems integration, defined as the capabilities which enable various actors to define and combine together all the necessary input for a system (Hobday et al., 2005: 1110), assemblies and to some extent components can also be excluded from scrutiny on account of their non-project-based nature.

In the case of assemblies, systems integration is argued to take place: "*…at the individual supplier firm level and is a fairly simple manufacturing process…*" (Hobday et al., 2005: 1113). In the case of components, or sub-systems, systems integration takes place:"*…usually within a single firm and involves a highly complex process with many different steps…*" (Ibid., 2005: 1113).

Thus, when speaking in the context of complexity, the defining characteristic of a CoPS, is its project-based nature; i.e. that it is delivered according to a "projective" integration method. This, according to Christensen and Kreiner (1991), entails that:

- New goals are continuously defined
- Coordination is designed specifically for each project, i.e. coordination (mechanisms) varies from project to project
- Success depends on the achievement of goals in relation to explicitly defined expectations.

In the following section, we will review these characteristics in relation to the study of CoPS and technological systems.

Methodological and analytical issues in CoPS

Based on the above exposition, CoPS can be defined:

- By their systemic nature
- By their dual social and technological composition
- By their mixed temporal characteristics, having both an *ex-ante* defined expiry date and an element of *continuousness* throughout an ill-defined lifetime of operation
- By their project-specific, situated governance / coordination structure
- By their actor-negotiated success / performance criteria

In other words, even though the units of analysis in the CoPS literature are the project and its output, we argue for a need to refrain from observing CoPS as solely a question of innovation management in an industrial understanding, and advocate not only a more explicit system focus, but also an STS / socio-technical approach to innovation in construction (cf. Harty, 2005), in order to fully encapsulate and understand the technological complexity and the element of distributed agency that are at play in CoPS. Technology (both in CoPS (implicitly) and in LTS (explicitly)) is seen as a structuring device. We should therefore apply a perspective that is sensitive towards understanding the role played in relation to agency. Thus, in order to understand the argued shift towards service-based procurement and operation, we have to understand the "evolutionary" negotiated perspective as well and apply a theoretical / analytical perspective that can also encapsulate this dimension. As such, the product has to be seen in relation to the larger system or network in which is embedded.

The mixed temporal characteristics of CoPS further entail that we have to consider a series of issues from a project-specific and as well an operational system perspective, as illustrated in the following Figure 4.

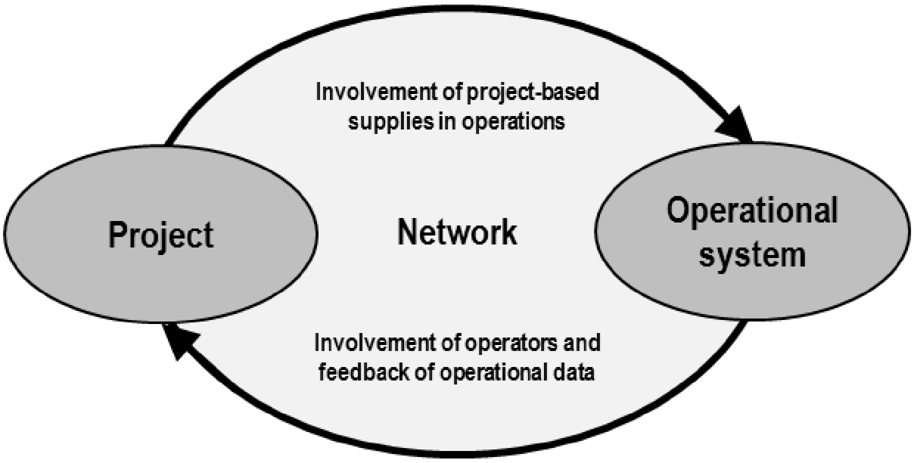

Figure 4. Project-system innovation cycle (Geyers and Davies, 2000: 1009).

Geyer and Davies (2000) and Barlow and Köberle-Gaiser (2008) introduced the notion of 'large technical system' in order to use a framework that integrates construction and operation phases.

> *"Both sides – the project and the operational systems – influence and shape each other, creating a dynamic that stimulates innovative behavior, forming a project-system innovation cycle" (Barlow and Köberle-Gaiser, 2008: 1394).*

Delivering CoPS projects requires the combination of project management capabilities (managing uncertainty and changes in user specifications) and systems integration capabilities. Thus, coordination mechanisms between the stakeholders of the construction value added-chain are critical factors for the success of service delivery. Coordination between construction and operation appears essential not only for successful innovation but also for the service quality delivered to the user. Moreover, there is also a necessity to integrate the complexity of the operational system and to examine the interface between the users of the building and service suppliers.

Thus, according to Geyer & Davies (2000) we should not confine ourselves to studying just the project, and the project's success criteria, but also the operational system in which the "continuousness" of the CoPS is unfolding. This intermingling of "temporary" and "permanent" characteristics also has repercussions for how we should observe and understand the shift in the nature of the multifarious mechanisms set in place to govern the various transactions between project-system participants. With this we mean that the increasing involvement of project-based suppliers in the operation of the CoPS, and the increasing involvement of operators and feedback of operational data in the design of the CoPS, set constraints for traditional ways of conducting business and open up for the need for new governance mechanisms and performance schemes to handle the new complexities that result from the very intermingling of interests and the hybridization of organisational forms and project-delivery mechanisms. The cases we have chosen to work with all reflect (to varying degree) these concerns. In the next section, we will briefly discuss the different cases, and the criteria for their selection.

Case study selection

Eisenhardt (1989) indicates that it is appropriate to conduct case study research when little is known about a phenomenon. So far, hardly any studies have examined CoPS in operation. Given the limited existent literature, a case study approach appeared relevant. It can provide a critical insight in this area where there is a lack of empirical analysis. The selection of case study is also one of the most important issues (Eisenhardt, 1989; Tellis, 1997). Gibbert and al. (2008, p.1468) ask researchers to "*provide a clear rationale for the case study selection*".

As a case selection method, we have chosen to use Hobday's (1998, 691) framework consisting of "*…many of the critical factors which define the character of a product and its 'complexity', along a range of dimensions independent of particular sectors or industries. These dimensions, which together provide a rough approximation of product complexity, help conceptualise how various aspects of complexity relate to innovation."* (Hobday, 1998, 693).

Thus, the critical product dimensions that Hobday (1998) has identified (see Figure 5 below) can be seen as proxies or indicators of complexity and they provide a selection of so-called product features which directly contribute to difficulties of managing production and innovation by adding uncertainty and risk (Hobday, 1998: 693).

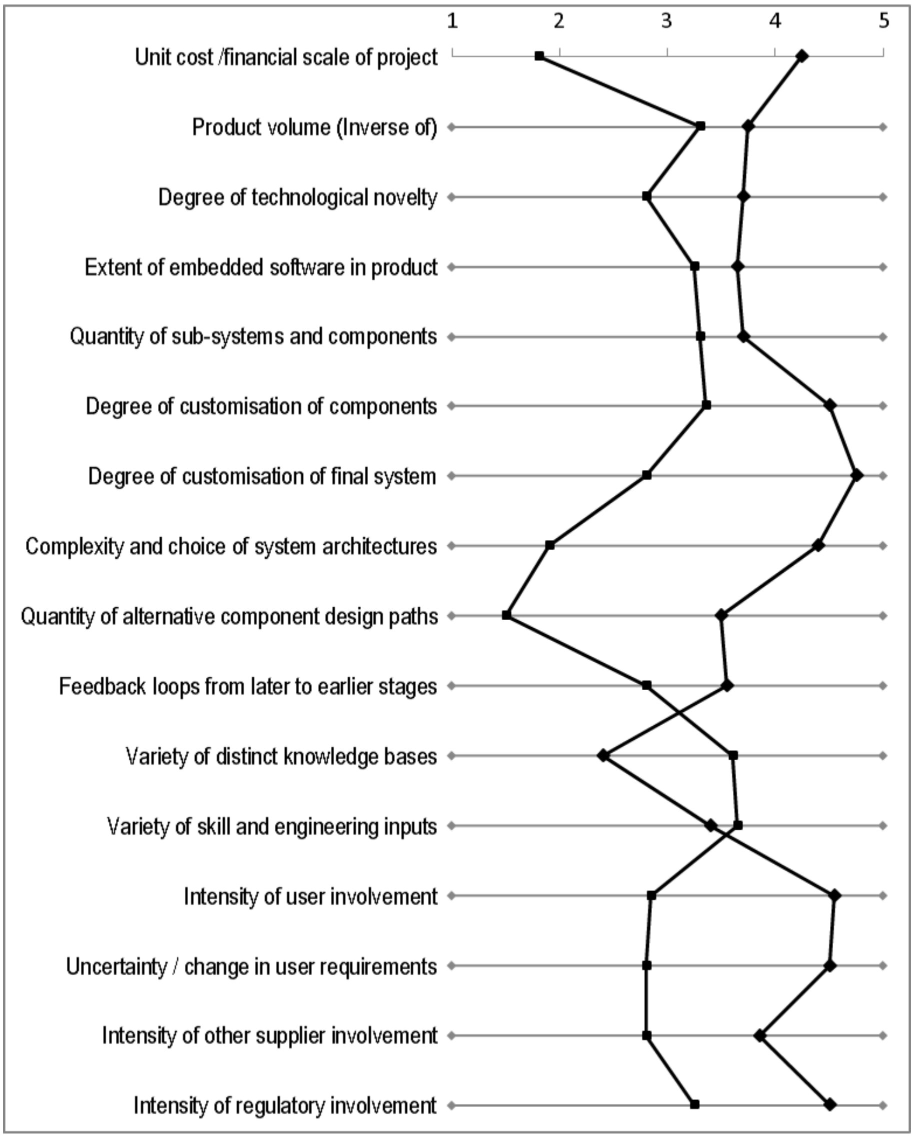

Figure 5. Some critical product dimensions of CoPS (adapted after Hobday, 1998: 691). '1' is very low complexity and '5'is very high complexity.

Determining the complexity of a given CoPS is an axiological problem. As Hobday (1998: 693) explains: "*Although the scales are somewhat arbitrary and some rely on the subjective judgement, they do help illustrate the range of factors involved.*" Furthermore, Hobday also argues that the terms 'complex' and 'complexity' is used as shorthand to describe the *combined* effect of several different critical product dimensions. While the critical product dimensions according to Hobday should be seen as being independent of particular sectors or industries, we argue that it is necessary to assess the degree of complexity relative to the relative to particular sectors or industries in order to avoid absolutist perceptions of the nature of CoPS and at the same time acknowledge the role of the sociotechnical system in which they (CoPS) are embedded (Geyer and Davies, 2009). This, however, also corresponds with Hobday's observation (although from an economic perspective) that it is "*…wise to view CoPS in relation to the market in which they are embedded, as the quality of their attributes can only be understood in the light of the demands of the marketplace [as] market structure […] and exigencies of regulation and user involvement will shape many of the parameters and choice within a particular context."* (Hobday, 1998: 694).

Using the above Figure 5 to develop a 'product profile' of a particular CoPS a heavy bias towards the right hand side of the figure indicates a CoPS of very high coordination complexity and risk whereas a scoring towards the left hand side "*…might indicate a batch produced stand-alone system with relatively little technological novelty and low risk."* (Hobday, 1998: 696). However, according to Hobday even such low risk and technologically 'trivial' systems are likely to impose more innovation coordination difficulties than mass produced goods. As such, a CoPS would generally tend to exhibit higher scores against most of the critical dimensions in Figure 5 than mass produced goods based on standard components. In particular, a CoPS would have more customised components, a greater number of suppliers, more regulatory constraints and a larger variety of knowledge and skill inputs than found in simpler goods.

Thus, a CoPS is not necessarily complex on all critical product dimension; it is however in average more complex (skewed towards the right hand side of Figure 5) than mass produced goods. In this study we have had an interest in working with a variety of different configurations of complexity according to Hobday's critical product dimensions in order to explore and find similarities and draw generalisations on the procurement and operation of complex products and systems in construction. In addition, we have chosen to focus on cases that exhibit additional critical characteristics relevant within the scope of the Eacobuild transnational program on research and innovation, namely their strong emphasis on users and clients and their application of new business models that focus on integration between design, production and operation – and not least feedback processes between these phases.

Thus, in summary the following criteria can be put forward to justify the selection of the six cases in the study:

- Each case represents a complex project. The six cases were chosen because they initially had the potential to be a CoPS. In the analysis of the six cases, focus was on both the project's development of new systems architecture and on the realisation of feedback processes as a strategy to optimize the established system design.
- French cases are all PPP projects since these projects are service-led contracts where the output to be delivered is specified (Hoezen and al., 2010). It also means that the scope of the contract goes further than design-and-build and encompasses operation and maintenance. The French cases were among the first PPP contracts signed in order to gather information on the operation stage.
- Danish cases are all concerned with different types of partnerships between public and private actors.
- In all cases, public authorities are demanding for packaged product and service delivery.

Table 1 shows the six cases and their differences with respect to type of partnership, stage of completion and the data material employed.

Partnership	Case	Stage of completion	Data material
ESPC/ESCO	Frederiksberg Municipality	Energy refurbishment activities commenced in 2013	Original tender documents (with all appendices) Interviews with main actors Articles (internet)
	18 high schools	Contract signed in 2010	Original contract (without appendices) Presentation/communication made by EIFFAGE and Region Centre Articles (internet) Interviews with main actors
Client partnership	UN City	Under construction during research project Second phase completed and in use by end of 2013	Documentary material Interviews Site visits Student reports
Client-supplier partnership	Green Lighthouse	In operation	Documentations Evaluations Reports Articles (newspaper)
PPP	INSEP	In operation since 2009	Original contract Presentation/communication made by VINCI Interviews with main actors
	The police station of Strasbourg	In operation since 2002	FM contract Reports Interviews with main actors

Table 1. The six cases and their differences with respect to type of partnership

The structure of each case follows the same scheme:

- The context
- The procurement characteristics
- The complexity of the project
- Type of contract
- Organisational structure
- Monitoring process
- Results
- Lessons learned

Key themes and research questions

Innovation in CoPS

Various forms of integrated solutions and new types of partnerships have been apparent as new solutions within the construction sector, and in many other sectors, to meet increased demands from the market and regulation, and different attempts have been made to examine their impact on innovation in the construction sector. This section addresses the way “integrated solutions” and “public-private partnerships” are configured in the construction sector as part of the innovation by the sector itself in its transition to social agendas such as energy and climate-adapted building etc. and the impact on the construction sector.

In the next three paragraphs, we address three central CoPS notations”) to explore how the CoPS approach can be applied in the construction sector to explore innovation in the sector. STS is used as a critical and constructive perspective to strengthen the analytical focus point.

Characteristics of innovation in CoPS

The standard model of innovation, which is used to examine mass production industries, is not adapted to CoPS (Winch, 2003). Under this traditional model, innovations tend to follow life cycle patterns from birth to maturity. Once a dominant standard is selected, innovation becomes incremental and large firms take over small one and produce large volumes to many customers.

The CoPS perspective strengthens the analysis of innovation in the construction sector by focusing on complex product systems as an alternative to industrial production, but in the application of the CoPS approach in construction as an analytical framework, it is necessary to consider that a boundary of CoPS does not necessarily follow the boundary of a construction project.

In the CoPS approach, complex products tend to be produced in projects with a high degree of system hierarchy, where the product architectures can be extremely elaborate, partly because designs are tailored for specific customers (Hobday, 2000: 795). The life cycle of complex products can extend over decades:

> *“In CoPS, innovation often proceeds long after the delivery of the product, as new features are added and systems are upgraded and modified (e.g. in IT networks and intelligent buildings)” (Hobday 2000 p. 795).*

In order to cope with product, technological and organisational complexity, companies often search for simplifying mechanisms and strategies such as standardization of previously customized components which can allow for production learning, cost reduction and new ways of innovation (Hobday, 2000: 796).

Davis (1998) suggests that some CoPS evolve through two phases of innovation. The first phase is the development of new systems architecture. This phase is strongly influenced by systems suppliers, regulators, standard-making bodies and large users. The second phase is characterised by development of new product generations. New products and components are introduced successively, without fundamentally changing the established system design (Hobday 2000 796).

The construction industry differs from other sectors by its project-based nature. Moreover, the construction industry is regulated by, on the one hand, legislation such as Building codes and ICT notices, and on the other hand agreements between the parties, such as contractual forms and performance specifications, which significantly determine the framework for the individual projects. This means firstly that the relationships between the institutional level and individual projects in construction are closely interwoven and secondly, that an understanding of innovation in construction cannot necessarily take its starting point in a sharp separation of the project and the institutional level. In other words, the boundary between each construction project and the institutional level, in which each construction project is embedded, is often a blurred area.

Gann & Salter (2000) have provided an analytical framework for understanding the construction industry as a business embedded in a context of both policy-making (regulatory and institutional framework) and knowledge production (technical support infrastructure). However, when it comes to identifying CoPS in the construction sector, focus has only been on construction projects such as intelligent buildings.

From a socio- technical perspective, Rohracher (2001) suggests that an approach to understanding the opportunities and constraints to innovation in construction is to analyse the building and the actors involved as a socio-technical system, i.e. to analyse dependencies and conditions, but also interests, perspectives and stakeholder interaction. Typical concepts used in analysing socio-technical systems are concepts such as critical issues, technological style and technological momentum. Rohracher (2001) suggests that one can make analyses at two levels: 1) the national and regional level and 2) the project level. At the national / regional level, the interaction between industry, government and market are weighted together with regulation, education, financial instruments etc. At the project level, focus will be on each construction project. Rohracher (2001) suggests that traditional buildings as technical systems are different from other artefacts such as cars, because there is not in the same way a close technical relationship between all sub-components, and this reduces the requirement for close interaction between the actors. Building systems are therefore more loosely coupled systems, being dependent on the interaction between actors (architects, planners, consultants, contractors, building services, etc.) who, when setting up a project, will be wired up to the project until it is over (Dubois and Gadde, 2002).

To understand transitions from one system to another, Geels (2004) have introduced the multi-level perspective (MLP) that operates with three analytical levels: niches, socio-technical regimes and exogenous socio-technical landscape. The three levels refer to configuration of increasing stability. The MLP proposes that:

> *"…transitions, which are defined as regime shifts, come about through interacting processes within and between these levels. Transitions do not come about easily, because existing regimes are characterized by lock-in and path dependencies, and oriented towards incremental innovation along predictable trajectories" (Geels, 2010: 495).*

Transition management and multiple-level perspectives of innovation focus on the ongoing engagement and integration of stakeholders, creation and stabilisation of supply chains, standardization of components, articulation of practices, and communication of shared goals and understandings (Geels, 2004).

Chris Harty highlights with the notion "unbounded innovations" how innovations such as 3 D CAD are taken into use at project and inter-organisational levels in construction. He distinguishes between bounded and unbounded innovations to differentiate between innovations where effects and consequences are related within a single organisation or interorganisationally, respectively. He has identified five features that are relevant to understand in the construction context into which innovations are introduced: "*The collaboration upon which construction work is based, its organization around particular projects, the centrality of communication to its performance, the importance of inter-organizational relations, and the way power is distributed*" (Harty, 2005: 513).

The notion unbounded innovations provides an alternative to the view that innovating across projects and between firms is about system integration through a single driving force, "an alternative that focuses on the mechanisms through which established roles , distinct disciplines, and traditional cultures contest and negotiate with and over new technologies or new ways of working" (Harty, 2005: 521).

Systems integrators at the core of the innovation process

The CoPS perspective strengthens the analysis of innovation in the construction sector by focusing on project-based companies' role as systems integrators and the capabilities it requires. However, within the application of CoPS in the construction sector, it may be relevant to note that it is not necessarily project-based companies that are systems integrators. In the CoPS approach, the project-based companies have the privileged role as systems integrators and a central research question is how the depth and breadth of the capabilities of systems integrators can be measured.

> *"Because the span of managerial control may be outside the boundaries of a single firm, collaboration is an important element of CoPS innovation. To develop new systems, integrators require a deep understanding of both the abilities of partner suppliers and the needs of demanding professional users, with whom they collaborate during innovation and production" (Hobday 2000: 796).*

In contrast to mass production, where module strategies are appropriate outsourcing strategies for production companies, the system integrators of CoPS have to develop outsourcing strategies that take into account the level of architecture, system and complementary knowledge that have to be in-house.

With the current energy demands and future challenges for construction for climate adaptation, complexity may well increase. It is often necessary to integrate complex products and systems within existing systems in order to manage products and systems to function in the context that they form part of. Gann and Salter (2000) suggest that the level of technical complexity increases when new generations of technology have to integrate with existing systems. A need arises for new specialisations that can support system integration. The location of the new specialisations can be in different parts of companies or between companies; but it is the project-based companies that position themselves in a role to provide system integration services (Gann and Salter, 2000).

Weaknesses in allocating the privileged role as systems integrators to project-based companies in complex settings such as the built environment include poor conceptualization of the institutional level and the construction project level, and a blurred relation between these, as well the distributed activities within the construction. Whyte and Sexton (2013) stress for example the "lack of attention to the diversity of actors involved, these actors' choices and motivations, and their processes involved in taking up and using new technologies across heterogeneous networks of practice".

Complexity: product, and organisation

The notation of complexity in CoPS has already been explained deeply in part one, why this section only highlights the analytical focus point related to innovation.

CoPS are defined by the complexity of the products and focus is on how the notion of complexity can be understood and applied beyond the level of products to the levels of processes and organisations.

CoPS can help to address innovative processes related to complex products and services, but in the use of the CoPS approach in construction, it may be necessary a priori not to define complexity as a matter of products but also as a matter of organisation.

The entrance and outcome of innovation in CoPS can also be a redefinition of the product (new integrated solutions) in the CoPS project organisation (new forms of public-private partnerships). At the same time, implementation of new structures has to cope with uncertainty. In a study of implementation of new IKT technologies in construction projects Chris Hart find that:

> *"Technologies are not finalized, fixed objects that can be imposed and to which people must adapt, but are malleable and can be transformed through contests over the building of systems. Unforeseen consequences are also considered, where attempts at alignment can result in the exclusion of necessary actors from the system, and trigger the assembly of alternate, parallel systems" (Harty; 2006: 521).*

Addressing complexity of the product as well as the organisation as an important innovation focus, both the specific configuration of private-public partnerships and integrated solutions become important categories in the analysis; a focus that is absent in CoPS studies.

Analytical focus points addressing innovation in CoPS in the construction sector

1. What is the boundary of the CoPS, including the interfaces between the project and the operational system?
2. How is the system integrator configured in the specific CoPS?
3. What is the complexity of each CoPS (innovation focus) and what type of feedback processes has been established as part of optimizing the CoPS.

Governance in CoPS

Hobday (1998b, 2000) introduced the term complex products and systems (CoPS) and emphasizes CoPS as the chief unit of analysis for innovation, management and competition analysis rather than the single firm. Hobday (1998b: 689) argues that the dynamics of innovation in CoPS are likely to differ from mass-produced commodity goods due to their distinctive characteristics. CoPS are characterised by being highly customised, engineering-intensive products, which often require several producers to work together simultaneously. Hobday (2000: 691-693) identifies a set of indicators of critical factors which defines the complexity of a CoPS. These include the quantity of tailored components and sub-systems, the hierarchical manner in which they are integrated together, the degree of technological novelty of the CoPS in question, and the variety of knowledge bases included in the CoPS. Further, user involvement in innovation tends to be high, and suppliers, regulators and professional bodies tend to work together with users ex-ante to negotiate new product designs, methods of production and post-delivery innovations. Markets are often bureaucratically administered, and contestability is low in contrast to commodity goods, which are characterised by arms-length market transactions. Examples of CoPS include a range of buildings and constructions, aircrafts, ships, telecommunications networks and a range of military equipment like missile systems and battle tanks.

In another paper, Hobday (2000) examines if a project-based organisation is the most appropriate delivery mechanism for complex products and systems compared to a more functional matrix organisation. Based on a case study of a large manufacturer of a wide range of advanced, high-cost scientific, industrial, and medical equipment, the paper illustrates the wide variety of organisational choices involved in producing CoPS and points out that the nature, composition, and scale of the CoPS in question is important for the appropriate choice of organisational form.

Hobday (2000) identifies some of the strengths and weaknesses of the two organisational forms for CoPS production. The project-based organisation is capable of:

– Creating and recreating a new organisational structure around each CoPS and customer.
– Coping with emerging properties in production and responding flexibly to changing client needs.
– Integrating different types of knowledge and skills and coping with the project risks and uncertainties common in CoPS projects.

The matrix organisation has its strengths where the project as an organisational form has its weaknesses: in performing routine tasks, achieving economies of scale, coordinating cross-project resources, facilitating company-wide technical development, and promoting organisation-wide learning. Further, project interests and incentives can work against the wider interests of corporate strategy and business coordination.

In line with the work on CoPS, Gann & Salter (2000) provide an analytical framework for understanding the construction industry as embedded in a context of both policy-making (regulatory and institutional framework) and knowledge production (technical support infrastructure). The model recognises not only the actors, but also the activities taking place. Further, the model acknowledges not only the construction industry in a traditional sense – namely contractors and consultants – but it also includes the clients of construction as well as the manufacturing industry delivering products for construction. Based on this resource-based perspective, Gann & Salter (2000) frame the links between different actors and activities as knowledge flows (see Figure 6).

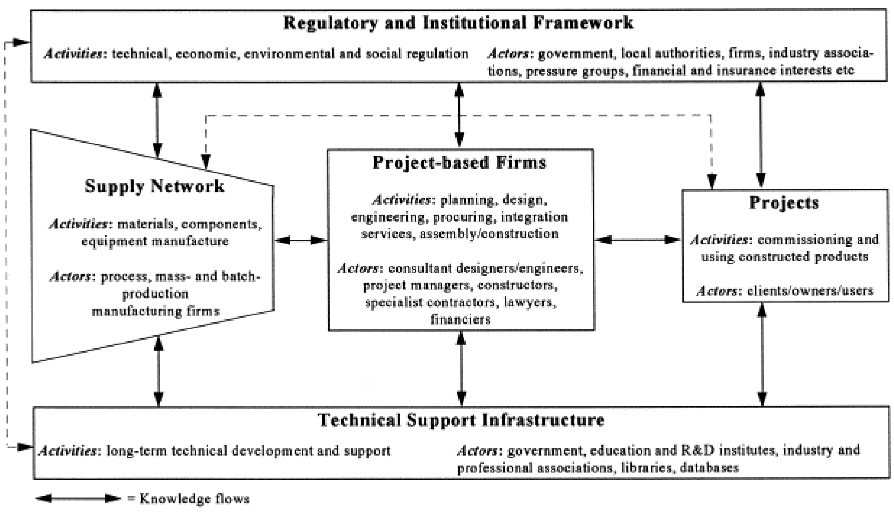

Figure 6. Knowledge, information flows and actors in project-based processes. Source: (Gann & Salter, 2000: 960).

As pointed out by Gann & Salter (2000), a major challenge for project-based firms is to link the project-based processes with the business processes of the firm. The project-based nature of construction implies that the interdependencies are primarily linked to the rather fluently, changing and ad-hoc patterns of cooperation with a rather great number of external firms. These links are important due to the relatively high degree of autonomy of the individual project, while the individual projects to a large extent determine the overall performance of a firm.

What is less clear is the character of these linkages. Haugbølle & Forman (2011) have identified a number of theoretical perspectives on these linkages in construction as: 1) knowledge flows (e.g. Gann & Salter, 2000), 2) functions and regulation (e.g. Carassus (ed.), 2004), 3) governance processes (e.g. Winch, 2000 & 2002), 4) a loosely coupled system (e.g. Orton & Weick, 1990; Dubois & Gadde, 2002), and 5) strong/weak ties (e.g. Granovetter, 1973; Pryke, 2004 and Chinowsky et al., 2008). Haugbølle & Forman (2011) propose an alternative perspective on these linkages as being constitutive rather than being fixed and taken-for-granted, which in turn explores and challenges the very ontologies at play (explanans/explanandum) when it comes to analytical units (project/firm), relations (couplings) and effects (performance/innovation).

Analytical focus point addressing governance in CoPS in the construction sector

1 How can the linkages be characterised in the systemic model of construction as a CoPS proposed by Gann & Salter (2000)?

Performance in CoPS

Transaction cost economics provide a framework to compare alternative modes of governance: markets, hierarchies and hybrids. According to the framework defined by Williamson (1991), uncertainty, frequency of exchange and asset specificity render most contracts incomplete. Therefore it is only possible to define procedures for resolving unforeseeable outcomes. Relational governance is often considered as a complement to contracts. Inter-organisational relationships bring trust (Adler, 2001) and facilitate the enforcement of obligations. However for large and complex projects informal control mechanisms are difficult to maintain. Thus, the aim of this section is to explore the detail and dynamics of contractual and relational governance mechanisms and their changing significance over time. In doing so, we will deal specifically with the question of what role performance management plays as a specific type of governance mechanism in the process of value creation. The aim is thus to examine how performance is governed in CoPS, focusing both on performance measurement as a matter of fact and as a matter of concern (cf. Georg and Tryggestad, 2009; Harty and Tryggestad, 2012), i.e. on objectives with measurable targets (Aubert et al., 1996; Barlow & Köberle-Gaiser, 2008) and on emergent *negotiated* objectives.

The issue of performance in CoPS

An important feature of applying a perspective of CoPS to the matter of value-driven processes in construction is that it directs our attention towards issues of distributed agency and the emergent and performative properties of production and decision making (Hobday, 1998). What this basically entails is that in order to understand how value is created and not least judged, we can give up the notion that the success or failure of a project can be judged against an "iron triangle" of cost, time and quality as "*…incubated by rationalist-normative project management theory*" (Sage et al., 2013: 284). Instead, we take an interpretive approach that: "*…draw[s] attention to the highly political character of seemingly technical measures of performance in projects…*" (Ibid., 2013: 284).

Two things in particular underpin the need to apply a wider or more nuanced perspective on how to understand performance and not least how to manage aspects of performance throughout the project process. First, the shift towards the delivery of integrated and service-oriented solutions has brought about an increasing proliferation of broader, qualitative and more dispersed client objectives. Second, and in continuation hereof, the increasing turn towards more hybrid forms of organisation and the intermingling of public and private interests have prompted the need to develop new governance mechanisms that consider the traditional contractual control as well as relational coherence (Clegg et al., 2002; Gottlieb and Jensen, 2012; Gottlieb and Haugbølle, 2013; Haugbølle et al., 2013).

Thus as Teubner (2006: 51) argued, today we face a “contractual gap” in that the contract can no longer be seen as "*the consensual exchange relation of two legal subjects to which the judge grants legal force”.* Rather, a contract should be understood as a polycontextual relation that simultaneously has to address legal, economic and productive acts in accordance with the intrinsic logic of the specific context. Thus, to reduce hazards of opportunism and deploy safeguards for every possible future contingency, formal control based on detailed and complex contracts is insufficient, as the contract can never stipulate every potential contingency. Conversely, the relational perspective focuses on the role of trust and promotes solidarity and information exchange.

As an example, consider a provider of integrated solutions that has to provide customers with details about activities to be performed. In a PPP project a Performance Measurement System (PMS) with Key Performance Indicators (KPI) is established according to the expectations of the public authorities. In the event poor performance or buildings unavailability, the payments to the private partners can be reduced. To be successful, measurement procedures have to go along with the quality of the service.

Performance criteria

Several different criteria exist that can be used to define project success and measure the level of performance of operation. Hudson et al. (2001: 1102) defined six dimensions of performance as follows:

Quality	Time	Flexibility	Finance	Customer satisfaction	Human resources
Product performance Delivery reliability Waste Dependability Innovation	Lead time Delivery reliability Process throughput time Process time Productivity Cycle time Delivery speed Labour efficiency Resource utilisation	Manufacturing effectiveness Resource utilisation Volume flexibility New product introduction Computer systems Future growth Product innovation	Cash flow Market share Overhead cost reduction Inventory performance Cost control Sales Profitability Efficiency Product cost reduction	Market share Service Image Integration with customers Competitiveness Innovation Delivery reliability	Employee relationships Employee involvement Workforce Employee skills Learning Labour efficiency Quality of work life Resource utilisation Productivity

Table 2. Critical dimensions of performance (Hudson et al., 2001: 1102)

Whilst indicative of the breadth of different performance criteria, this does not reveal how performance in CoPS is to be conceptualised. Following the insights from Barlow & Köberle-Gaiser (2008) and Geyer and Davies (2000), who combined the concept of large technical systems (LTS) and CoPS, we would argue that performance, in contrast to the traditional perceptions within the area of construction management, is no longer solely an issue confined to "the project" but that also the "operational system" has to be considered (Geyer and Davies, 2000: 992). Adding to this complexity, the project should be seen as consisting of a web or network of suppliers including *"…systems integrators, prime contractors, subcontractors, specialist suppliers and government regulatory bodies, responsible for executing projects to meet […] the public requirements.*" On the other hand, we have the operational system, which is composed of (facility) operators, owners and regulators that are responsible for operating and delivering services through a system to end users. Viewing the provision of building works and services in this combined LTS / CoPS perspective emphasises the heterogeneous and dispersed nature of technological change and the management hereof. This also extends to the issue of system performance, where Geyer and Davies (2000) argued that the efficiency of a system (CoPS) is dependent on a large number of different components that all contribute to the overall goal of the system. What this entails is therefore that performance has to be "measured" and evaluated according to a diversity of stakeholder perspectives and different technical, normative, regulative and cognitive-cultural concerns.

Somewhat along these lines of reasoning, Van de Riet (2003) has proposed the following typology of actor perspectives on (infrastructure) performance that considers technological, economic, public-policy and business-development factors. Focussing on the two dimensions of *performance domains* and *actor perspectives*, the following overview of divergent goals related to infrastructure performance is given:

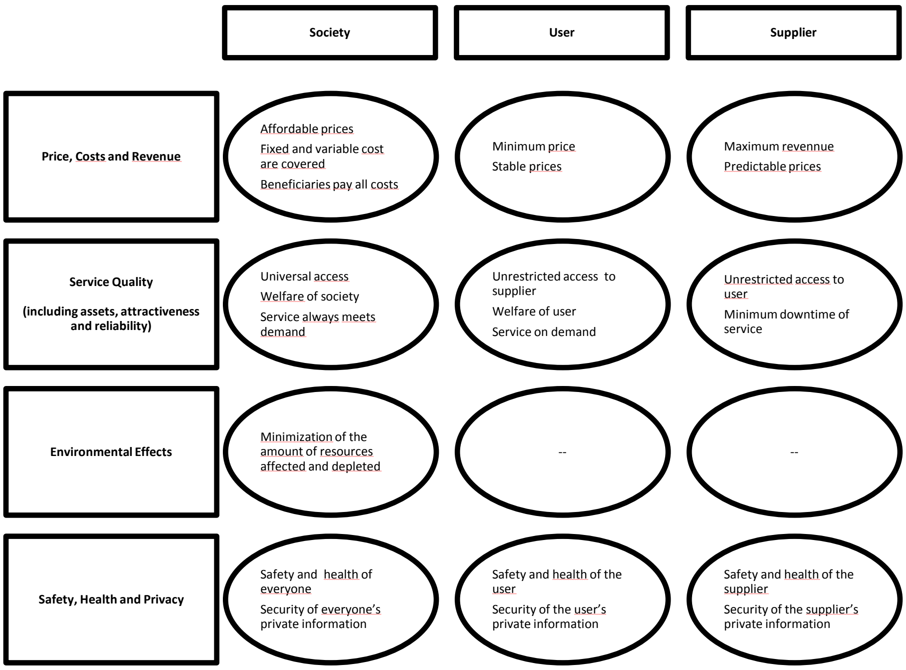

Figure 7. Overview of the divergent goals related to infrastructure performance (Van de Riet, 2003: 41).

The performance domains (left hand column in Figure 6) are related to infrastructure and are based on insights from various infrastructure sectors. In an LTS / CoPS perspective on construction works and services, we would however argue that these are also representative of the projects studied in this project. The second dimension, (top row in Figure) highlights very broadly different actor perspectives on infrastructure. In reality, Van de Riet (2003) argued, there are a myriad of possible perspectives on infrastructure, however these can usually be seen as combinations of three basic actor views, being society, user and supplier. For the purposes of this study, keeping in line with the CoPS perspective, we however operate with the following four actor perspectives: (i) society, (ii) operational system, (iii) project; and (iv) user.

For each performance domain, each actor has different goals to achieve and the idea behind the above typology is that it can guide an understanding "*…about the background of conflicts of interests in debates about the performance of existing infrastructure and the design of necessary changes.*" (Van de Riet, 2003: 39). In other words, being sensitive to the heterogeneity of different legitimate goals and aspirations of different actors involved in complex projects and CoPS enables us to understand what motivates particular discussions and to understand the various types of governance mechanisms that are put in place to deal with the controversies at stake in different project systems.

Analytical focus point addressing performance in CoPS

Following the above model, we argue that controversies, or contradictions (cf. Gottlieb and Haugbølle, 2013), can arise both as a result of tensions between different actor perceptions within a single performance domain and as a result of contradictions between goals in different performance domains. The crucial research question in relation to performance in CoPS thus is:

1. How can contradictions and controversies between different actors' perspectives on performance goals be balanced by means of innovative contractual mechanisms that each represents a specific strategy for the handling of this complexity?

Cases

This chapter begins with an introduction to the differences between the Danish and the French system as the basis for comparative studies between Denmark and France. This is followed by three Danish cases and three French cases.

Comparative studies - Construction business in France and Denmark

Background

Table 3 summarises some key figures on France and Denmark. The population of France is about 12 times the population of Denmark, while the area of France is about 15 times the size of Denmark. Thus, the population density is somewhat higher in Denmark compared to France, and the two countries are positioned above and below the European average, respectively. The degree of urbanisation is roughly the same.

In economic terms, both countries are positioned above the European average. While the gross domestic product (GDP) of France is comfortably higher than the European average, the gross domestic product of Denmark is significantly higher than both France and Europe in general.

The same difference can be observed with regard to investment in research and development (R&D), where Danish investment is almost 50% higher than the average.

With regard to construction activities, the contribution from construction to the GDP is markedly lower in Denmark than France and Europe in general. A similar marked difference with regard to construction employment cannot be observed. It should be noted, though, that the definition of construction activities does not include consultancies. Despite its small size and population, Denmark has a number of engineering consultancies within the top 150 global design firms (Engineering News-Record, 2013). It may be speculated that a larger share of the Danish GDP stems from knowledge-intensive businesses like engineering consultancies due to the more prominent role of consultants in the Danish building process compared to France.

	Denmark	France	EU-27
Population (in millions)	5.6	65.3	503.3
Area (km^2)	42,895	632,834	4,324,782
Population density (people/km^2)	129.7	103.0	116.9
Degree of urbanisation[1]	75.3	81.8	73.8
Gross Domestic Product (million EUR)	245,037	2,032,296	12,923,838
Gross Domestic Product/capita ('000 EUR)	43,800	31,100	25,600
Gross expenditure on R&D (% of GDP)	3.09	2.24	2.03
Construction contribution to GDP (% of GDP)	4.7	6.3	5.9
Construction employees (% of total based on hours worked)	6.9	7.9	7.4

Table 3. Key figures on Denmark and France compared to EU-27 countries. Note 1: Degree of urbanisation measured as percentage of population living in densely populated areas plus intermediate urbanised area. Note 2: Year 2012 if available, otherwise 2010 and 2011. Source: (Danmarks Statistik, 2013; Insee, 2013; Eurostat. 2013).

Similarities and differences

There are a number of notable similarities and differences between the Danish and the French construction business systems. This section is by and large an extract based on a conference paper by (Haugbølle et al., 2013).

As in most mature markets in the developed world, the construction market for refurbishment in both Denmark and France is by and large of the same size as the market for new buildings.

The business structure, and thus the position of the main actors of the building process, differs between Denmark and France. The Danish building process shares many of the same characteristics as the professional system in the UK, which is dominated by consultants. This is quite different from the French industrial system in which contractors are more dominant (Levring & Bonke, 1996; Winch & Campagnac, 1995; Winch, 2000 & 2002; Carassus, 2005).

Contrary to France, a Bureau de Contrôle does not exist in Denmark and insurance companies play a more modest role in the Danish building process compared with the French building process, where construction insurance plays a significant role (Söderberg et al., 2004). However, two building defects funds were established in Denmark in the 1980s within social housing and refurbishment of aging multi-family dwellings in order to inspect buildings for defects and provide insurance cover. In recent years, a new mandatory insurance scheme for private housing developments has been implemented. Insurance is offered by some private insurers, but not all.

The typical procurement protocols in both countries are traditional (or trade) contracting, main (or general) contracting, and design-build contracting. Contracts in Denmark are typically based on the ABR89 General Conditions for Consulting Services (1989), AB92 General Conditions for Works and Supplies for Building and Civil Engineering Works (1992) or ABT93 General Conditions for Design-Build Contracting (1993). It is mandatory for publicly supported clients to follow these agreed documents, whereas private clients are free to choose whatever procurement protocol they deem fit. In practice, the agreed documents, with some modifications, form the bulk of construction contracts in Denmark (Levring & Bonke, 1996). Similar agreed documents exist in France.

Integrated delivery mechanisms, including private financing of public projects, have developed along quite different paths. In recent years, much attention is being paid to integrated delivery mechanisms in Denmark. This has led to a hybrid practice of design-build contracting – by some practitioners termed “controlled design-build contracting” – in which the client exercises a greater influence on the design than is usual for the ordinary design-build contract. The client makes the initial contact to a design team for a conceptual design, which is then followed by a slightly adapted design-build contract in which the client retains some degree of control of the design (Söderberg et al. 2004; Levring & Bonke, 1996).

In Denmark, the development of new delivery mechanisms has been supported by a number of subsequent development programmes: Project New Ways of Collaboration, Clients Create Value (in Danish, Bygherren skaber Værdi), and the PLUS network (Partnering, Learning, Development, Collaboration). The diffusion of integrated delivery mechanisms has been championed by the public authorities and certain key actors in the building process like the contractor, NCC. Today, partnering has become a fairly widely used delivery mechanism, while it is still in its infancy for energy-service companies (ESCO). Mechanisms like public-private partnerships and integrated procurement are seldom used (see e.g. Larsen et al. (eds.), 2010).

France has long experience in private finance procurement, primarily within infrastructure projects; more specifically road construction. Public authorities grant specific rights to a private partner to construct, maintain and operate the infrastructure for a given period. The private partner operates the service at his own risk and is remunerated in the form of a fee paid by the users of the service. Owing to this experience, French companies working in this market have developed strong capabilities to design and construct roads as well as to operate, maintain and finance the infrastructure during its life cycle.

Only a limited number of buildings have been delivered under this form of procurement. Indeed, according to the French Act no 85.704 of 12 July 1985, the public client generally drafts two different contracts with the architect and the contractor, respectively. Design, build and operate (DBO) is possible, but the client has to demonstrate that this is less expensive or technically necessary. However, finance cannot be transferred to the private partner.

In June 2004, a new law was passed, which proposed a complementary framework. It introduced the partnership contract ("Contrat de partenariat"). Under this new scheme, design, build, finance and operation could be transferred to private partners. The partnership contract has become the most commonly used public-private partnership (PPP) contract. At the end of June 2012, 122 contracts had been signed. This change in the regulatory framework has encouraged the major French contractors to develop new operational service capabilities in order to maintain, operate and upgrade buildings throughout their life cycle. Their strategy has been two-fold. First, the contractors used the PFI market in the UK to develop facilities and management capabilities, as well as to acquire knowledge of the different stages of a building's life cycle. Second, on the basis of this experience, the general contractors have been awarded most of the French partnership contracts.

Case 1: ESCO: Frederiksberg municipality

Driven by the 2006 EU Directive on Energy Services and the 2007 Danish strategy for energy improvements of the building stock, recent years have seen a proliferation of initiatives and activities aimed at reducing energy consumption in the built environment. One of the initiatives that have gained the most attention and the most widespread use is ESCO.

ESCO is an abbreviation of Energy Service Company. According to Vine (2005: 691) an energy service company is a company that *"…is engaged in developing, installing and financing comprehensive, performance-based projects, typically 5-10 years in duration, centred around improving the energy efficiency or load reduction of facilities owned or operated by customers*."

Bertoldi et al. (2006) have provided a definition of ESCOs that draws a distinction between different types of energy service company. Thus, they used the term Energy Service Provider Companies (ESPCs) to refer to companies that *"…provide energy services to final energy users, including the supply and installation of energy-efficient equipment, and/or building refurbishment, maintenance and operation, facility management, and the supply of energy (including heat)*" (Bertoldi et al., 2006: 1820).

Although an ESCO also offer the same services, there are some differences of a rather crucial nature. While an ESPC provides a service for a fee and takes no risk, an ESCO:

- guarantees the energy savings (as reflected in the contract),
- can provide finance, or via energy savings guarantee assistance in arranging finance, for the operation of an energy system, and
- has its remuneration directly tied to the energy savings achieved (Bertoldi et al., 2006: 1821).

As such, an ESCO accepts a degree of risk for the achievement of improved energy efficiency in a user's facility. This is echoed in the EU directive on energy end-use efficiency and energy services (The European Parliament, 2006) in which an ESCO is defined as: *"…a natural or legal person that delivers energy services and/or other energy efficiency improvements measures in a user's facility or premises, and accepts some degree of financial risk in so doing. The payment for the services delivered is based (either wholly or in part) on the achievement of energy efficiency improvements and on the meeting of the other agreed performance criteria*."

Jensen et al. (2013), in their study of ESCOs in Denmark, document that especially municipalities have championed the uptake and use of this particular way to improve the standard of public buildings and to increase energy efficiency. Thus, they document that in the beginning of 2013, 30 municipalities (of the 98 municipalities in Denmark, are involved in, or preparing, ESCO contracts (Jensen et al., 2013: 2407). Recently, Frederiksberg municipality (see Frederiksberg Kommune, 2012a; 2012b; 2012c; 2012d; 2012e; 2012f) has also chosen to realise energy reductions by means of an ESCO approach, and this is the focus of the present case.

The context

Frederiksberg municipality's interest in energy refurbishment and ESCOs is motivated by a commitment to realise CO_2 reductions and energy savings as a part of the Danish national target to be independent of fossil fuels by 2050. A large part of the municipal CO_2 emissions are related to the municipal building stock and energy consumption is a decisive factor in these CO_2 emissions. Therefore, in 2011, the municipality decided to put up for tender the task of realising "*…a part of this potential according to a model in which the municipality enters into an agreement with an energy service company (an ESCO)"* (Frederiksberg Kommune, 2012a; own translation).

In the beginning of 2013, Frederiksberg Municipality (in guise of FK Properties, being the municipal property operator) entered into an agreement with Schneider Electric on the energy refurbishment of approximately 80-100 municipal buildings. The actual refurbishment activities are planned to be completed by 2017, after which the municipality and Schneider Electric will commence a partnership on the operation of the completed project and documentation of the guaranteed savings.

The procurement characteristics

The works were tendered as a design-build contract and encompass approx. 80-100 properties owned by the municipality, including daycare institutions, schools, cultural institutions and administrative and sports facilities. In total 211,000 m^2 of buildings were put up for tender. Eight of these properties were designated as "Track 1 properties" entailing that the municipality is contractually obliged to initiate the energy-reducing measures upon contract signing, i.e. in 2013. The remaining properties, the so-called "Track 2 properties", will be energy refurbished subject to a subsequent energy analysis.

Track 2 properties will be bundled in so-called "year categories" that will be in accordance with the annual financial allocations established by the municipal council for the years 2014, 2015, 2016 and 2017.

In addition to the track 1 and track 2 properties, a so-called "flagship project" has been designated. The purpose of this project is to present the ESCO project to the public. This project is to have a good signal value and include visible CO_2 reduction measures, e.g. photovoltaic cells, solar thermal collectors, geothermal heating system, etc.

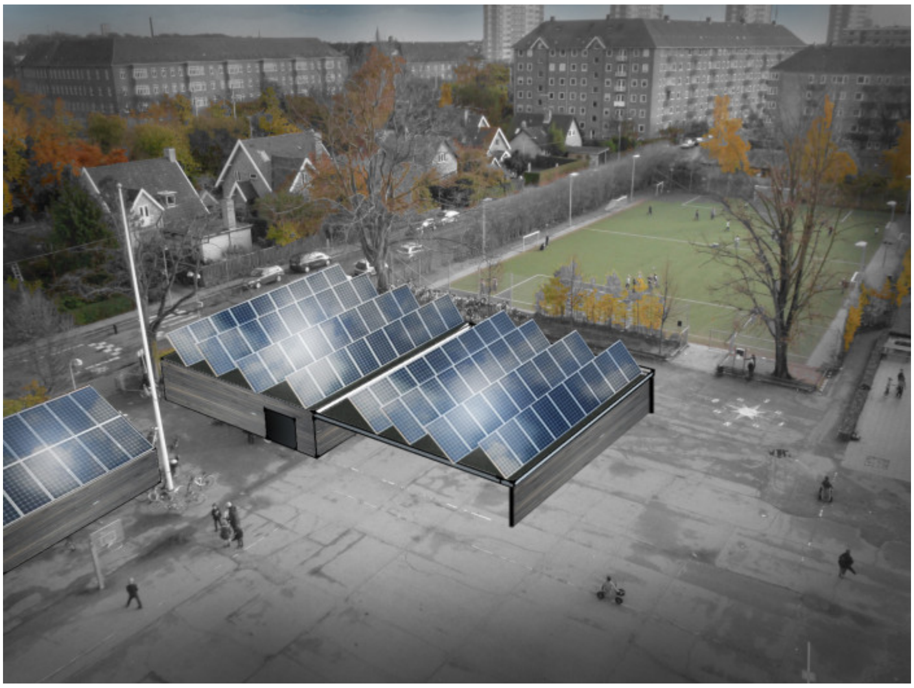

Figure 8."Photo voltaic building on the flagship project" by Schneider Electric is licensed under CC BY 2.0

The actual work being tendered concerns measures to optimise lighting, heating and ventilation. Potentially, improvements of both installations (the technical systems) and the building envelope (primarily insulation, doors and windows) are covered by the contract, depending on the feasibility of the improvements. The contract also covers measures related to the installation of renewable energy technologies.

The project covers three phases in addition to phase 0 (tender), as illustrated below:

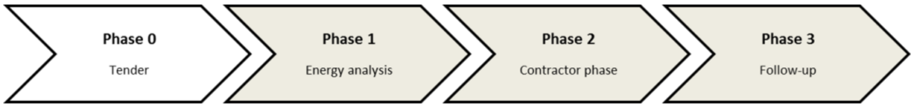

Figure 9. Phases in the project (from the tender documents)

The phases are: (i) energy analysis, i.e. mapping of the potential for energy reduction, (ii) contractor phase, i.e. design and execution of energy-reducing measures; and (iii) follow-up, i.e. operation including verification of obtained effects and educational activities for municipal personnel prior to handover.

In the selection stage in phase 0, potential contractors/operators were assessed on their economic and financial ability and on their technical capacity, and four operators were invited to bid for the contract. The actual contract was awarded based on the most economically advantageous tender approach using the following weighted sub-criteria:

1 Economic model (60%)
2 Suggested technical solutions (20%)
3 Flagship project (10%)
4 Investigation and completion competencies (10%)

This model was chosen due to the complexity of the project and the client's need to balance financial and technical concerns, including the municipality's obligation as a "climate municipality" to reduce CO_2 emissions and at the same time keep within the annual financial allocations.

The complexity of the project

The project can be considered complex due to the highly varied portfolio of properties included in the tender. Specifically, the track one properties selected:

– vary in size
– have a functional width, i.e. represent different types of use
– represent different building traditions due to year of completion; and
– test the width and depth of the ESCO's "project catalogue" / competencies

Further adding to the complexity of the project are two things in particular. First, the use of the properties might change during the contract period with regards to e.g. the number of users in the individual buildings, the number of rooms being utilized, the periods of use of the different rooms, as well as the actual use of the rooms including equipment etc. Second, the municipality reserved the right to refurbish or change building components that are not covered by the contracted energy services, if such works will result in energy reductions. As both of the above concerns impact the energy baseline of the properties, this leads to issues in relation to the actual enforcement of the monitoring process.

Following Hobday's (1998: 690) description of Complex Systems and Products (CoPS) complexity can be understood as: "*…the number of customised components, the breadth of knowledge and skills required and the degree of new knowledge involved in production, as well as other critical product dimensions.*" Using these critical product dimensions as a starting point, we can draw up a characterization of the complexity of the ESCO case accordingly:

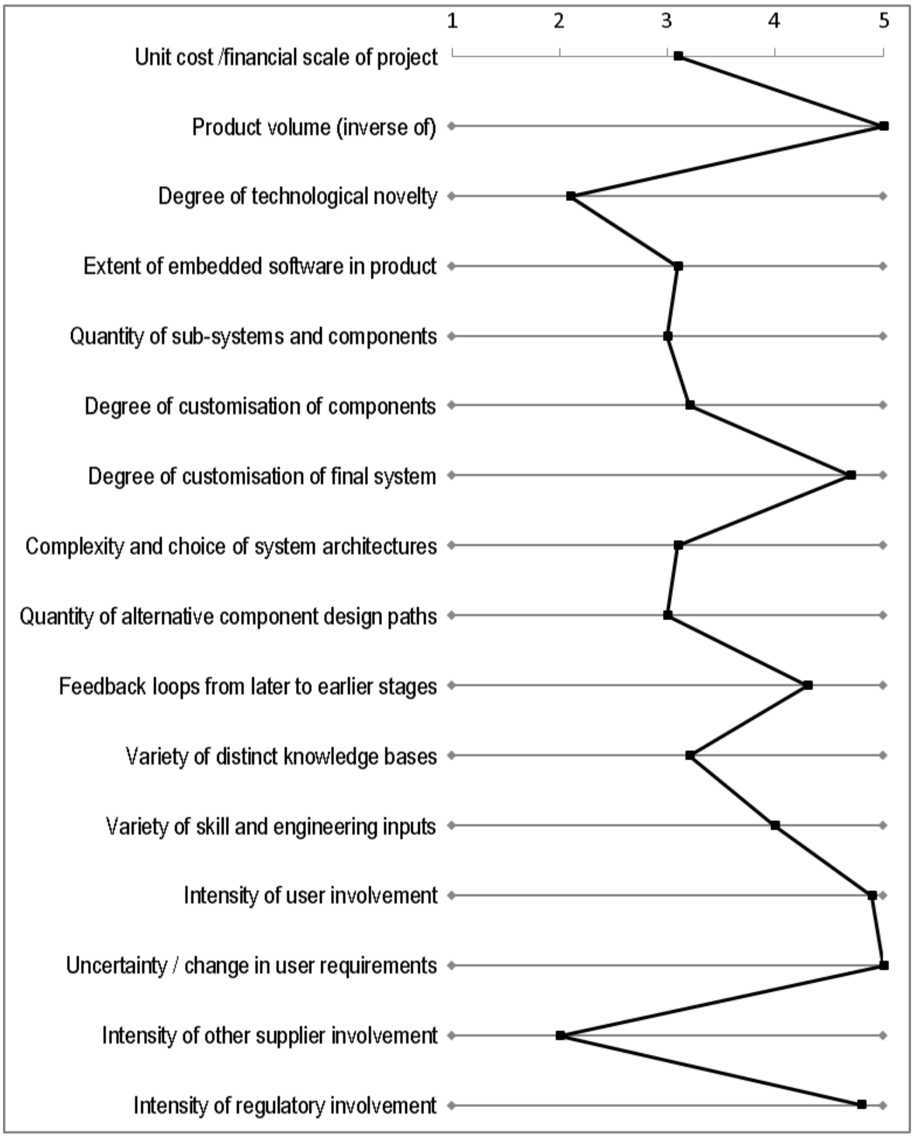

Figure 10. Complexity of the ESCO case. (5 is 'very high', whereas 1 is 'very low').

Unit cost / financial scale of project: Score – medium
The unit cost/financial scale of an ESCO project can vary much from case to case. Christensen and Sundman (2007) have reported from Danish cases that total investments in energy services varied from as little as € 67.000 upwards. The Frederiksberg case is the largest ECSO project in Denmark, however compared to “conventional” projects the financial scale can be considered medium.

Product volume (Inverse of): Score – very high
The product volume in the ESCO project is small in the sense that each project is customized and solutions have to be integrated within existing product systems.

Degree of technological novelty: Score – low
Technological novelty is just below average. Although new technological solutions may be produced ESCO is more a matter of organisational / contractual novelty than technological innovation.

Extent of embedded software in product: Score – medium
The extent of embedded software in product is medium. Specific solutions might have a high extent of embedded software; however, could also be rather mundane e.g. refurbishment of windows and facades. On the Frederiksberg case software is used for monitoring energy consumption. The software is at the core of the guaranteed savings scheme.

Quantity of sub-systems and components: Score – medium
The quantity of sub-systems and components could be high depending on the specific ESCO in case. In this case a substantial number of sub-systems and components have been utilised.

Degree of customisation of components: Score – medium
Although, each ESCO solution has to be adapted to fit client needs standard components have been used.

Degree of customisation of final system: Score – very high
Each ESCO solution is bespoke due to its specific integration with existing systems.

Complexity and choice of system architectures: Score – medium
Integration between different sub-systems induces complexity. A given solution not only has to be adapted in a given product, but could also be part of a larger supply network e.g. on local or regional scale.

Quantity of alternative component design paths: Score – medium
Component design path depends on the given ESCO wherefore quantity of alternatives are somewhat high.

Feedback loops from later to earlier stages: Score – high
Continuous monitoring of actual energy consumption is used extensive to correct solutions and ensure that energy savings targets are met. Feedback from track 1 properties is furthermore used in the design of technical solutions for track 2 properties and the possible renegotiation of the contractual terms.

Variety of distinct knowledge bases: Score – medium
As in any construction project, ESCO solutions include a wide variety of distinct actors and knowledge bases as is also discussed further in “organisational setup” section of the case.

Variety of skill and engineering inputs: Score – high
High due to the number of direct and indirect stakeholders that are part of the project on strategic as well as operational levels. The success of an ESCO critically depends on the ability of all stakeholders to contribute towards meeting requirements for energy savings.

Intensity of user involvement: Score – very high
Very high, as energy services typically are implemented in existing products, companies and buildings and have to be developed in close dialogue between the client and the ESCO – and also additional stakeholders.

Uncertainty / change in user requirements: Score – very high
See above.

Intensity of other supplier involvement: Score – low
The ESCO thus operates as both a technical consultant and as a design-and-build contractor during the project and is thus responsible for all supplies. Due to the scope of the project and the number of possible technical solution other suppliers will be involved, however not in a scale exceeding conventional projects.

Intensity of regulatory involvement: Score – very high
As Vine (2005: 694) have argued: "*The legal and regulatory frameworks are not compatible with energy-efficiency investments, particularly energy performance contracting. In particular, measurement and verification protocols for assuring performance guarantees are not understood.*" Furthermore, Vine (2005) has also noted that the EU is heavily engaged in establishing a market for ESCO in Europe. Furthermore, in Denmark, ESCO is mentioned in the government's energy strategy (Regeringen, 2009) as a business model that can help reach the national energy reduction targets.

Type of contract

The project comprises four different agreements: (i) a partnership agreement, (ii) a consultancy and analysis agreement (iii) a contracting and implementation agreement; and (iv) a service agreement. The partnership agreement can be mutually terminated by each of the parties, after which the agreement relationship will have the form of an ordinary agreement without the same degree of reciprocity and development of ideas and methods as presupposed in the partnership.

The phase one agreement between the municipality and the ESCO is based on the Danish "ABR 89 – General Conditions for Consulting Services", whereas the agreement in phase two is based on the Danish "ABT 93 – General Conditions for Turnkey Contracts." The ESCO thus operates as both a technical consultant and as a design-and-build contractor during the project. The third phase of the project is governed by a monitoring and operating contract that is entered by the parties in order to ensure the delivery of the guaranteed savings that are the object of exchange in the contract. Such a guaranteed savings approach is the most commonly used approach to ESCOs in European countries. In contrast to a "shared savings approach", this entails that it is municipality that finances the refurbishment and thus does not bear any performance risk – a risk that instead is assumed solely by the ESCO.

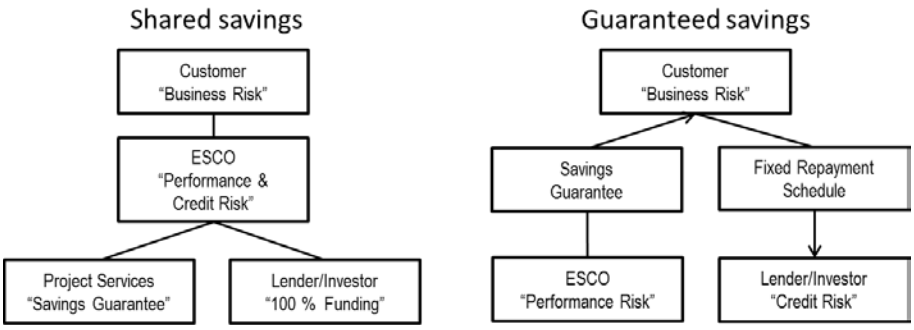

Figure 11. Primary savings structures (Dreessen, 2003 in Bertoldi et al:, 2006: 1822).

In the Frederiksberg case, Schneider Electric, as the ESCO, makes suggestions for specific improvements to the properties and guarantees the municipality's savings. Should the savings not be met, Schneider Electric will cover the difference. If savings in excess of the guaranteed savings are realised, the surplus will be split three ways, with one-third going to Schneider Electric, one-third to Frederiksberg municipality and one-third to the properties covered by the contract.

The contract between Schneider Electric and Frederiksberg municipality was entered in 2013, and a total of DKK 30 million was allocated to (i) energy refurbishment of track 1 properties, (ii) cover the expenses related to the services of the track 1 properties in phase 3 (follow-up and monitoring) and (iii) conduct the energy analyses of all track 2 properties. Furthermore, the following investment framework was set up in accordance with the annual financial allocations of the municipality:

– In 2014 a maximum of DKK 23 million have been allocated
– In 2015 a maximum of DKK 34 million have been allocated
– In 2016 a maximum of DKK 31 million have been allocated
– In 2017 a maximum of DKK 30 million have been allocated

For the guaranteed energy reduction, the maximum pay-back time of the investment must not exceed 14 years.

Organisational structure

The project's formal and general organisational structure comprises a "management group" and a "contract group". The management group assumes overall responsibility for ensuring that the objectives in the partnership agreement are complied with. The management group consists of participants from the senior management at the municipality, the ESCO and the ESCO's potential technical consultants. A central task of the management group is to function as a conflict resolution board in the eventuality of disputes related to the services. The contract group is the operational authority of the formal organisation. The contract group has authority to make corrections and decisions pertaining to allocation of personnel, time schedules, execution methods and minor financial changes.

In line with the specific partnership agreement and the general implementation of partnering in Denmark (cf. Gottlieb & Haugbølle, 2013), the project operates under a governance scheme in which leading employees from the ESCO, the ESCO's technical consultants and the ESCO's subcontractors can only be substituted at the discretion of the client. Moreover, the client can demand substitution of employees in order to ensure project success. Following Geyer and Davies' (2000) conceptual model of project-system interfaces, the project organisation structure can be illustrated accordingly:

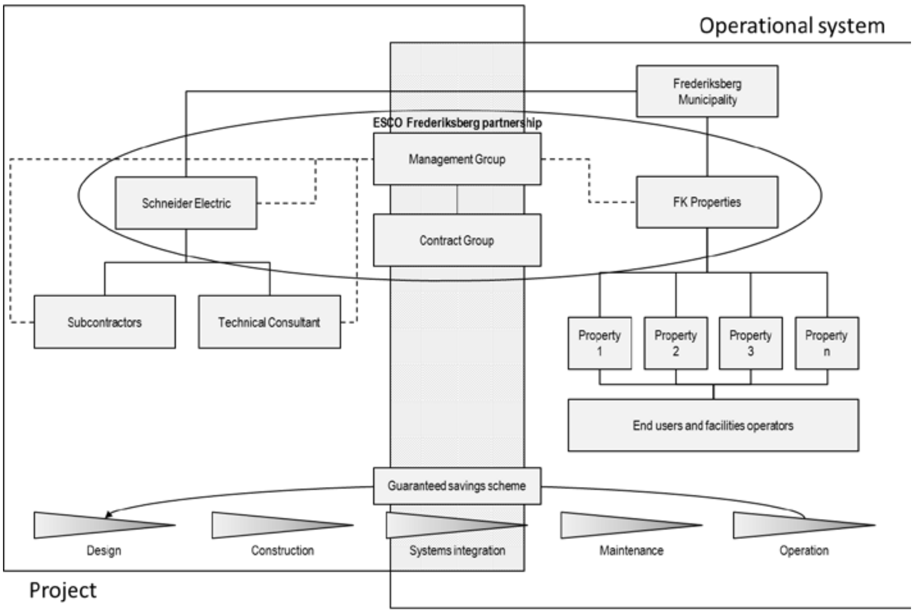

Figure 12. Project-system interfaces in the ESCO project.

Monitoring process

The monitoring process is central to the ESCO agreement. As the projects are completed under a guaranteed savings contract and in accordance with a strict municipal investment framework, client and well as contractor have a mutual interest in establishing a solid foundation for the monitoring process. A central aspect of the monitoring process is the preliminary establishment of the “energy baseline” that constitutes the basis on which the bidders have to calculate their guaranteed savings. The baseline is established as the energy consumption of each property, corrected for the number of degree days (weather normalized). The same calculation principles have to be applied for each of the properties, and the guarantees for the annual categories have to be based on the same principles as applied in the basis for calculation of savings in the track 1 properties.

As a part of the service agreement, the ESCO has to conduct training programmes for the municipality’s employees to ensure that these are capable of servicing the energy solutions. Once a year, the ESCO is contractually obliged to give an account of the exact energy consumption of each individual energy source as a part of the calculation of the guaranteed energy savings. Moreover, accounts have to be submitted to the municipality four times a year to be addressed in the current project management, budgetary projections and control of effects.

Results

Due to the time frame of the project, it is not possible to conclude on the results of the ESCO project in terms of actual energy savings. It is, however, possible to point at some preliminary and more general qualitative results. First, it should be noted that the ESCO in itself has been a catalyst for the refurbishment of the municipal building stock. Due to strict financial control and reduced annual financial allocations, the ESCO approach constituted a solution to both the municipal energy reduction targets as well the general maintenance backlog of the properties to accommodate for increased use due to population growth in the municipality.

Second, on the economic results, projections from Frederiksberg Municipality estimate that by the end of 2013 the ESCO-Frederiksberg partnership will have implemented energy saving measures that will reduce the municipal energy purchases for the track 1 properties by app. 1,100,000 kWh/year electricity and 1,800 MWh/year heating; corresponding to app. DKK 2.5 million. The continued energy refurbishment of the municipal properties until 2017 will result in a total reduction in electricity and heating expenses of around DKK 11 million per year.

Lessons learned

Innovations

This case represents a type of delivery system for mobilising private financing of public services. It is an example of a dual financial and organisational innovation (see also the UN City case) under the auspices of the ESCO that functions as a systems integrator coupling the project and the operational system. As such no product innovations have been developed.

Governance mechanisms

In terms of governance processes, this coupling of the project and the operational system takes place through a mixture of distinct policy, business and learning processes as proposed in the model developed by Haugbølle et al. (2012) presented previously in this report. The policy processes that predominantly takes place between the regulatory framework on one hand and the various businesses on the other hand, can be characterised as a politicisation of industry business processes by the setting of targets – or management by objectives. On the topic of business processes, the case provides an example of a hybrid organisational arrangement in which both traditional transactional as well as relational governance mechanisms are applied. These cover the standard description of services and conditions for the provision of works and supplies within building and engineering (ABR89 and ABT93) and a partnership agreement that runs for the entire duration of the operation of the technical installations. This combination has proved pivotal in the concurrent negotiations between the municipality and the supplier regarding changes to the contract. Thus a recent legislative change in relation to the so-called 'solar cell law' reduced the payment for the overproduction of electricity with 70 percent leading to a reduced profitability of the technical installations and prolonged payback period. The change in payback time has not had any contractual consequences as this according to the municipality only constitutes a minor change to the existing contract between the municipality and the ESCO that can be settled without a new tender. Finally, the learning processes are centred on the guaranteed savings scheme which with its baseline measurements and monitoring of energy consumption in the properties that proven to constitute an effective feedback mechanism directly links the project with the operational system and provides, if not real-time feedback, then at least a highly responsive mechanism for the concurrent and subsequent upgrade of the municipal facilities.

The performance process and the value to the end users

With regard to performance measurement, Frederiksberg municipality and Schneider Electric have been successful in in meeting a series of performance demands at societal level as well as in relation to both user and supplier side. At societal level, the ESCO setup help meet national emission reduction targets and at the same time, both Frederiksberg municipality and the ESCO profit financially from the partnership without placing any limitations on the use of the properties.

Case 2: Client partnership: UN City

This chapter is in part based on two previous conference papers by Haugbølle et al. (2012 and 2013).

The context

The capital area of Copenhagen is growing rapidly. The number of inhabitants is expected to increase by 100,000 people or 18% by 2025. At the same time the business structure is changing rapidly. Heavy industry is disappearing from the Port of Copenhagen, which is freeing up new areas for urban development (see Figure 13). One of the most prominent areas is Nordhavnen, the Northern Harbour of Copenhagen (By & Havn, 2009).

Figure 13. Today Nordhavnen is an industrial area. Photo: Kim Haugbølle.

In December 2005, the Danish government and the City of Copenhagen reached an agreement on the principles that would govern urban development of the Port of Copenhagen, including Nordhavnen. This agreement became an Act of Parliament that was adopted on 22 May 2007. In May 2008, an open international ideas competition on the sustainable city of the future was launched, attracting some 180 proposals. In March 2009, the result of the competition was announced. The winning proposal, titled "Nordholmene – Urban Delta", was developed by a team composed of COBE, SLETH MODERNISM, Polyform and Rambøll. During the summer of 2009, the winning proposal was reviewed, and its development strategies were further detailed and specified. The six themes of the winning proposal are 1) islets and canals, 2) identity and history, 3) five-minute city, 4) blue and green city, 5) CO_2 friendly city, and 6) intelligent grid. During 2010-11, the City of Copenhagen developed a supplement to the Municipal Plan as well as a local plan for Nordhavnen (By & Havn, 2009).

Nordhavnen is expected to be developed over the next 40 years to house 40,000 inhabitants and 40,000 employees. The development of Nordhavnen is divided into three stages. The first stage covers the inner Nordhavn (the so-called Århusgade Quarter), comprising about 350,000 m^2 of new gross floor area and preservation of some of the existing buildings with a gross floor area of 70,000 m^2. In the second stage, scheduled to start in 2018, an additional 200,000 m^2 may be developed. In a third stage – which has not yet been detailed – the entire Nordhavnen may eventually be developed to include buildings with a gross floor area of 3-4 million m^2 (By & Havn, 2009).

The UN City is the first of a number of new developments to be constructed in the inner part of Nordhavnen. The intentions behind the development of the UN City are to gather all of the representations of the United Nations in Denmark in one location in order to stimulate inter-agency operations and collaborations etc. Today, the United Nations have eight agencies in Denmark, located in different locations, with some 1,100-1,200 employees. The eight agencies include the Nordic Office of UNDP (UN

Development Programme), the European headquarters of WHO (World Health Organization), the headquarters of the Supply Division of UNICEF (UN Children's Fund), one of the Liaison Offices of WFP (World Food Programme), one of the Liaison Offices of UNFPA (UN Population Fund), the headquarters of UNOPS (UN Office for Project Service), the Nordic Office of UN Women and the two collaborating centres of UNEP (United Nations Environment Program) UNEP Risø Centre (URC) and UNEP-DHI Centre (Haugbølle et al., 2012 and 2013).

The UN City actually consists of two campuses in the Northern Harbour of Copenhagen (Nordhavnen). Campus 1 encompasses the domicile of the UN and is situated on the Marble Pier (Marmormolen) as part of the Århusgade Quarter (see Figure 14). Campus 2 includes a fully automated high bay warehouse for UNICEF with a capacity of close to 40,000 cubic meters, which was built in the Free Port at the outer part of the Northern Harbour of Copenhagen and operational from the beginning of 2012. The warehouse handles goods for development and emergency projects around the world (Haugbølle et al., 2012 and 2013).

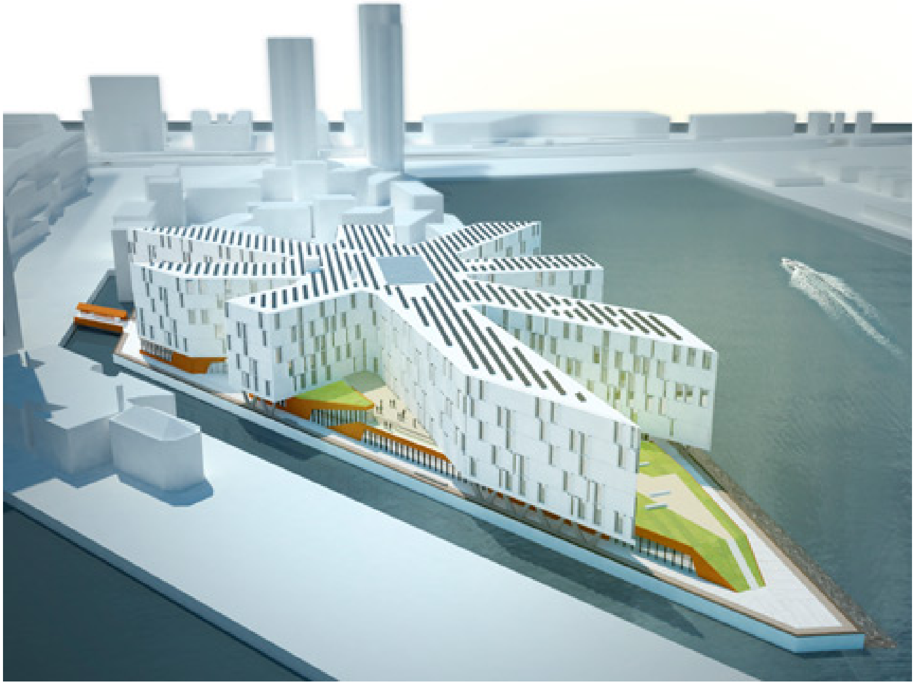

Figure 14: The star-shaped UN City. Architects: 3XN A/S.

The new domicile of the UN at Campus 1 will be constructed in two phases. The first phase covers the construction of some 28,000 m^2 gross floor area and some 5,000 m^2 of basement in a single storey for technical installations and storage. This phase was finished in the beginning of 2013. The building is constructed as a star-shaped building with eight "fingers", of which phase 1 consists of the central and Eastern part of the star, making up the first five "fingers". In the beginning of 2014, the second phase completed the star by adding the last three "fingers", after the existing UNICEF warehouse had been demolished. This increased the gross floor area by 17,000 m^2 to a total of 45,000 m^2 and added some 3,000 m^2 extra to the basement (Pihl & Søn A/S, 2012; Haugbølle et al., 2012 and 2013).

The building has been constructed as a low-energy class 1 building according to the Danish Building Regulations, which means the energy consumption is projected to be lower than 50 kWh/m^2/year. In addition, the building is certified according to the American certification scheme LEED (Leadership in Energy and Environmental Design) with the goal of achieving a minimum score of LEED Gold and reaching at least 73 LEED points according to Version 3 of the LEED scheme. In fact, the building reached platinum. Furthermore, the developer, FN-BYEN P/S, was one of the first

Danish organisations to become a Green Building Partner. The main requirement of the European Union's Green Building scheme is to reduce energy consumption by 25% compared to national regulation (European Commission – Joint Research Centre – Institute for Energy and Transport, 2006). The building uses recycled rainwater for toilet flush, cooling is with sea water, all lighting is automatically controlled, photo-voltaic cells is installed on the roof of the building and a specially designed solar-shading system provides protection against the sun (see Figure 15). Due to strict security measures, the building is erected on an isolated island. The island is linked to the mainland through one bridge, which is only accessible by foot or by small vehicles (Haugbølle et al., 2012 and 2013).

Figure 15. UN City. Photo: Kim Haugbølle.

The procurement characteristics

The development of Nordhavnen is being carried out by the developer CPH City Port and Development I/S. CPH City Port and Development was established in October 2007 and is owned 55% by the City of Copenhagen and 45% by the Danish government, which exercises its ownership through the Ministry of Transport. CPH City Port and Development I/S is responsible for development of the properties owned in Ørestad and the Port of Copenhagen, along with the operation of port activities through its subsidiary; Copenhagen Malmö Port (CMP). The company is required to carry out its activities on ordinary commercial grounds, predominantly through the sale of building rights (Haugbølle et al., 2012 and 2013).

The local plan for Marmormolen includes 23,000 m^2 of office buildings, 28,000 m^2 housing, a hotel of 25,000 m^2, the 45,000 m^2 for the UN City and 58,000 m^2 for the so-called LM Project. The LM Project includes two office towers at Marmormolen and the tip of Langelinie, and is connected with a bicycle and footbridge at a height of 65 m. The local plan for Marmormolen was approved by the City of Copenhagen on 10 December 2009 (Københavns Kommune, 2010).

The development of Marmormolen (the Marble Pier) was initially handled by the Byggemodningsselskabet Marmormolen P/S consortium, owned by CPH City Port and Development (50% ownership) and the private investor N & S P/S (50%), which in turn is owned by Nordkranen A/S and SNS Property Finance. During 2011 CPH City Port and Development increased its ownership to 90%, while the ownership of N & S P/S was reduced to 10% (Haugbølle et al., 2012 and 2013).

The UN City was developed by FN-Byen P/S with its associated limited partnership company. The company was owned by CPH City Port and

Development (99.2% ownership) and Nordkranen A/S (0.8% ownership). The purpose of the company was to prepare the area for construction, and then to construct and let properties at Marmormolen. In December 2011, a new consortium called Harbour P/S, owned by CPH City Port and Development (8.5% ownership) and the two pension funds ATP (45.75% ownership) and PensionDanmark (45.75% ownership) bought the UN City along with the building rights for the nearby LM Project for DKK 2.1 billion. CPH City Port and Development sold most of its ownership of the UN City and the LM Project and now holds only a minor share of ownership (Haugbølle et al., 2012 and 2013).

While ownership of the UN City is with the consortium, CPH City Port and Development is acting as the building client as well as the letting office of the property. The Ministry of Foreign Affairs is the lease-holder on a long-term lease contract of annually DKK 77.5 million for 15 years for the UN City and on a long-term lease contract of annually DKK 42.9 million for 25 years for the warehouse (Udenrigsministeriet, 2010). The UN representations are the actual users of the UN City. On behalf of the UN representations, the Ministry of Foreign Affairs hired Alectia and PLH Arkitekter as consults for the user organisations. As is customary for UN representations, the nation hosting the UN representation makes properties available to the UN representations and pays the lease. As the Ministry of Foreign Affairs does not in itself have the necessary skills and organisation to manage building projects, the Ministry is obliged by law to have the Danish Palace and Property Agency under the Ministry of Finance as construction and facility manager (Haugbølle et al., 2012 and 2013).

The new headquarters at UN City has been designed by one of the leading Danish architectural firms: 3XN A/S. The architects also drafted the master plan for the Marble Pier together with architects Kim Utzon (for the hotel), SCHØNHERR LANDSKAB (the landscape) and Steven Holl Architects (the LM Project), which formed the backdrop for the local plan. The consulting engineers were Leif Hansen Rådgivende Ingeniører A/S, who merged with Orbicon during the project (Haugbølle et al., 2012 and 2013).

Land development was undertaken by the contractor Aarsleff A/S as a turnkey contract and with Tscherning as sub-contractor. The detailed design and the construction work were contracted as design-build. After a pre-qualification round, six contractors were selected for participation in the limited tender in the period 15 March 2010 – 17 May 2010. The selection of contractor was based on economically most advantageous tender and followed the European regulation on public tendering (Official Journal of the European Union, 2004). The contractor E. Pihl & Søn A/S won the tender. Part of the tendering requirement was an obligation for the contractor to take over the consultancy team from 3XN A/S and Orbicon/Leif Hansen Rådgivende Ingeniører A/S. Later the contractor Pihl & Søn A/S was nominated as contractor for the second phase of the UN City, following negotiations. Although the extension was put out for tender, the tender process was cancelled due to too high bids from the tenderers (Haugbølle et al., 2012 and 2013).

The complexity of the project

According to Hobday (1998b: 691), complexity of complex products and systems (CoPS) can be measured along 16 variables. The case has been analysed along these 16 variables as shown below:

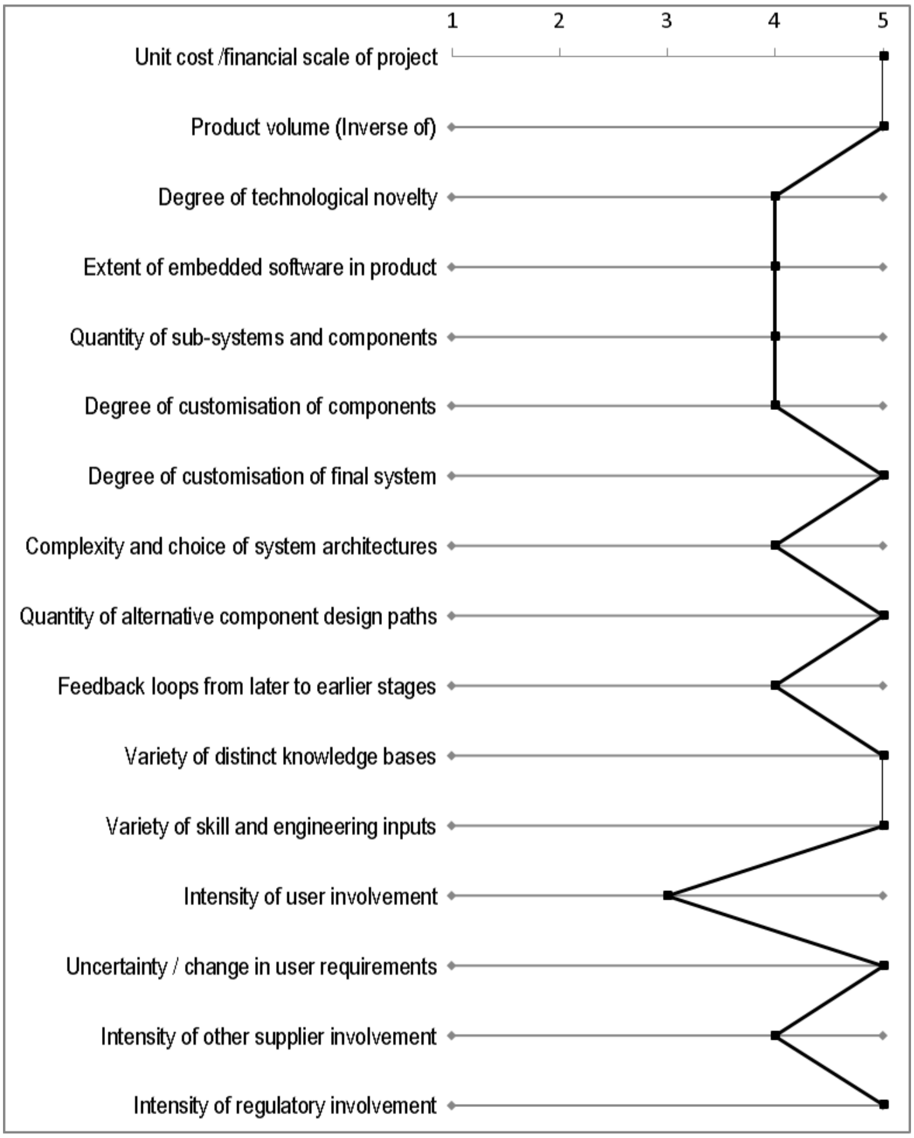

Figure 16. Analysis of complexity of the case of the UN City (5 is 'very high', whereas 1 is 'very low').

Unit cost/financial scale of project: Score – very high

The building costs for the UN City have not been reported in sum, but the building costs for the warehouse were expected to be around DKK 450 million, the building cost of phase 1 of Campus 1 was expected to be around DKK million and phase 2 of Campus 1 was expected to be around DKK280 million. The total annual operating and lease costs for both facilities were estimated to DKK116.4 million (2010 prices) and a one-off payment of DKK70 million. An additional annual operating and lease cost of DKK30 million (2011 prices) was expected for the second phase of the UN City from 2014 onwards (Udenrigsministeriet, 2010 & 2011). Thus, the financial scale and time horizon of the project is very significant.

Product volume (Inverse of): Score – very high

This is a one-off project, never to be repeated again.

Degree of technological novelty: Score – high

A unique and advanced design coupled with a range of new technologies and solutions have been applied in this project. These novel solutions reside along a number of standard solutions.

Extent of embedded software in product: Score – high

Sophisticated software and hardware solutions have been applied in building management systems, installing electricity supply through photovoltaic panels and not least in establishing security measures, due to the risk of terrorist acts.

Quantity of sub-systems and components: Score – high
Due to the size of the project as one of the largest office buildings in Denmark, there are a high number of sub-systems and components installed in the building.

Degree of customisation of components: Score – high
Many components, sub-systems etc. are fairly conventional and well-known in order to cut costs. However, a number of cost-driving components, like the solar shading system, the stairway in the hallway etc., are specifically customised to this particular building.

Degree of customisation of final system: Score – very high
The design of the building is unique. The original design of the building as a “snake” in the master plan and local plan was completely remade into the star-shaped form when the design team faced serious challenges with daylight supply, and new members entered the design team with new ideas.

Complexity and choice of system architecture: Score – high
The system architecture is more complex than typical due to the star-shaped design of the building, the size of the project and the special requirements for security etc.

Quantity of alternative component design paths: Score – very high
A number of solutions like the stairway, the solar shading system and the overall design have gone through several more alternative designs than is customary. Add to this the complete redesign of the overall architectural form of the building.

Feedback loops from later to earlier stages: Score – high
Extensive feedback loops have been required during the project, but still within the usual framework of the phase-model for building projects.

Variety of distinct knowledge bases: Score – very high
A large range of distinct knowledge bases have been included in the project such as architectural expertise, a broad range of different engineering fields, manufacturing expertise, extensive construction management experience and expertise in logistics.

Variety of skill and engineering inputs: Score – very high
The required skills and engineering inputs have included all customary types of engineering plus additional skills related security specialists and to water management due to the harbour location.

Intensity of user involvement: Score – medium
The actual users are a diverse group of UN organisations. Their input has been supported by a specially appointed consultancy team. However, their actual involvement has been filtered through an arms-length principle. The arms-length distance to the actual users has fostered uncertainty and prolonged response times in the decision-making process.

Uncertainty/change in user requirements: Score – high
The composition of the demand side has been highly complex, as described above, with a number of UN organisations, the Ministry of Foreign Affairs as leaseholder, By & Havn as client etc. While most of the requirements have been relatively ordinary requirements for office work spaces, a range of user

requirements with regard to security, energy performance, compliance with the LEED certification scheme etc. have been out of the ordinary.

Intensity of other supplier involvement: Score – high
Most of the suppliers have played a fairly conventional role as suppliers, although the security issues have caused challenges with respect to logistics. Some suppliers have been intensively involved, for example Viking Markiser – the manufacturer of the solar shading panels.

Intensity of regulatory involvement: Score – very high
Public regulation has played a significant role in this project due to the establishment of the client organisation as a partnership between the municipality and the government (By & Havn), the development of the area (an Act of Parliament), the financial framework (lease holder is the Ministry of Foreign Affairs) and the approvals from the municipality e.g. of the design of the solar shading system. Since the Ministry of Foreign Affairs is effectively the leaseholder and paying a substantial annual lease, the budget has been debated and approved in the Standing Committee on Finance in the Danish Parliament. Indirectly, the Building Regulations have also played a significant role in setting requirements for e.g. energy.

Type of contract

The types of contracts in play in this project include:

- With regard to the master plan: The international competition was followed by a consultancy contract with the winning consortium.
- With regard to the architect competition: Prizes were provided for the winners.
- With regard to the project execution, two types of contracts were applied:
  - General consultancy contract according to ABR89.
  - “Controlled” design-build contract according to ABT93.
- During the operational phase: A lease contract.

Organisational structure

Figure 17 provides an organisational overview of the interface between the building project and the operational system based on Geyer & Davies (2000). The building project is at the left-hand side and the operational system is at the right-hand side.

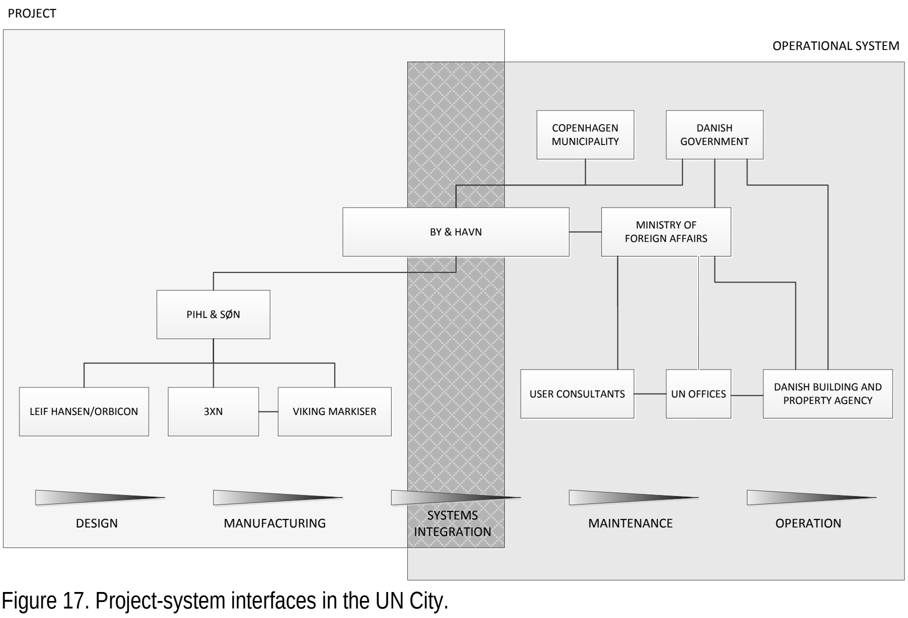

Figure 17. Project-system interfaces in the UN City.

Monitoring process

The monitoring process follows the typical monitoring and control procedures of construction projects both internally in participating firms and externally with regard to the authorities. On top of these typical procedures, the construction project is also subject to the usual control and monitoring procedures mandatory to public construction projects financed by the standing committee on finances of the Danish Parliament. In addition, the project has been developed and scrutinised according to the American LEED certification scheme as well as the European Green Building scheme.

Results

As has been emphasised by the Swedish Engineering Academy (IVA, 1997) the client side of construction can be understood as a nodal point with relations to four different groups of actors: 1) the construction industry, 2) the regulatory system, 3) the users, and 4) the building owner. As argued by Haugbølle et al. (2012 and 2013), this case has illustrated the complex and emergent character of the demand side in construction: multiple user organisations (in this case eight UN organisations), extensive role separation (such as owner of building rights, developer, construction client, building owner, financier, user, tenant, leaseholder and letting office) along with overlapping roles between the regulatory system and the business element (the double role of the City of Copenhagen as both authority and part owner of the developing company), and repeatedly changes in the ownership structure over time.

In terms of the roles and responsibilities of the Danish client, the agency is enacted by a private developer, which is fully owned by the government and the City of Copenhagen as a partnership (in Danish “interessentskab” abbreviated I/S). As the largest land owner and developer of a vast number of the most attractive sites in Copenhagen, CPH City Port and Development I/S plays a crucial role in the development of Copenhagen. Although the developer is publicly owned and has to comply with a range of public regulations (e.g. on public tendering procedures), the company is effectively operating as a private company. It is required by law to carry out its activities on a commercial basis, for example through the sale of building rights. Although the board of CPH City Port and Development I/S is appointed by the government and city, the developer is operating at arm’s length from the political system without the usual direct democratic control of public organisations and with a more narrow commercial scope (Haugbølle et al., 2012 and 2013).

With regard to the supply side, the various services have been delivered by separate parties with individual contracts: financing was obtained through arrangements with private investors, and construction was done by consultants and contractors. In this respect, the execution of the building project followed fairly traditional pathways. Further, the operation of the facility is expected to follow a traditional course as a lease contract with the Danish Building and Property Agency (Haugbølle et al., 2012 and 2013).

Lessons learned

Innovations

This case represents one type of delivery system for mobilising private financing of public services. It is an example of an organisational innovation as defined by OECD & Eurostat (2005: 51): “An organisational innovation “…is the implementation of a new organisational method in the firm’s business practices, workplace organisation or external relations”. The project also showed other types of innovations, notably the emergence of the product innovation of a new advanced solar shading system.

Governance mechanisms

Turning towards governance, the governance processes of policy, business and learning within and around the project will be characterised in line with the model developed by Haugbølle et al. (2012) based on the work of Gann & Salter (2000).

The policy processes predominantly take place between the regulatory and institutional framework on one hand, and businesses on the other hand. The first policy process is related to the provision of public goods by reference to broader national objectives towards international competition. In the Danish case, the political ambition of maintaining and expanding Copenhagen as the sixth largest location for UN activities was one of the driving forces behind the establishment of the UN City. The second policy process is related to the commodification of public goods through the establishment of a legally binding framework for exploiting the building rights in the Northern Harbour based on a specific Parliamentary Act, which was supplemented by local provisions based on the Planning Act. A third policy process is concerned with the privatisation of public policies through the establishment of a partnership between the government and the City. The establishment of a partnership between the government and the City by a Parliamentary Act led to the formation of a fully publicly owned development organisation, which operates on a commercial basis to provide public goods. In this way, public authorities are effectively relegating decision-making authority to private actors. As such, the partnership between the government and the municipality is the epitome of what Pedersen et al. (1992) have coined the privatisation of public politics (Haugbølle et al., 2012 and 2013).

The business processes across both the property market and the construction market are characterised by differences and similarities along 1) ownership, 2) cash flows, and 3) contractual forms. First, the time of ownership in the Danish case is in principle infinite. However, the contract period of the lease is limited to 15 years and 25 years, respectively, for Campus 1 and Campus 2. Second, financing is provided through the sale of building rights to private investors, who can (and did) pass on the ownership to new investors. The contractual arrangements of building the facility are very typical of conventional procurement. The subsequent operation and maintenance is financed through the rent paid by the lease-holder, which was enacted through an appropriation in the standing committee on finance of the Danish Parliament. Third, the case study has illuminated the reproduction of typical business relations between the actors in the building process. Despite the complexity on the demand side, and the extraordinary security and confidentiality issues involved in building for the United Nations, the procurement procedures have been fairly conventional in their application of a design contract and a subsequent design-build contract. Part of the tendering requirement included the obligation that the winning contractor take over the contract with the design team in what may be labelled a “controlled design-build” contract (Haugbølle et al., 2012 and 2013).

The learning processes points at two observations related to 1) direct learning from academia, and 2) the importance of international lessons. First, the case illustrates that direct learning and interaction with academia hardly took place at all in the actual construction project. Second, learning from international expertise played an important role. International certification schemes on sustainability like the American LEED system and the European Green Building charter have played a prominent role in the design of the UN City (Haugbølle et al., 2012 and 2013).

The performance process and the value to the end users

With regard to performance measurement in relation to society, the UN City has been instrumental in securing the continued location of the UN agencies. At the level of the operational system, the developer achieved certification as the first Danish Green Building Partner. It is also likely – but difficult to quantify – that the developer made a profit on the sale of the UN City. On a project level, the ambition was to secure at least Gold in the LEED certification scheme, but the project even managed to achieve Platinum. For the users, their new office building provides them with a common and shared facility, which can support increased knowledge exchange and networking across the various UN organisations.

Case 3: Client-supplier partnership: Green Lighthouse

The context

Green Lighthouse was designed and built as a demonstration project to showcase Danish competences within energy up to the United Nations COP 15 climate summit held in Copenhagen in December 2009.

The building was designed for, and is used by, the Faculty of Science at the University of Copenhagen to service students with career guidance, information about exams, courses, etc. Furthermore the building is used as a meeting place for researchers and others associated with the faculty. The building is a 950 m^2 circular green building. The building was designed and built to meet the requirements of low-energy class 1 (BR08) and it was Denmark's first public CO_2-neutral building. Green Lighthouse came into being on the basis of a close public-private strategic partnership between Copenhagen University, the Danish Building & Property Agency (client), The City of Copenhagen, VELUX and VELFAC.

The procurement characteristics

The strategic partnership established a steering committee to manage the development of the partnership's shared vision of Green Lighthouse. They created a mutual contract between the parties, including an agreement of how possible conflicts should be managed in the partnership if they arose. The partnership together developed the programme for the building.

The programme addressed three different aspects in which the partners involved wanted to illustrate new possibilities related to 1) the building as a good example of a CO_2-neutral building based on existing technologies and knowhow, 2) new types of PPPs and 3) the green campus buildings as an example of how a green building does not conflict with architectural, functional and indoor-climate qualities (Green Lighthouse, 2013).

The parties played different roles in the partnership:

– The Danish Building & Property Agency /The Ministry of Science, Innovation and Higher Education were the client on Green Lighthouse and own the building .The Danish Building & Property Agency managed the construction project and participated in the process of defining requirements for the energy concept and architecture of the building.
– Copenhagen University represented the users of Green Lighthouse. Copenhagen University was one of the initiators behind Green Lighthouse, and Copenhagen University participated in the process of defining requirements for the building. The University pays the standard rent for use of the Green Lighthouse.
– The City of Copenhagen participated as an active partner in the process and this collaboration has ensured effective regulatory treatment in the construction process.
– VELUX and VELFAC have been "vision partners" in the partnership, and the companies contributed with expert skills as well as technologies and products. The companies were selected due to their business area and they were already deeply involved in both product development of new products to meet future requirements for buildings as strategy work in relation to defining future requirements. The companies participated in the

process of defining requirements as well the energy concepts such as the indoor climate and daylight in the building. VELUX has also served as the project manager for the steering committee.

The construction project was offered as a turnkey project and a contract was signed with a consortium consisting of Hellerup Byg as turnkey contractor, Christensen and Co. Architects A / S as architects and COWI as engineer. The contract included an agreement on commissioning and operating the building for the first year.

The cost of building Green Lighthouse was DKK 37 million. The Ministry of Science, Innovation and Higher Education paid DKK 33 million. The VELUX Group and VELFAC provided development work and components. Various components were furthermore provided by WindowMaster, Faber, Rockwool, Veksø, Knauf and Danogips.

The complexity of the project

The complexity addressed three issues: technical, organisational and use.

The organisation of the demonstration project was complex since the role of the building component suppliers changed from being suppliers for the construction project to being strategic partners with the public client in. This required establishing new organisational structures and integrating different actor perspectives in the development of the construction programme.

The public-private partners had an ambitious vision regarding energy performance, quality of light and indoor-climate, as well as architectural design, and this vision brought together new building components, new and different technical solutions and new design solutions that had to be integrated in the building to fulfil the vision. The buildings function as part of a university and as a demonstration-building made it difficult to predict the use of the building. This influenced the design of the capacity of the different technical solutions regarding energy use and indoor climate. Following Hobday's (1998: 690) description, we can draw up a characterization of the complexity of the Green Lighthouse case accordingly (5 is 'very high', whereas 1 is 'very low'):

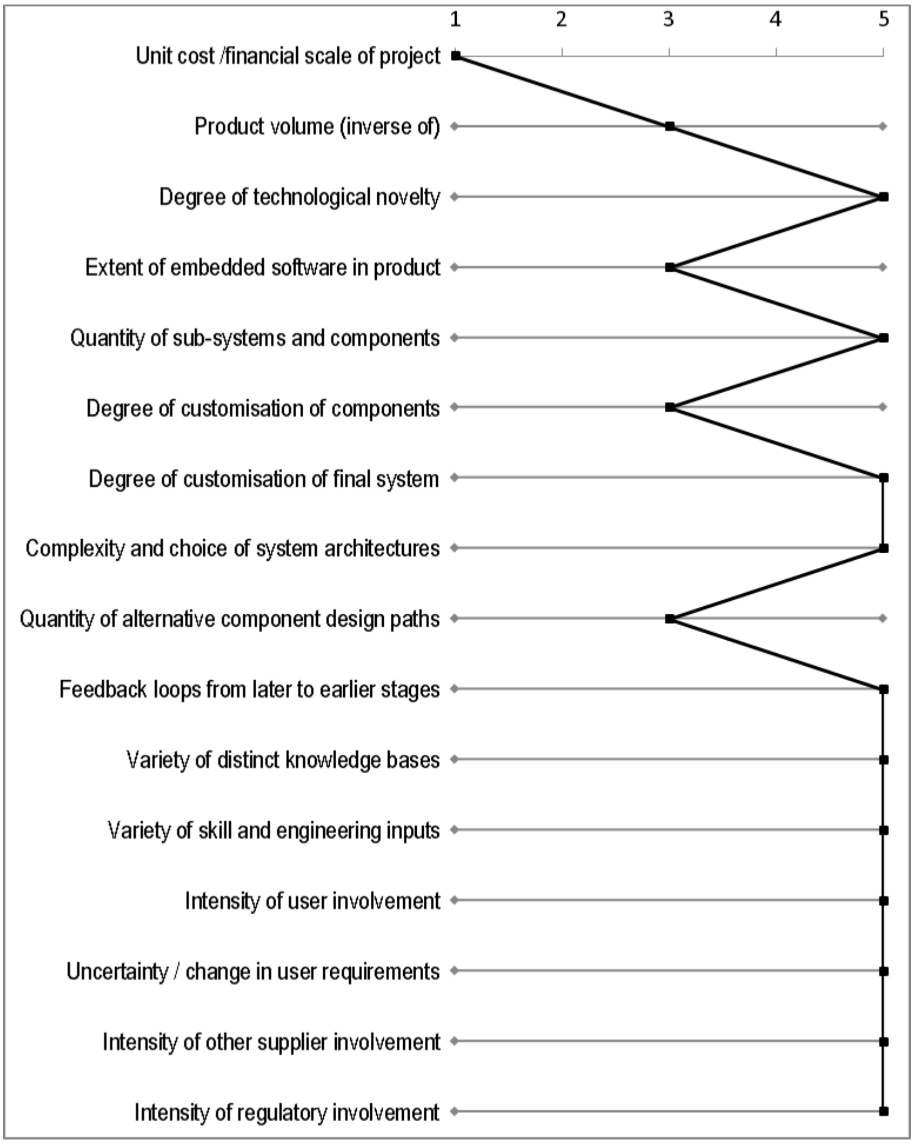

Figure 18. Complexity of the Green Lighthouse case (5 is ‘very high’, whereas 1 is ‘very low’).

Unit cost / financial scale of project: Score – very low
The building costs are small.

Product volume (Inverse of): Score – medium
This is a one-off project, never to be repeated again, but different aspects/solutions have inspired others constructions projects and in this way repeated.

Degree of technological novelty: Score – very high
Technological novelty is high because of new architectural design, new building components and different technical solutions. Furthermore all the different parts are integrated due to high expectation to energy- light- and indoor climate performance.

Extent of embedded software in product: Score – medium
The extent of embedded software in product is not known, but it is expected that specific solutions might have a high extent of embedded software, and also the control system can be based on advanced software. However it is well known software components.

Quantity of sub-systems and components: Score – very high
The quantity of sub-systems and components are high due to the use of many different technical systems.

Degree of customisation of components: Score – medium
Average. Although, each technical solution has to be adapted to fit client needs standard components have been used.

Degree of customisation of final system: Score – very high
The building is designed to meet the university's specific needs.

Complexity and choice of system architectures: Score – very high
Integration between architectural design and different energy-, light- and ventilation subsystems induces complexity.

Quantity of alternative component design paths: Score – medium
The challenge was to integrate the various technical solutions and design. With respect to this integration, there were several ways of doing this.

Feedback loops from later to earlier stages: Score – very high
Continuous monitoring of actual energy consumption is used extensive to correct solutions and ensure that energy savings targets are met. Experience has been picked up and used by the partnership behind the project.

Variety of distinct knowledge bases: Score – very high
Low energy constructions solutions include a wide variety of distinct actors and knowledge bases.

Variety of skill and engineering inputs: Score – very high
High due to the number of direct and indirect stakeholders that are part of the project on strategic as well as operational levels.

Intensity of user involvement: Score – very high
The users were represented in the partnership

Uncertainty / change in user requirements: Score – very high
Very high because of changes in use of the building. The building's use as a showcase was more extensive than planned and played a major role for the buildings energy performance.

Intensity of other supplier involvement: Score – very high
Very high due to the establishment of the private public partnership.

Intensity of regulatory involvement: Score – very high
Very high: Firstly the building was designed to the requirements of low-energy class 1 (BR08). Secondly the Danish Building & Property Agency /The Ministry of Science, Innovation and Higher Education were the client on Green Lighthouse and own the building .The Danish Building & Property Agency managed the construction project and participated in the process of defining requirements for the energy concept and architecture of the building. And thirdly the City of Copenhagen participated as an active partner in the process and this collaboration has ensured effective regulatory treatment in the construction process.

Type of contract

- The strategic partnership was established in December 2007
- The strategic partnership contract was signed in March 2008
- The architectural competition was launched in March 2008
- The turnkey contract with the winner consortium was signed in July 2008
- Development project in response to the applied technologies

Organisational structure

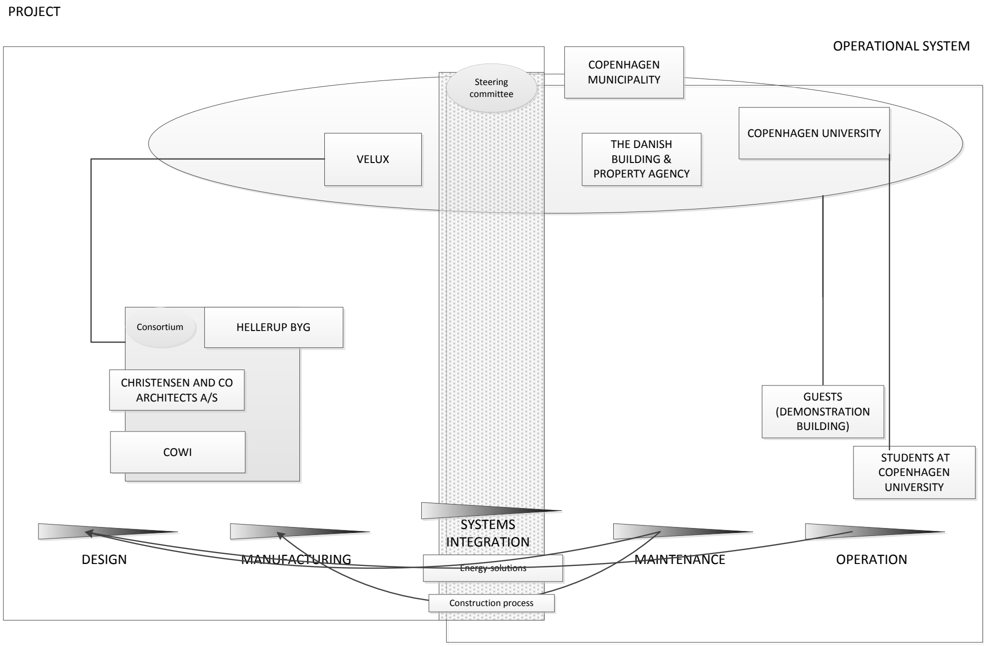

Figure 19. Project-system interfaces in the Green Lighthouse project.

Monitoring process

The public-private partnership behind Green Lighthouse evaluated the building's energy performance, indoor climate and sustainability.

The building was built as a demonstration project and the public-private partnership behind Green Lighthouse all had an interest in following up on the project's objectives in relation to the building's performance, process and solutions. The building's energy consumption, including the different technical solutions (heat pump solution, combined with solar energy, borehole storage and district heating coupling), were monitored in operation over a three-year and the building's actual performance and expected performance were compared. Experience with both the process of commissioning the technical systems and the use of the building was included in this monitoring process. This systematic monitoring of energy consumption was conducted in an EUDP project in a group consisting of COWI, the Danish Building & Property Agency, Copenhagen University and Velux.

The building's sustainability was subsequently assessed through certification of the building by LEED, where it achieved LEED Gold and by DGNB, where it achieved DGNB bronze.

When construction was completed under a traditional turnkey contract, the monitoring points used in relation to the construction project were those usually applied.

Results

Energy consumption was found to be much higher than expected in the first year in operation. Several reasons were identified. Firstly, it had been difficult to plan the use of the building. As a demonstration project, the building has been such a success that the number of guests has been much higher than estimated. Secondly, an error in the execution phase meant that a damper was missing in the natural ventilation system, which had a major impact on the energy consumption until the fault was identified and corrected. It could have been difficult to find this fault, if monitoring of the building had not been systematic. Furthermore, half of the solar cells were not connected. Thirdly, it was complicated to get all the different technical systems to work together and it took longer than expected to run-in the system. At the same time the initial adjustment of the system required high technical skills. The turnkey contract included an agreement on commissioning and operating the building for the first year and it would have been difficult to adjust the technical system without this agreement.

Lessons learned

Innovations

The close public-private partnerships between the public client, the users and the suppliers, resulted in a situation in which the suppliers changed role from suppliers to the construction project to drivers of the project together with the client and user in the programme phase. In this case the partnership has had the role as system integrator. This had an impact on the innovation structures that were going on in the project as the key feedback processes in the project was established between the expected energy consumption (design phase) and the actual energy consumption (use phase). These feedback processes has subsequently led to the discovery of errors in the construction phase and provided significant input and adjustment on both the design work and product development. A key learning from the case is that this type of partnership can contribute to both the system design phase and the subsequent phase of development where systems are upgraded and modified in the CoPS perspective.

Governance mechanisms

In the case a prominent governance process was politicization of the industry-business processes. Firstly the involvement of the suppliers in the partnership impacted the design process itself, as the visions of the suppliers played a major role, with strong focus on daylight, passive energy from the sun and indoor climate. Secondly this influenced the following up activities in the operation phase, as the suppliers had a strong interest in both energy performance and indoor climate; they were keen to follow up these aspects as part of product development.

The performance process and the value to the end users

Lessons learned from the performance perspective were firstly that it can be very difficult to predict the use of buildings in terms of both time scale and number of users. This has an impact on energy design and installations, etc. and the ability to establish energy performance objectives.

Secondly, it is very important to integrate adjustment and operation of technical systems for a period in the contract because of the complexity of the whole energy system and as a way to find design and construction errors. Error detection will be very difficult for the ordinary operating managers.

Case 4: PPP: National Institute of Sport and Physical Education

The context

INSEP (National Institute of Sport and Physical Education) brings together a large number of top-level athletes specialising in a wide range of sports. The Institute is located in the Bois de Vincennes forest west of Paris, and it is the training centre for the French sports elite. About half of the medals gained by French athletes at the Olympic Games (16 out of 33 in 2004, 21 out of 40 in 2008 and 19 out of 34 in 2012) were won by athletes trained at INSEP.
In 2005, the Ministry of Sport decided to renovate INSEP in order to modernise the site.

Figure 20. The building hosting the director. Photo: Frédéric Bougrain

Figure 21. Athletic tracks. Photo: Frédéric Bougrain.

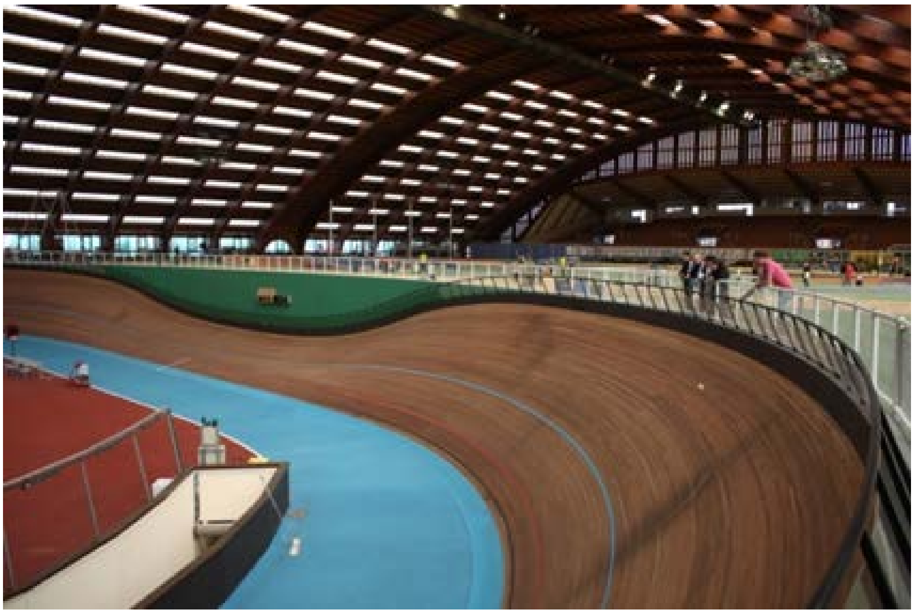

Figure 22. Cycling tracks. Photo: Frédéric Bougrain.

The procurement characteristics

Two different public procurement schemes were used:

1. The renovation of the southern section was carried out under a public management contract. The Ministry of Sport was the client since it was the best actor to deal with the risks associated with the management of the sports facilities.
2. A public-private partnership tender proposal was retained for the renovation, maintenance and operation of the northern section. Since it was crucial that the delivery deadline was set to enable the preparation of athletes for the 2008 – 2012 Olympiad, and the complexity of the renovation was high, a partnership contract was considered as the most appropriate solution. The case focuses on this second procurement process.

Before choosing this second solution for the northern section, the public authorities had to prove that it offered value for money. A comparison with the conventional public procurement process option was necessary. The cost of the deal was about 8 % less than the cost of continuing public sector provision. Moreover the risks of cost overruns and of longer delivery times were higher for traditional procurements.

Finally, since the delivery deadline set to enable the preparation of athletes for the 2008 – 2012 Olympic Games was crucial and the complexity of the renovation was high, a partnership contract was considered the most appropriate solution.

The complexity of the project

The transfer of design, build, finance and operation to private sector partners and the multiplicity of services (hospitality, catering, cleaning, security, waste management, maintenance and operation of buildings and coordination of these services) increased project complexity since interfaces between stakeholders, organisations and project phases were multiplied. Moreover, it was required to maintain the building in operation during the renovation.

Complexity is analysed along the framework proposed by Hobday (1998) as illustrated in Figure 23.

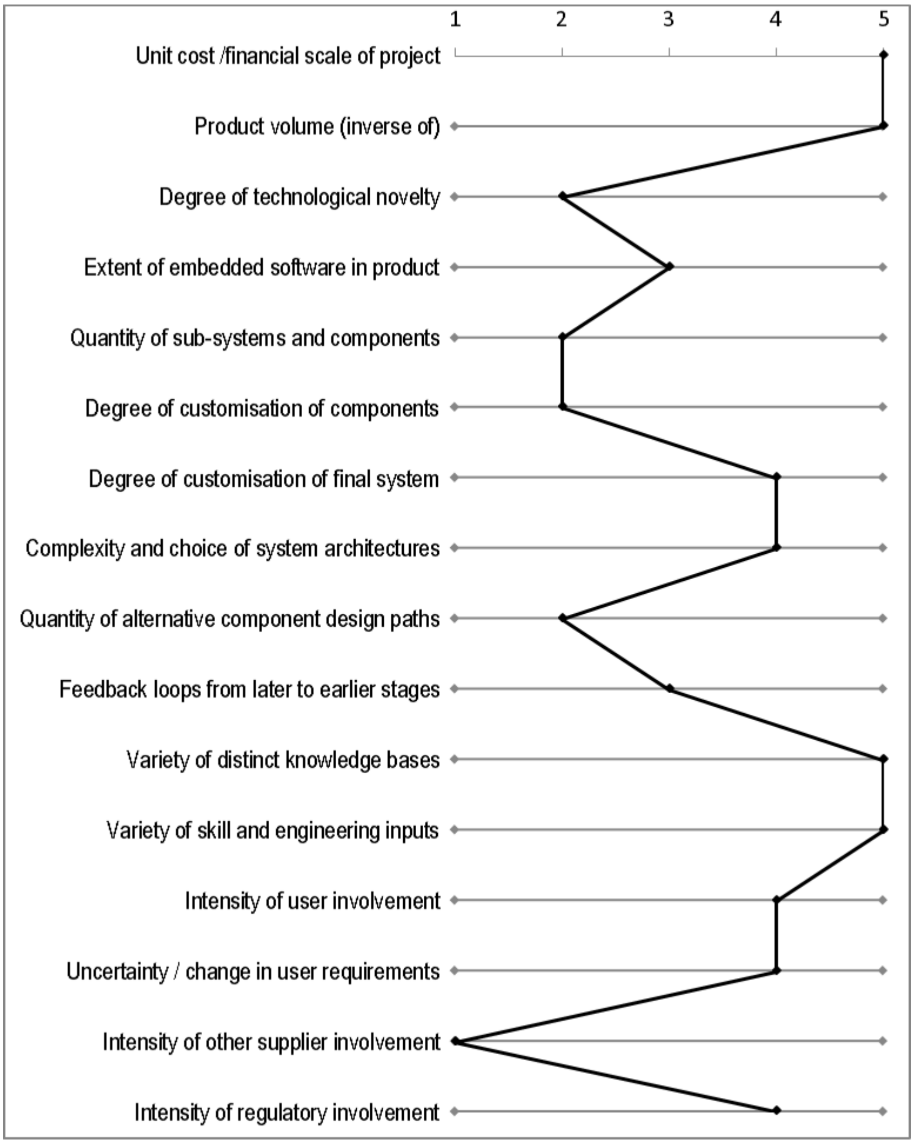

Figure 23. Complexity of the INSEP case (5 is 'very high', whereas 1 is 'very low').

Financial scale of project: Score – very high
The project was the first large PPP projects launched at the national level. The financial arrangement was very complex (in every PPP project there is a mix between debt and equity – usually, about 90% of the project is paid with debt and the remaining part through capital). INSEP had to benefit from the help of financial consultants.

Product volume (Inverse of): Score – very high
This is a unique project. Moreover, since it was a renovation, the private operator had to take into account the constraints of the existing buildings.

Degree of technological novelty/ quantity of sub-systems and components/ degree of customisation of components: Score –low
The organisation of the project was innovative. However, there was no technological innovation in the project. Components were mainly conventional and not in huge quantity.

Extent of embedded software in product: Score – medium
Software is mainly limited to the help desk and a centralised control station. These systems are at the core of the service level agreement.

Degree of customisation of final system: Score – high
This is a unique project. The result was obtained after three rounds of competitive dialog.

Complexity and choice of system architectures: Score – high
Complexity is due to the renovation. The architect was constrained by the existing buildings which forced him to be innovative.

Feedback loops from later to earlier stages: Score – medium
During the renovation phase, feedback loops were limited despite the integration of design, construction and operation within the same team.

Variety of distinct knowledge bases / variety of skill and engineering inputs: Score – very high
The consortium gathers several leading companies in their own field (hospitality, catering, construction, facility management).
Intensity of user involvement: the competitive dialog was a strong opportunity for INSEP to present its needs. Moreover, the flexibility of the contract allowed some adaptations.

Uncertainty/change in user involvement: Score – high
Despite the formal contract signed between partners, several changes occurred during the renovation and operation of the buildings in order to integrate new user requirements. Moreover, during the renovation phase, asbestos was found in one building.

Intensity of other supplier involvement: Score –very low
Suppliers were not really involved in the project

Intensity of regulatory involvement: Score – high
Regulation is very strong in the building industry. The novelty of the new PPP procedure increased the complexity of the project. Moreover, regulation concerning the access of handicap people has been strengthened.

Type of contract

– The partnership contract was awarded in December 2006;
– The contract concerned the renovation, maintenance and operation of the buildings for the thirty years of the contract and the delivery of services (hotels, catering, cleaning…). It was signed between the Ministry and a Special Purpose Vehicle (SPV). The renovation costs reached EUR 102 million and the annual unitary payment was EUR 12 million. The renovation works started in June 2007 and ended in January 2010 ;
– Output specifications were integrated in the contract in order to monitor the consortium.
– Within the consortium, the company in charge of hospitality, coordinated the helpdesk but it did not have any authority over the other members of the consortium.

Organisational structure

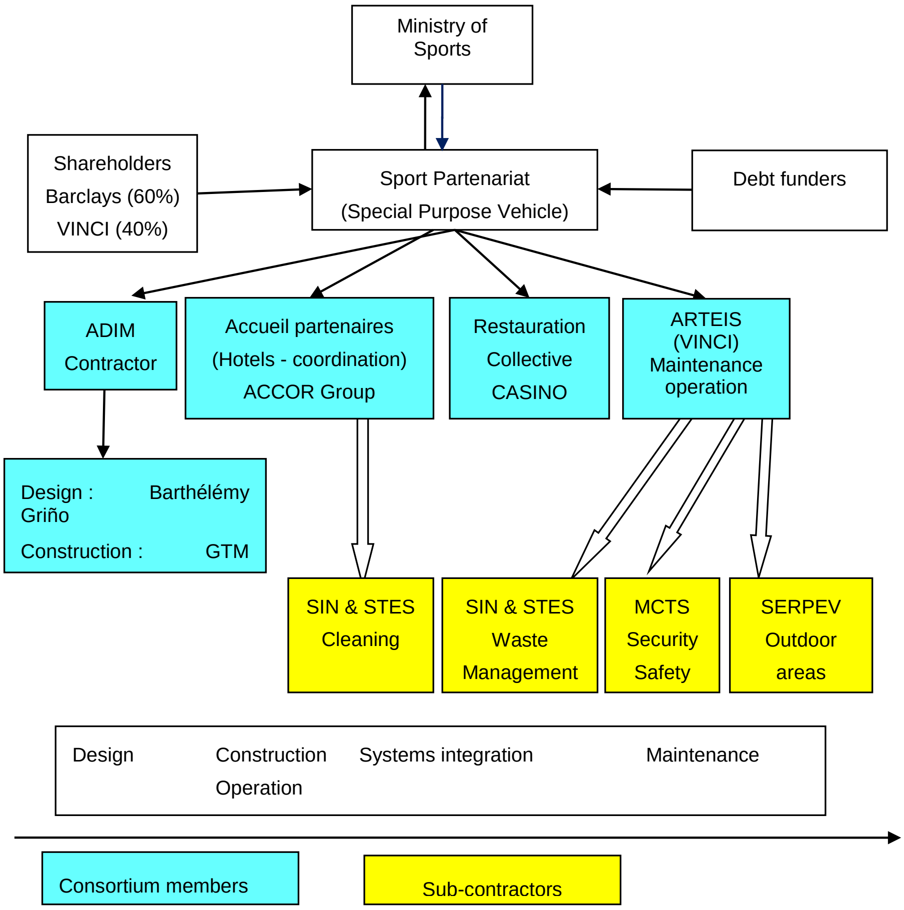

Figure 24. Organisational diagram

Monitoring process

To monitor the consortium, output specifications were integrated into the contract. However some monitoring procedures were not adapted. At the beginning, it took more than half a day to monitor the quality of the cleaning. Therefore both parties agreed to modify their approach. The number of key performance indicators (KPI) was reduced from 276 to 153 in order to improve the efficiency of the monitoring procedure and to enforce the contract.

Users report issues to an onsite helpdesk. Then, the appropriate service team is mobilised by the private partner. Demands have to be satisfied within a certain time limit which depends on the significance of the part of the buildings concerned. For example, significance is high for the restaurant and the medical pole but medium for offices and low for rooms. Penalties are higher the more central they are to the delivery of services which are considered as significant by INSEP. They apply when the private partner is not able to react in time or in the event of repeated errors. This helpdesk is the interface between the users and the facility managers. It also allows for records of response times and data on the pattern of operational errors.

Results

Despite the formal contract signed between the partners, several changes occurred during the renovation and operation of the buildings. The public authority tended to adopt the behaviour of traditional public owners: INSEP asked for new services once the partnership contract was awarded (e.g. a balneotherapy complex was created and the architecture of the R&D lab was modified after the enrolment of a new manager).

The construction was not completed on time because INSEP asked for several changes during the renovation. Moreover asbestos was found in one building. Under traditional public procurement, the works would have stopped and the client would have modified the initial contract with the contractor. This modification of the initial contract is usually very time consuming and the contractor always tries to benefit from the bilateral negotiation. In this project, the contractor who was member of the consortium decided to take the risk (while nothing about this risk was mentioned in the initial contract) and to pursue the renovation works. At the end, the delay was one month. Despite a delay of one month, INSEP was very satisfied since the budget was not modified. Moreover, it was aware that such a result would never have been attained under traditional public procurement procedures.

Once the renovation had been completed, some contractual services appeared to be not adapted to the day-to-day life of the residents. Consequently services were modified but the financial perimeter of the contract was kept unchanged. There were no financial consequences, but according to the private consortium, most changes were time consuming.

All actors also indicated that the service quality is now better than before. For example the mail desk is open from 8 am to 10 pm instead of 7 am to noon and 2 pm to 5 pm. The reception desk also lengthened its opening hours. New services were created for people who come to INSEP for short training periods (such as a luggage room).

Despite this positive feedback, some elements of dissatisfaction remain. The contract is interpreted differently by the stakeholders. Firstly this is due to a change of employees within INSEP. People who took part in the competitive dialogue and in signing the contract had left INSEP. Secondly the output specification was not always well specified.

Budgets for maintenance and operation are also limited because the public authority (INSEP) had no experience in this field and in the past had had a very limited budget dedicated to these tasks. Finally it also appears that the interface between the contractor and the system operators (two different companies belonging to the same large French contractor) was not very efficient. Due to a lack of experience in similar projects and to the penalties associated with construction delays, the contractor strongly focused on the delivery of the buildings. Moreover, the system operator did not have any incentive to adopt a whole life cycle cost approach. This was due to a serious lack of data for technical equipment and to the separation between construction and operation within the consortium. Indeed, the input of the division in charge of maintenance and operation was not sought by the construction team located in a different division.

Maintenance is also lacking since the company in charge of maintenance and operation did not realise that it would have to operate the building 24/7. Moreover, some renovation activities are still ongoing in the Southern section of the INSEP campus. Thus, the private company in charge of cleaning the buildings has to work more than expected because most people living and working on the site tend to bring dust and mud inside the buildings.

Changes during the construction phase have also an impact on the performance of the contract. For example the private consortium had incentives to operate buildings and manage systems in order to reduce energy consumption. However, INSEP asked for new services (e.g. balneotherapy and TVs in the rooms of the athletes). Thus, the reference base had to be redefined before developing any energy performance mechanisms.

Lessons learned

Innovations

No technical innovation was developed during the project. This shows the influence of shareholders and debt funders who cannot accept any delay during the construction phase. Indeed, delays would postpone the receipt of rental income. However, the novelty of the procedure contributed to the creation of organisational innovation. At the end of the construction, INSEP did not have staff available to measure service delivery performance. However, two people were recruited to supervise the private partner. VINCI also intended to modify its organisation for future PPP contracts in order to avoid divisional silos.

Governance mechanisms

In long-term contracts, all events cannot be anticipated. There are always unexpected events. In this case, such events were due both to the novelty of the procurement process and the difficulty for public authorities (INSEP and the Ministry) to propose a clear output specification for services. However thanks to some flexibility during the operational period, it was possible to integrate new service requirements. Several supplementary clauses were signed to adapt the contract to the needs of the user.

The performance process and the value to the end users

Among the companies involved in the project, the general contractor and the operator (VINCI) took large risks. Information on building structures was imperfect and there was asbestos in one building. This was due to INSEP's poor knowledge of the condition of its buildings. Despite this situation, delays were respected. Moreover, the company in charge of maintenance and operation had to face the imprecision of the contract and the new requirements of the public partner. This illustrates the difficulty for the public users to think in terms of service delivery. This company also did not have information on users' behaviour. It discovered during the first years of the contract that the athletes hosted in the dormitories were not traditional students. Companies in charge of catering (CASINO) and hospitality (ACCOR) did not have to face similar unexpected events. This is also due to the fact that services are the core business of these companies while for a company such as VINCI this was the beginning of a new activity. These elements explain why the contract has not really been profitable for VINCI.

There is a strong paradox in this project. The team managing INSEP considers that the service quality is not as good as expected. However, all occupants indicate that the situation is much better than in the past. Similarly, former champions who had the opportunity to visit the Institute where they had previously trained, consider that the facilities are really outstanding. This tends to prove that public asset management was very poor at INSEP for many years. One advantage of such a contract is to reduce the ability of the public authority to reduce operational expenditures and to fail in the long run to properly manage its asset.

Case 5: Energy Saving Performance Contract: 18 high schools

The context

Region Centre is a political administration gathering six French counties. It owns high schools and is in charge of operating them. As the owner of properties gathering 106 high schools (95% of its assets), Region Centre aims at reducing energy consumption for two reasons:

1 To contribute to the reduction of greenhouse gas emissions;
2 To reduce its energy bill.

An audit was launched in 2008 to find out more about the energy consumption of each high school, the efficiency of heating equipment and the quality of building facades. Thus, energy issues became part of the culture of this administration. This knowledge allowed better asset management. Thirty high-schools were selected on criteria such as high energy consumption, poor building quality and no ongoing investment to improve energy performance.

The procurement characteristics

Two different public procurement schemes were possible: PPP and traditional public procurement.

The public-private partnership tender proposal was retained for the renovation, maintenance and operation of 18 high schools. Since the complexity of the renovation was high and the Region expected a life cycle cost approach and performance-based approach, a partnership contract was considered as the most appropriate solution.

Before choosing PPP, public authorities had to prove that it offered value for money. A comparison with the conventional public procurement process option was necessary. The cost of the deal was less than the cost of continuing public sector procurement. Moreover the risks for cost overruns and for longer delivery time were more pronounced for traditional public procurement.

The complexity of the project

The complexity was threefold: technical, organisational and financial:

1 None of the 18 high schools were similar (different architectural style, different year of completion…). One of them was even classified as an historical building. Consequently, the implementation of technical solutions was very diverse. Moreover, the public authority wanted to implement renewable energy. Finally, some technical data were lacking (such as the length of the building facades);

2 The organisation of the renovation was also complex since the high schools were occupied. Most of the works had to be done during holidays since it was not possible to disturb classes. Some directors of high schools were also against PPP. They did not want to see private operators replacing public servants.

3 The aim was also to develop a performance-based contract. However, Region Centre was not familiar with this type of approach.

The public administration benefited from the assistance of several consultants before, during and after the competitive dialogue, since it was using the partnership contract for the first time.

Complexity is analysed along the framework proposed by Hobday (1998) as illustrated in Figure 25.

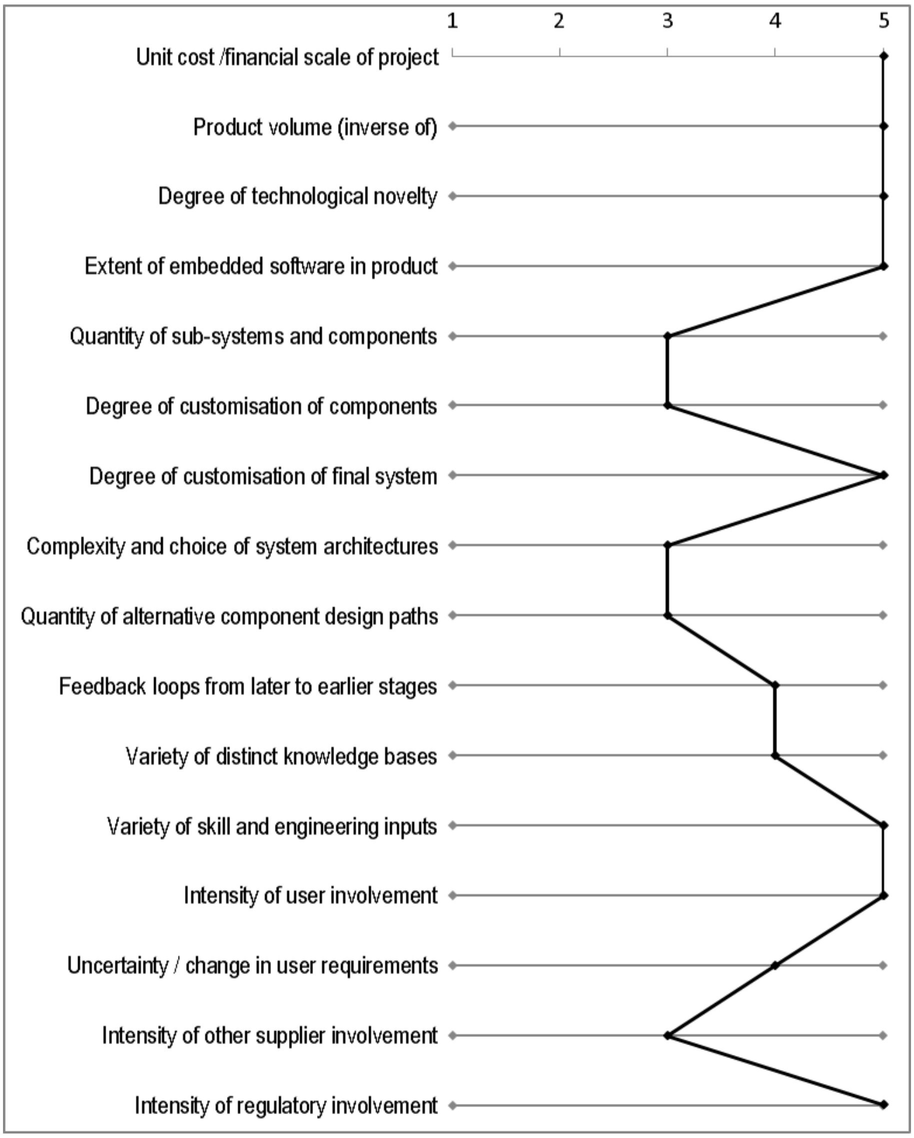

Figure 25. Complexity of the EPSC case. (5 is 'very high', whereas 1 is 'very low').

Financial scale of project: Score – very high
The project was one of the first energy saving performance contract. The financial arrangement was very complex. The project was financed with a mix between debt and equity. Local public authorities had to benefit from the support of lawyers and financial consultants.

Product volume (Inverse of): Score – very high
The operator had to renovate and improve the energy performance of 18 high schools presenting different architectural characteristics. Each renovation was specific to the buildings. Moreover, the energy target is different for every school.

Degree of technological novelty: Score – very high
The internet energy platform, the help desk and the centralised control station were conventional but specific to this project. Moreover, the core business of the private company (EIFFAGE) was in construction. Operating and optimising energy systems were new activities. To fulfil its tasks, the company had to develop new software. In some high schools classified as historical building, specific technical solutions had to be developed.

Extent of embedded software in product: Score – very high
Several sensors were used to check the temperature of the high schools in use (classrooms, dormitories, offices, houses, laboratories, and gymnasium). The help desk and a centralised control station are the backbone of the

ECSP. Specific software were develop in order to monitor energy consumptions.

Quantity of sub-systems and components/ degree of customisation of components: Score – medium
Several sensors were used to monitor energy consumptions. Components were mainly conventional.

Degree of customisation of final system: Score – very high
This is a unique project. The contract was the result of three rounds of competitive dialog involving the leading companies in the field of energy saving.

Complexity and choice of system architectures: Score – medium
The architect had a limited role compared with the design office. However, two high schools were classified as historical buildings. Consequently, renovation and insulation works were done under strong constraints. Innovative solutions had to be developed to respect architectural constraints.

Feedback loops from later to earlier stages: Score –high
Feedback loops were limited between renovation and operation teams. However, there are continuous feedbacks during the operation of the buildings in order to reduce energy consumptions and to reach the ambitious targets.

Variety of distinct knowledge bases / variety of skill and engineering inputs: Score – high to very high
The ESPC was not only based on the optimisation of energy systems but also on the renovation of buildings and actions to increase the awareness of the users. Strong engineering skills were required in dynamic thermal modelling and simulation.

Intensity of user involvement: Score – very high
The user was involved through the competitive dialog. The operator also tries to involve the users during the operation of the building in order to reduce energy consumptions (through actions to promote environmental awareness). For example, users (students, professors …) are involved in communication activities (making of movies…).

Uncertainty/change in user involvement: Score – high
Once the contract was signed, change was limited and due to the reduction of subsidies for photovoltaic systems. The contractor also discovered asbestos in one building.

Intensity of other supplier involvement: Score – medium
One supplier was involved in one high school classified as historical building. Specific windows were developed for the renovation of the facades.

Intensity of regulatory involvement : Score – very high
Regulation had a strong impact. It mainly concerns energy issues, security in high schools, accessibility for handicapped people, and subsidies for photovoltaic systems.

Type of contract

– The partnership contract was awarded in July 2010;
– The contract concerned the renovation, maintenance and operation of 18 high school buildings for fifteen years. The goal was to reduce energy consumption by 42% and greenhouse gas emissions by 58%. The total costs of the project reached EUR 80 million and the annual unitary

payment is EUR 5.2 million. After fifteen years, energy savings will not be enough to pay the investment. The renovation works started in August 2010 and ended in December 2011 ;

– The private consortium does not supply energy. Region Centre considered that it did not bring any added-value and it could have led to an increase of energy prices since it benefited from regulated prices.
– The private consortium is also supposed to train at least one technician per high school (those who will be in contact with the public project manager) and to raise the awareness of the students of the high schools.
– EIFFAGE was awarded the contract and two different subsidiaries of the group were in charge of renovation works and operation of the high schools. The architect and the design office were the main subcontractors of the building company. The role of the design office was to identify solutions that optimize energy savings. However, the risk was only supported by EIFFAGE.
– Although renovation concerned energy systems, primary focus was on wall insulation. This was one of the reasons why EIFFAGE was selected. COFELY, its main competitor during the competitive dialogue, is more specialised in improving the efficiency of energy systems.

Organisational structure

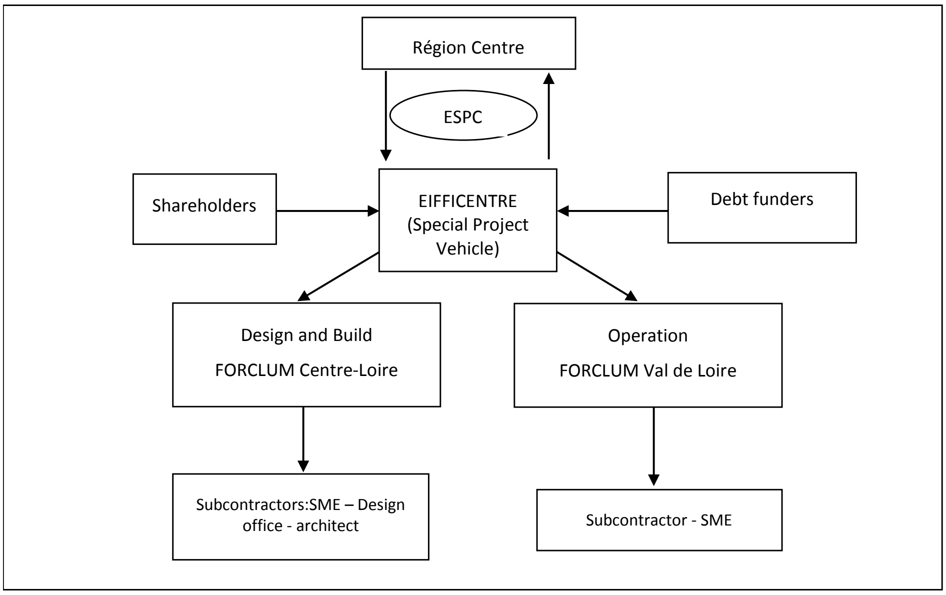

Figure 26. Organisational diagram

Monitoring process

To monitor the consortium, the public authority is assisted by the consultants who assisted the Region during the competitive dialog. Twice a year the consultants have to write a report presenting how the operator is responding the demands of the users and whether he is respecting his contractual obligations (such as a minimum level of temperature in classes). They also help the Region when supplementary clauses are added to the initial contract.

Every high school is equipped with a centralised control station that allows the operator to watch over the performance and the optimisation of all the technical installations. It is also used to control all energy consumption units. Users also inform an Internet platform when temperatures are too low and equipment is failing. The technical agents working for the public authority do not always signal faults on the Internet platform.

The Region has underestimated the cost of the monitoring process. It has to double check the information provided by the private partner.

Results

The contract proved to be flexible. Once it was awarded, renovation works were modified. Indeed, the French government decided to reduce subsidies for photovoltaic energy. Thus, Region Centre decided to cancel the installation of solar photovoltaic systems on the roof of some high schools.

The renovation was done on time. In one high school, the consortium found asbestos and it had to support the costs associated with this bad surprise. This contract forced the consortium to implement solutions that promote life cycle costs.

At the operational level, when a technical problem appears, the operator tends to be very reactive in order to avoid penalties. Most problems identified by the users are solved within 24 hours. In the past, problems tended to continue unresolved since the contracts with facility managers were short-term and not performance-based.

However, despite this reactivity, the technicians working for the high school consider that the operator only brings short-term answers. The operator never tries to understand why technical problems appear and then develop sustainable solutions. Most of the time the people who are employed by the high schools have more expertise since they have worked in the buildings for several years.

The training sessions delivered by the operator were not always adapted to the needs of the local employees. The operator was also not really able to raise the awareness of students. It collaborated with a local association since it considered that it had no competencies in this field. However, the local association did not provide the Region with reports on its actions. Moreover, professors did not like very much to see outsiders coming in the school. Thus, the collaboration stopped.

No satisfaction enquiry has been developed. Feedback is uneven. It depends on the high school. In old schools that were heavily refurbished, users are very satisfied (they were suffering from the heat during the summer and from the cold in winter time). Conversely, the impact of the renovation was smaller in schools built about 20 years ago. The users do not feel the improvement while they were disturbed by the renovation works for a whole year. Moreover, critics can be very strong when the level of comfort temperature has decreased. In the past, it was quite common to heat high schools up to 23 – 24 degrees. However, the contract indicates that the private consortium has to heat buildings to around 19 – 20 degrees. The operator tends to respect its obligations and to dissatisfy the users since he is penalized when energy consumption is too high.

The employees of the high schools frequently do not understand why the Region outsourced the operation of the buildings since they were satisfied by the work done by public employees. Similarly, the directors of high schools criticize this contract. They have the feeling that they are working more without receiving any financial compensation.

The private consortium is supposed to reduce the overall energy consumption by 42%. However, every high school has its own target and the consortium has to reach the target for each of them. A good result on one school cannot be compensated by a bad performance at another. When energy savings are not met, the consortium must pay the difference. Conversely, when the savings exceed the guaranteed performance, the gains are shared: 50% to the consortium, 25% to the Region itself and 25% to the Region to finance works aiming at improving the energy performance of the 18 high schools.

In the first year the bonus for the consortium was EUR 62 whereas it was EUR 80 000 for the Region. This is due to the way the gains are shared. During this first year, the consortium compensated the losses at high schools by half of the surplus, whereas the Region received only the surplus. In the second year, the performance was worst. The consortium had to pay about EUR 110 000 to the Region (savings were not met and the operator was penalized for not responding in due time to the needs of some high schools). The consortium considers that its inability to reach the target is due to an error in establishing the energy baseline of two high schools. The energy used to heat the water was apparently not integrated in the baseline. The Region and the consortium are still examining this issue.

Lessons learned

Innovations
The organisation of the project and the service provided are innovative. ESPC on such a scale are not widespread. Moreover, the renovation and the contractual energy performance are very specific to each school.
There was also an attempt to implement life cycle cost solutions. This was the result of a strong focus on energy performance. However, the transition between building works (acceptance of work) and the operation of the high schools was not so good. This was the first experience of EIFFAGE in this field (the project was also its first ESPC and the aim was to learn from the project) and the two different business units (construction and operation) still have to learn to work together.

Governance mechanisms
The ESPC has considerably changed the role of the stakeholders of the project. Usually, the architect and the general contractor are the key players in a building project. In the design team, the architect had a limited role. The leader was the design office who was in charge of identifying the solutions that could optimise energy performance. Similarly, in the EIFFAGE group, the business unit in charge of optimising energy systems took the lead over the general contractor. The public authority had also to adopt a specific organisation in order to supervise and monitor the private partner. This monitoring process was much costly than expected.

The performance process and the value to the end users
These long-term contracts have to create value for the user in order to compensate for the investment costs. In this case, the public project manager estimated that the premium due to the spread between public and private financing rates cost about EUR 2 million extra. However, he considered that the Region will still benefit from this project and was right to adopt this procurement process, since similar renovation on such a scale and on time would not have been possible with traditional public procurement. Moreover, it would have been more difficult to have such a long-term performance-based contract. Moreover,, the private partner took large risks. The regional authorities did not provide him with information on users' behaviour. Data on surfaces of building facades were lacking and the private partner discovered asbestos in one building. In traditional projects similar risks are never taken. This imprecision explains part of the difficulties to reach the expected energy target.

Case 6: PPP: The police station of Strasbourg

The context

The police station of Strasbourg was built before the new law on public-private partnership was enacted in June 2004. The aim was to gather together several services which were scattered throughout Strasbourg. It was also seen as a solution to combat insecurity in the city.

Several similar projects were supposed to be launched. However, only Strasbourg was financed. The aim of the Ministry of Interior was to use this project to learn more about private financing and facility management.

Figure 27. Police station of Strasbourg. Photo: Frédéric Bougrain.

The procurement characteristics

The procurement scheme was complex and this was the first time it was used by the Ministry of the Interior. In October 1997, SCIC development was selected as the preferred bidder and the architectural project was validated in January 1998. However, the Ministry of Finance stopped the procedure until December 1999. Indeed, it considered this procedure as inappropriate and too expensive in the long run. Finally, the contract was signed in June 2000 for 25 years. The contract was a combination of a lease with a second formal contract indicating the rights of the occupant. Due to its position the Ministry could terminate the lease before 25 years. Under this contract, design, build, finance, major repairs and replacement were transferred to private-sector partners.

The facility was successfully delivered two months early in January 2002.

The complexity of the project

First, the multiplicity of services hosted in the police station increased project complexity. It multiplied interfaces between all services and project stakeholders. Moreover, each service had different requirements that were not always compatible with one another. For example, the police station has to host people who are held in custody and those who are complaining. Both are never supposed to cross each other. These elements increased the difficulty of the users to specify their requirements.

Second, the contractual scheme was so complex that it increased the risk borne by the investors. This risk was due to the possibility for the Ministry of Interior to terminate the lease. Since a police station is a very specific asset, investors feared they would be unable to find new occupants.

Complexity is analysed along the framework proposed by Hobday (1998) as illustrated in Figure 28.

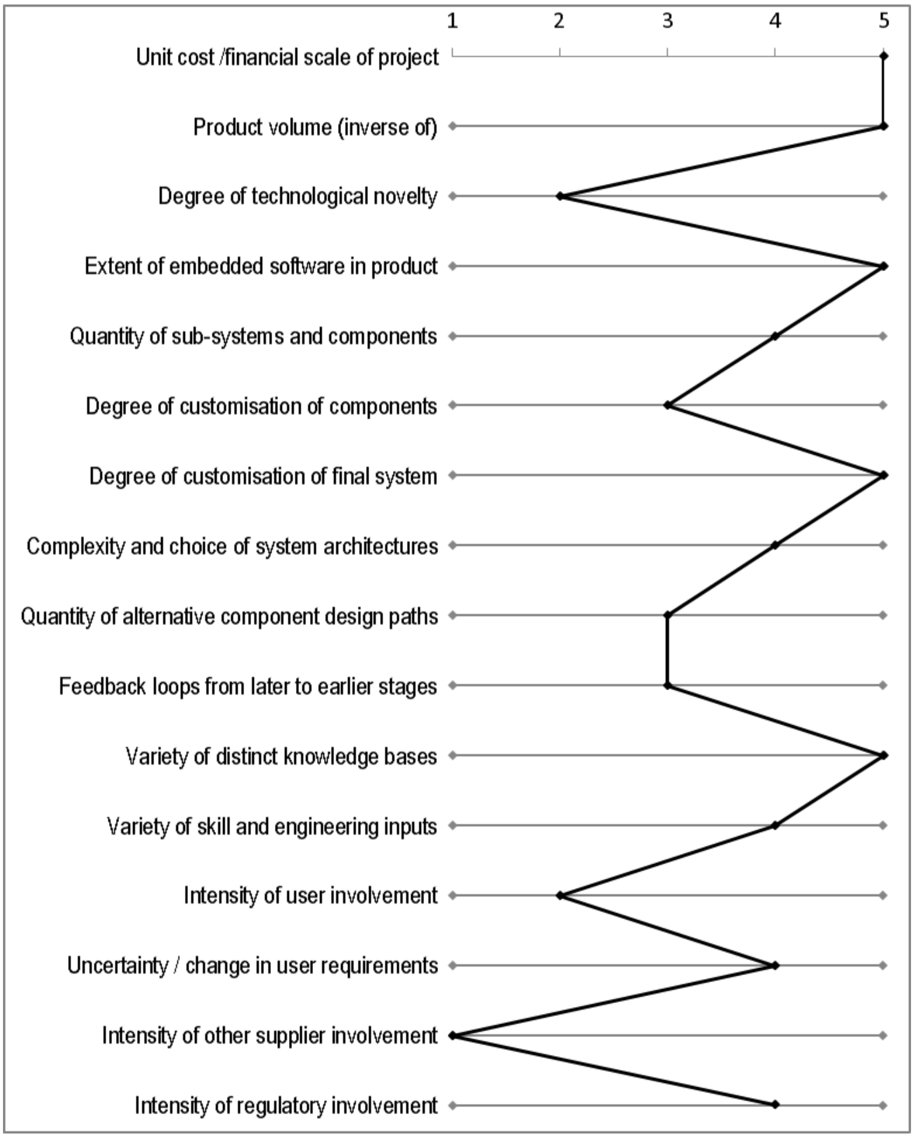

Figure 28. Complexity of the Police station case. (5 is 'very high', whereas 1 is 'very low').

Financial scale of project: Score – very high
The contractual scheme was very complex (there was no procurement framework for PPP at this period) and it increased the risk borne by the investors.

Product volume (Inverse of): Score – very high
The contractor had to take into account the multiplicity of services hosted in the police station which increased project complexity. Moreover, several contract concern the delivery of services (cleaning, facility management, catering, phone reception…). These elements made the project unique.

Degree of technological novelty: Score – low
The organisation of the project was innovative. However, there was no technological innovation in the project.

Extent of embedded software in product: Score – very high
Several software are embedded in the building (the help desk and security systems).

Quantity of sub-systems and components/ degree of customisation of components: Score – medium to high
Components were mainly conventional. Since the building hosted several services that follow different goals, components were used in large quantity.

Degree of customisation of final system: Score – very high
This is a unique project. It was the first and last police station built under this framework.

Complexity and choice of system architectures: Score – high
The interior architecture was complex since the police station gathered several services and hosted people who are held in custody and those who are complaining.

Feedback loops from later to earlier stages: Score – medium
Feedback loops were limited during the construction of the building. However, there are continuous exchanges between the facility manager and the users.

Variety of distinct knowledge bases / variety of skill and engineering inputs: Score – high to very high
The PPP concerns design, construction, operation and finance. Knowledge bases were diversified. Engineering input was quite strong particularly for software and security equipment.

Intensity of user involvement: Score – low
The output specification was not well defined. Public authorities had difficulties in defining their expectations and service levels. During the operation, the user did not know several times if he had to handle a problem or to ask the private owner or the operator.

Uncertainty/change in user involvement: Score –high
No change was made during the construction. During the operation, the organisation of the police stations was modified (some services moved). The uncertainty concerning the procurement process was also strong. Once in operation, the main change concerned the financial contract (the rent increase was limited).

Intensity of other supplier involvement: Score – very low
Suppliers were not really involved in the project.

Intensity of regulatory involvement: Score – high
The regulatory environment (security and thermal regulations, procurement process) influenced the development of the project and increased the complexity of the project.

Type of contracts

Two contracts were signed in December 1999 between the Ministry of the Interior and a Special Purpose Vehicle (SPV) gathering three financial institutions. The contracts concerned design, construction, finance, major repairs and maintenance of the police station for 25 years. Several separate contracts were also signed:

- between the SPV and a developer;
- a design and build contract between the developer and a team gathering a general contractor and an architect;
- between the tenant and user of the building, and a facility manager(after the delegation of the SPV);

The occupant also signed several small contracts for catering, cleaning, phone reception, outdoor areas.

The costs reached EUR 24 million.

Organisational structure

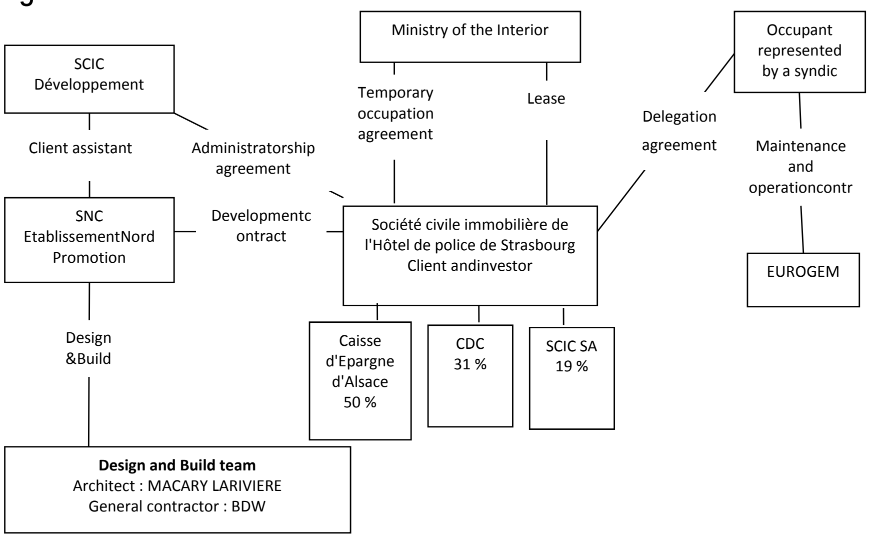

Figure 29. Organisational diagram

Monitoring process

The monitoring process is contractually very loose. However, the syndic who represents the occupant was able to ask for supplementary services for the SPV. For example, he referred to the Civil Code to require regular building façade restoration. This evolution is due to the ability of the syndic to develop a relationship based on trust with the SPV. Moreover, it appears that the project was quite profitable for the investors in PFI. Thus, they were not reluctant to provide supplementary services.

However, the syndic representing the occupants deplores not being able to influence the allocation of resources for major repairs and replacement. He just monitors the use of the budget.

The contract with the facility manager is not performance-based. It is more a duty-based contract. In the event of poor maintenance, the syndic is not really able to penalize the facility manager. However, the relationship between partners is very good since the facility manager has always been able to comply with the demands of the occupants.

Results

Once the construction was completed, several problems appeared:

- Difficulties were experienced by the public authority in clearly defining their expectations and service levels. Consequently, several parts of the police station were not well designed. For example the acoustics of the shooting gallery, the reception desk was too small and the acoustics in the reception hall were quite bad. People working there suffered from the echo. Thus, it was necessary to invest EUR 50 000 to improve the quality of the work station;
- Ventilation did not work in some offices and when it did it was very noisy;
- The pump for heating had to be replaced since it was not adapted to the size of the building;
- The walls of the building started to crumble off after a few years;
- Plumbing was quickly defective;
- The paving stones had to be replaced because of a defect.

These results are apparently due to budgetary constraints that appeared during the call for tenders. To reduce the budget, the Ministry lessened its expectations.

According to the occupant and the facility manager, the architect and the general contractor also did not know the specifics of a police station, and particularly the behaviour of the people working there or who go through the place. For example, vandalism is quite frequent. Thus, equipment has to be robust.

The contract has been flexible during the operational period. The main change concerns the rent paid every year by the public tenant. The syndic considered that the financial charges were too high. This was due to the inappropriate risks that were transferred to the private sector before design and construction. The result was a higher risk premium charged to the public sector. For example, the rent rose from EUR 3,331,947 in 2002 to EUR 4,180,052 in 2007. The syndic considered that this increase was obscene. Thus, in 2008, he negotiated a new gradual rent increase which was formerly based on the change in the index for construction costs. After negotiation, the shareholders of the SPV agreed to limit the increase to between 2.5 per cent and 4 per cent of the construction cost index. This included retrospectively 2007 and the shareholders refunded the occupants EUR 114,032. After this agreement, the rent is divided in two parts: the first concerns the financial rent (investment costs and financial charges) and the second maintenance and operating costs.

Lessons learned

Innovations

The project was not very innovative. However, the contractual mechanism was completely new (there was no framework for PPP). At the national level, the Ministry learnt a lot from this project since it was the first experience with this new procedure that can be considered as a form of PPP. The Ministry realised that it had to raise its internal competences in facility management and in financial engineering. After this project, a project group was formed to develop output specifications for police stations. The person representing the syndic of the police station of Strasbourg was the head of this working group. Specifications are regularly updated to integrate changes in the regulation.

A new procurement framework was also established in 2003. This contributed to reducing the risks perceived by private investors. This framework integrates design, build and operate (DBO) and design, build, finance and operate (DBFO). The first case was more popular since local authorities (such as municipalities) finance part of the project (for example by offering the land). This approach reduces delivery costs. It usually takes around eight months between the description of the programme and the beginning of the building works, instead of 24 months with the traditional public procurement.

Moreover, the office in charge of managing the estate of the Ministry considers that PPP is no longer appropriate since nobody knows the specifications of a police station 15 years from now. National priorities and regulations are changing too fast. Consequently, long-term contracts are not adapted to the needs of the Ministry. For example, the space for people who are held in custody now has to be 7 square meters with toilets (instead of 6 without toilets in 2000). Thus, the question is more about building flexibility than contract flexibility.

Governance mechanisms

The contract is not precise on several issues. In many cases the user does not know if he has to handle a problem or to ask the private owner (the consortium) or the operator.

It seems that equity investors in this project have made large gains. This explains why they accepted to modify the financial clauses before the deadline written in the contract. Since private partners do not seem to lose money, they accept to provide services which are not contractual.

The performance process and the value to the end users

The police station was not always well designed. This was due both to the difficulties of public authority to define its expectations and the lack of experience of the architect and the contractor with police station. Despite this situation and some malfunctions of equipment in operation, the occupant considers that the service quality is good. The maintenance and operation contract is not performance-based but the operator answers very fast to the needs of the occupants. Moreover, the owner is contractually forced to offer an operational building. This quality is also explained by the budget dedicated to maintenance and operation, which is more than three-times higher in Strasbourg than in other police stations located in the East of France (EUR 20 per square meter versus EUR 6).

Cross-cutting analysis and conclusion

The construction industry is often criticized for its inability to innovate, to improve its practices and to provide value for its clients (Egan, 1998).

To fulfil the expectations of demanding clients, new project-delivery mechanisms have been developed. Approaches focusing on performance-based building or new procurement processers such as new forms of private-public partnerships are considered as solutions improving the overall performance of the industry.

The main objective of this project was to understand how the development of integrated solutions in construction led to distinct configuration of actors and structures. Furthermore, the project analyses whether these changes modified project processes and contributed to the delivery of new value to the end users.

In this report we have argued that an understanding of the coupling between new values for clients and new project-delivery configurations can benefit from including the notation of CoPS to weight the systemic and contextual factors in which the formation and stabilization of the coupling between values and new project- delivery methods takes place.

The French and Danish cases represent six different types of delivery systems to deliver public goods. The cases are analysed and discussed in relation to three themes that public procurers need to be aware of when changing delivery system: innovation, governance and performance. The next three sections discuss the experiences from the six cases in relation to each theme. For an overview of the differences and similarities between the different types of partnerships, see Table 4 and Table 5 below.

Type		ESCO	Client partnership	Supplier partnership
Case		Frederiksberg Municipality	UN CITY	Green Lighthouse
Innovation	Project	Refurbishment project and delivery of energy services	Conventional project	Traditional project demonstrating Danish energy-solutions
	Operational system	Frederiksberg Municipality	Complex	University
	Systems integrator	ESCO partnership	Developer	Steering committee
	Feedback mechanism	Guaranteed savings scheme and energy baseline	Certification schemes	EUDP project/stakeholder interest in performance
	Type	Organisational	Organisational Product: Solar shading panels	Products: Integration of energy solutions
Governance	Policy processes	Politicisation of industry business processes by setting objectives (MBO)	Commodification of public politics (commercialisation)	Politicisation of industry business processes
	Business processes	Medium-term <14 years	Infinite, but with 15-25 years lease period	Ad-hoc
	Learning processes	Establishing energy baseline and monitoring energy usage	Applying international standards	Energy regulation strategies & supplier knowledge
	Contractual mechanisms	Combining relational and transactional mechanisms: ABR 89, ABT 93, partnership agreement	Transactional contracting: controlled design-build	Strategic partnership and turnkey contract
Performance	Society	CO_2 reductions and fulfilment of national energy target	Support Copenhagen as a major UN location	CO_2 reductions, national business strategy and facilitation of a green campus
	Operational system	Cost neutrality Flagship project Attainment of guaranteed savings	Profit – selling building rights Green Building certification	Functioning energy solution s and energy savings Indoor climate User satisfaction
	Project	Conform to annual financial municipal allocations Profit	Low-energy class 1 LEED Platinum certificate	Knowledge and experiences with integrated energy solutions in use Profit
	Users	Unchanged use Easy maintenance	Increase knowledge exchange	Inspiration Functioning energy solutions

Table 4. Summary of Danish cases

Type		PPP	ESPC	PPP
Case		INSEP	18 high schools	Strasbourg police station
Innovation	Project	Renovation carried out under a public management contract	Refurbishment with a strong focus on energy performance	Construction of a building hosting 7 services.
	Operational system	Consortium of different stakeholders.	The company which refurbished the high schools	Separate contract for maintenance and operation
	Systems integrator	SPV	SPV	SPV + bilateral relationships between the client and the operator
	Feedback mechanism	Key Performance Indicators Onsite helpdesk	Centralised control station and KPI (mainly energy consumptions)	Contract is not performance-based
	Type	Process Organisational	ESPC contract	Financial and organisational
Governance	Policy processes	Educational and sport policy	Environmental and educational policy	Security policy
	Business processes	Long-term ~30 years	Medium-term 15 years	Long-term 25 years
	Learning processes	International inspiration	Monitoring energy usage	Learn about private financing and facility management
	Contractual mechanisms	Primarily transactional	Primarily transactional however (relational at the level of each high school)	Combining relational and transactional mechanisms: a lease contract and a formal contract indicating the rights of the occupant
Performance goals	Society	International leadership in sport	Reduction of greenhouse gas emissions	Centralisation of police services and improving security
	Operational system	Reduce energy consumption Raise the service quality	Reduce energy bill and CO_2 emissions	Better service quality
	Project	Modernise site Keep within budget LCC	Different energy targets for different schools Renovation of 18 H Schools	New police station
	Users	Better service quality	Comfort temperature	Better service quality Development of “design, build and operate”

Table 5. Summary of French cases

Innovation

The research on innovation in this study concerned how new configurations of partnerships in the construction sector occur as part of the innovation by the sector itself in its transition to social agendas such as energy and climate-adapted building etc. This addresses the issue on where and how different configurations of various public-private partnerships come into being in the construction sector, how new innovative structures are taken into use in construction projects and what types of feedback processes that have been established as part of the innovation (research question 1).

The boundary between each construction project and the institutional context in which each construction project is embedded is often somewhat blurred. There is a general lack of understanding of the impact of the institutional context on innovation, and project practices in general. By using a CoPS approach it is possible to deepen the understanding of how a construction project is not only subject to a certain institutional context, but it actively interprets and translates institutional challenges to problems to be solved, which in turn alters the institutional context.

The six cases were chosen because they initially had the potential to be a CoPS. In the analysis of the six cases, focus was therefore on both the project's development of new systems architecture and on the realization of feedback processes as a strategy to optimize the established system design.

The results from the six cases support Gann and Salter’s (2000) view that innovation not only should be understood in the light of what the individual construction project can deliver in terms of new innovative solutions within the framework of type of tender, building program, design and execution. Rather, the analysis stresses the point that in order to understand innovation in construction, it is relevant to understand the interplay between the institutional context and the individual construction project.

By focussing on the development of new systems architecture, this interplay is thematised and the six cases show how this interplay takes place in a phase before the tender phase in which new types of partnerships are established and the project content is defined; often by redefining established institutional norms for both partnerships and project content. At the same time the results suggest that feedback processes from the individual construction projects, which help to anchor the experience in future projects, are already pre-structured by precisely this seemingly invisible pre-phase.

The CoPS approach raises the question of complexity and focuses primarily on product complexity. One of the urgent institutional challenges in the construction industry is to transform the construction sector to provide for a building with focus on energy performance. Using a CoPs approach in the construction sector there is a need to include additional aspects in the understanding of complexity to meet both the sector’s challenges in shifting to focus on energy performance, and the construction sector’s specific interaction with society.

The case results indicates that the following dimensions of complexity appear in connection with the development of the systems architecture, where the institutional challenges are interpreted and translated into concrete practice in the construction project, i.e. the meeting between the institutional context and the actual construction project.

- Technical complexity (integrating energy solutions)
- Organizational complexity (new partnerships between private and public actors)
- Process complexity (new types of contracts and performance goals)
- User-complexity (new types of interactions with the use phase)
- Service and operational complexity (long lifespan and involvement of new stakeholders)

The extent to which these dimensions of complexity occurs depends on the institutional challenges that are addressed in the given construction project, which in turn depends on which actors are the key actors in defining the project in the pre-stage.

The cases show that different types of partnerships between public and private partners can be systems integrators between the operational system and the construction project's realization of solutions. Management of the different complexity dimensions will be embedded in the partnerships, depending on which actors are involved in the partnerships.

Similarly, the character of the feedback processes taking place in the individual construction projects will be embedded in the given partnerships. Feedback processes cannot be understood in isolation, but need to be understood in the specific context they are embedded in. Therefore, there will be inner coherence between the project's complexity dimensions, the established partnership, the content / scope of the project and the project's innovation focus. There must be actors who have an interest in creating feedback processes and take experience into use in their own context, otherwise the experiences remain unused and there is no optimization of the system design in the long term.

The experience gained from the analysis of the management of complexity dimensions and how new innovative structures are taken into use in construction projects and transform both the construction project and the operational system, points generally to the following:

Technical complexity (integrating energy solutions)

– Composition of technical systems must be considered.
– It may be difficult to run-in technical solutions and a period of troubleshooting is needed. It may also be difficult for operating employees to take over the operation of complex technical systems, and this challenges the division of labour between the project and the operational system.
– New types of alliances are established between suppliers of building components, suppliers of energy technology and technical consultants, all of whom have an interest in buildings' energy performance in the use phase. This can exclude architects from the design phase.

Organizational complexity (new partnerships between private and public actors)

– New partnerships are established between private and public actors, which involve the development of new types of agreements between the parties. This may involve a change in the division of labour between traditional project-based organizations in the construction sector and the rest of the delivery system as well as new types of client systems.

Process complexity (new types of contracts and performance goals)

– New types of performance-based contracts require a high degree of flexibility, which challenges the parties' confidence in each other.

User-complexity (new types of interactions with the use phase)

– It is difficult even through the involvement of users in the initial stages to predict the use of the buildings both in short term and long term. This creates uncertainty in the design phase. At the same time, this indicates that the value for the users can not only be built into the product (building and service) but the value for the users must also be seen as a process in which value is constantly being created in the actual use of the building.

Service and operational complexity (long lifespan and involvement of new stakeholders)

Services are at the core of most PPP projects. Under this scheme public authorities do not buy any more a building but the services attached to a building. Moreover the long-term nature of the contracts could render them inflexible in the face of the inevitable uncertainty regarding future requirements over the long contract periods. Thus there is a necessity to find element of flexibility. In several occasions, trust and relational governance bring this flexibility and facilitate the enforcement of the contracts.

Overall, the experience demonstrates that the construction sector's innovation is characterized by a continuous translation of societal demands, project-related requirements, requirements from the operational system and user requirements in the individual construction project, and that this translation is done in many places by many different actors in the construction sector. At the same time the cases show that management of the construction projects' different dimensions of complexity and the built-in feedback processes are all central to the development of the construction sector.

The proposal for closer focus on the construction project's pre-phase and feedback processes between pre-phase and traditional construction project phases as well as the use phase, is an alternative perspective to the view that innovation between projects and companies is about system integration through a simple driver, an alternative that instead focuses on the multifaceted innovation processes taking place, initiated by different actors, that all in different ways, contribute to the solution of complex problems in construction.

Governance

As stated in previous sections this study intends to analyse and categorise the processes and mechanisms, which govern the delivery of complex products and systems in construction (research question 2). More specifically, this study has taken the framework proposed by Gann & Salter (2000) as its starting point. This framework understands construction as a complex of supply networks, project-based firms and projects that are embedded in a context of regulation and knowledge production.

The linkages between the various elements in the model by Gann & Salter (2000) are perceived as knowledge flows. Undoubtedly, the links can be perceived partially as knowledge flows, but in an early analysis of two of the case studies Haugbølle et al. (2012) suggest an understanding of construction as a technological system and ask through which technologies the interactions between the various constituents of construction take place. Technology may be perceived as the sum of artefacts, processes and knowledge. Taking this early analysis one step further, the complete collection of case studies illustrates that the relations between the various actors are kept in place via a diversity of technologies. These include financial instruments like capital investments in the UN City; organisational arrangements like the Public-Private Partnerships of INSEP and police stations in France as well as the strategic partnerships with manufacturers in the case of Green Lighthouse; contractual arrangements like the ESCO contract of Frederiksberg Properties etc.

It also appears that the delivery of CoPS modifies the traditional relationship between buyer and supplier. Indeed the coordinator of the project has to manage networks including suppliers, designers, contractors, facility managers, financial institutions and government authorities. In PPP projects, the coordinator is the Special Purpose Vehicle (SPV) which organises the division of tasks (design, construction, operation and finance) among the partners of the SPV (Brady et al., 2005). The management of these complex interfaces is the key issue to deliver integrated solutions to clients and to create value for the end users.

Previous policy analyses of Danish construction as a cluster or a resource area (Erhvervsfremme Styrelsen, 1993 and 2000) have adopted an understanding of the interactions as framed through three distinctively different, yet interrelated markets:

– A product market between the supply network and the project-based firms.
– A construction market between the project-based firms and the building owners.
– A property market between building owners and users.

Further, we would like to repeat the alternative perspective on the constituents of construction suggested in the early analysis of Haugbølle et al. (2012). This alternative perspective is illustrated below in Figure 30. More specifically, a clearer distinction between building owners on one hand and users on the other hand is introduced. In most cases, the building owner and users will be interacting through a property market either through a sales process or a lease contract.

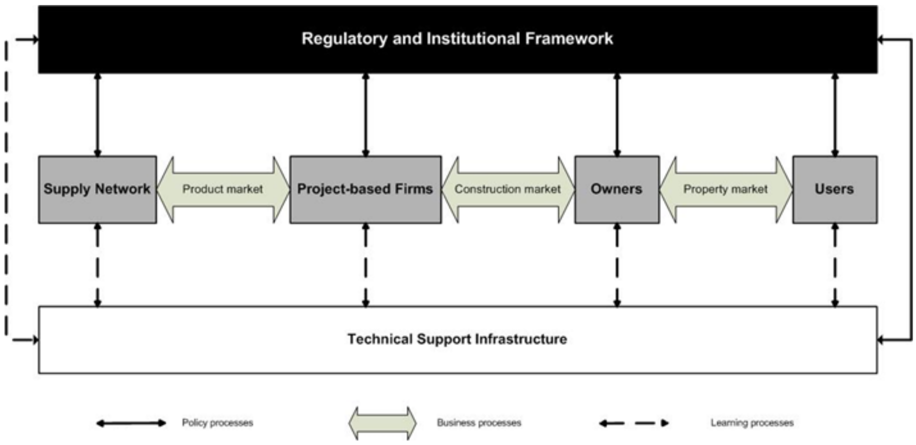

Figure 30. An alternative perspective on the construction system. Source: (Haugbølle et al. 2012: 452).

The complete collection of case studies in this volume supports the early suggestion made by Haugbølle et al. (2012) that the dominant character of the interactions between actors is taking place through policy processes, business processes and learning processes. This is not to imply that all the processes are at play with the same weight in all situations or between all actors. Business processes seems to be particular important with regard to interactions in the business system of the supply network, the project-based firms, the building owners and the users since most of the products and services are being exchanged through the three types of markets mentioned above. The interaction between the regulatory and institutional framework on one hand and the business system and the technical support infrastructure on the other hand may be more dominated by policy processes of policy formulation and policy implementation. The interaction between the technical support infrastructure on one hand and the business system and the regulatory framework on the other hand may be dominated by learning processes related to education by educational institutions, the adoption and adaptation of knowledge from international centres and schemes like LEED, and the development and dissemination of new knowledge from research institutions and the like.

Performance

In this section, we will summarise the main findings in relation to the third research question presented in the introduction, namely how the recent changes in procurement procedures towards public-private partnerships are reflected in specific performance management processes and the delivery of value to end users.

An interesting feature of the performance criteria and goals that have been identified in the four of the six cases and summarised in the above Table 4 and Table 5 is the relative absence of contradictions or divergence across the four different actor perspectives (society, operational system, project and users) that have been applied in the analyses. The different types of project-service delivery mechanisms that have been the focus of the case studies (i.e. supplier partnerships, PPPs, ESCO/ESPCs and client partnerships) seem to have been able to bridge and converge potentially conflicting perspectives and interests rather than aggravating these, as is often the case in traditional infrastructure projects (cf. Van de Riet, 2003; Olander and Landin, 2005).

A number of factors might have contributed to this; however in particular, the hybridisation of the contract, i.e. the employment of a combination of transactional and relational contractual mechanisms, might be seen as an explanation for this climate of conformity. Whereas transactional obligations are linked to economics exchange, relational obligations are concerned with social exchange (Shore and Tetrick, 1994). Another defining characteristic is that relational contracts focus on the contingent and reciprocal exchanges between partners, transaction contracts assumes that transactions between parties are independent events, i.e. that they are not long-term and ongoing (Shore and Tetrick, 1994: 95).

Turning our attention to the Danish cases, we see that each of these cases, with the exception of the UN City case, employ a combination of transactional and relational mechanisms that taken together constitute a governance frame that has been effectively able to handle the different, divergent targets of the stakeholders. Especially in the Danish ESCO case the distinct and tailored project-system setup, employing a broad range of economic, contractual and organizational mechanisms seem to have played a prominent role in ensuring that performance goals in different *actor perspectives* can be effectively met through a balanced and integrated network configuration. This has also been the case in the Green Lighthouse case where the strict focus on performance issues by all parties and the distinct translation of different performance goals into tangible energy solutions helped bridge the different actor perspectives present in the project.

The main lesson of these cases is in other words that it is possible to balance different actors' goals and concerns by means of different procurement routes that represent *integrated and situated* responses or strategies to the handling of complex service deliveries. In particular, going from observing an isolated project to observing an integrated project-system network as the unit of governance help shift focus to understanding different actors' equally legitimate aspirations and performance goals – and hence develop new responses and governance mechanisms that can facilitate better value not only for the client but for the whole spectrum of stakeholders involved in the procurement and operation of complex products and systems in construction.

General conclusions

All cases illustrate how construction projects become more and more complex and require the development of new relationships between clients and providers of integrated solutions. This is due to:

- The number of interdependencies among the stakeholders of the projects (users and companies in charge of construction and facility management).
- The multiplicity of users with different requirements and the overlapping roles between the regulatory and the business systems (as in the case of the UN City).
- The necessity to define ex-ante services and to propose key performance indicators which will be easy measured (cf. the INSEP case).
- The uncertainties surrounding these projects which are unique. These uncertainties require flexibility in order to deal with all contingencies that were not anticipated at the bid stage. In such situation relational governance is considered as a complement to contracts.

One of the aims of the case studies was also to explore whether the move towards integrated solution provision provide better value for the clients. The answer is not straightforward.

In the French cases, the service quality is higher than in the past. Conversely the link between the project execution and the service delivery is still far from being perfect. It also appears that the level of requirements of the public user has increased, as it did not have the same level of expectation when the service was done by internal staff.

In the Danish cases, the short-term benefits seem evident in the ESCO case at least, where the municipality will have its building stock energy refurbished in a cost-neutral way – and at the same time contribute to national energy targets. Also the Green Lighthouse and the UN CITY cases illustrate how the distinct configuration of public and private clients and suppliers has led to the fulfilment of performance goals on many levels thus providing value for the client. On the other hand, the Danish projects are still in their early phases of operation, and as in the French cases, the link between the project execution and the service delivery is not optimal, as the Green Lighthouse case illustrates most prominently, where the energy consumption was found to be much higher than expected in the first year in operation. However, the subsequent efforts to successfully reduce energy consumption illustrate the strength of the close client-supplier partnership.

To fully understand the move towards enhanced performance and increased complexity in construction, more research is required. Indeed there is a need to analyse how the very delivery of integrated solutions combining building and operation can contribute to the reduction of energy consumption in buildings.

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To fulfil the expectations of demanding clients, new project-delivery mechanisms have been developed. Approaches focusing on performance-based building or new procurement processers such as new forms of private-public partnerships are considered as solutions improving the overall performance of the industry. The main objective of this project was to understand how the development of integrated solutions in construction led to distinct configuration of actors and structures. Furthermore, the project analyses whether these changes modified project processes and contributed to the delivery of new value to the end users. This report summarises the results from work undertaken in the international collaborative project "Procuring and Operating Complex Products and Systems in Construction" (POCOPSC). POCOPSC was carried out in the period 2010-2014. The project was executed in collaboration between CSTB (Centre Scientifique et Technique du Bâtiment) and SBi/AAU (the Danish Building Research Institute/Aalborg University).

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