

Maximising the social value of constructed assets: public-private-innovation at work

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Implementing PPI in the Built Environment

The paper presents a new industrial innovation arena in line with present Danish and international efforts towards public private partnerships with generic rules for cooperation and integration of research in innovation processes. The method supports the more traditional way of innovation through a broad-spectrum approach based on utilization of for instance research, users and operation experiences.

Basis is three perspectives: the business system, a cross-disciplinary understanding and an integrative experimental building programme. Research is an important actor in the efforts to create constructed assets which meet social goals. However, it is important to recognize the contextual settings for building research if sector developments in practise are to be achieved. The effect of research depends on other actors in the business system. Clients, regulatory bodies, professional associations and building trade organizations constitute one level in the systemic framework; another is firms – architects, consulting engineers, contractors and suppliers – operating on the individual project level.

The interplay between these actors can be seen as an innovation process as proposed by Winch (2010) where the initiative to new processes or products may originate from one, or several, or from a network of actors. Integrators are actors who undertake a brokering role and promote comprehensive solutions to be used in specific building processes. There is a crucial need for a shift in research and knowledge to a more interdisciplinary focus on practice. This development can be facilitated by integrators such as networks which can cross traditional borders within technical disciplines, and between technical and social disciplines with a starting point in user needs, and between the construction phase and subsequent operating phase.

In Denmark 30 years use of experimental building projects supported by networks of participating companies as integrators across disciplines and life cycle phases has provided valuable knowledge about this approach to innovation (Bonke & Olsen, 2010).

Keywords: Public-Private-Innovation, Experimental Building, Learning

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1. Introduction

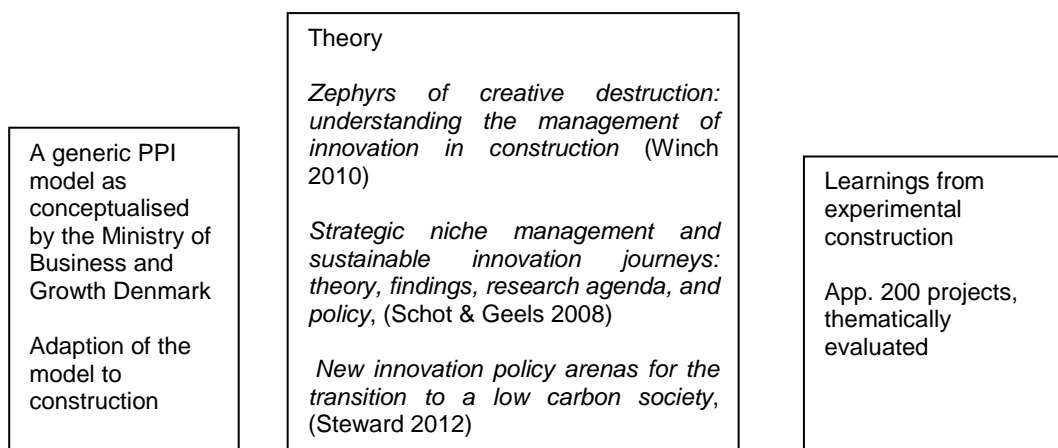
Coming years' development in society will confront the construction sector with daunting challenges. Such challenges concern the implementation of new sources of energy, reductions in energy consumption, increased weight on sustainable solutions, lifecycle assessments in refurbishment projects, more effectiveness in operation of buildings, and better productivity (Kristiansen et al, 2005).

To meet these challenges many western countries have tried, as an approach to stimulate public clients and private companies, to develop new forms of collaboration thus facilitating a comprehensive sharing of different actors' and professionals' knowledge and best practices.

In Denmark the discussions about this approach have been focusing in particular on the interplay between clients, users, designers, contractors and manufacturers – and the track to explore towards better interaction has been much inspired by the concept of experimental building projects. This model grew out of building needs in the public sector, with the first steps taken in the late 1970s followed in the next decades by continuing refinements based on evaluations of experiences from a long national tradition for testing new ideas in real building projects (Bonke et al, 2001; Clausen, 2002; Olsen, 2003). Also other countries, not least Sweden, have thoroughly reported on this approach, often referred to under the term 'demonstration projects', to innovation in construction (Bröchner et al, 1997; Fermentias et al, 2010)

However, in order to convert visions for change into more practical methods and underlining the need for collaboration on a wider basis the Danish government in 2012 published a rough outline for innovation through so called *PPI Public Private Collaboration on Innovation* (in Danish: "OPI Offentligt-Privat Innovationssamarbejde") (Erhvervs- og Vækstministeriet, 2012). Unfortunately, the governmental model is not particularly adapted to innovation in the building sector. Therefore in the following the original approach is reviewed and further developed by inspirations from theory on niche management and from evaluations of cases. This innovation model, or industrial arena, is fully applicable for private clients as well.

Thus, as a point of departure the modelling of a *construction approach* to Public Private Collaboration on Innovation (PPI) will be based on the pillars of recognition as illustrated below:



A domain specific PPI model for construction PPI BUILD - a new industrial arena

2. A first step on the road towards Public-Private Innovation

The Danish government has recently taken an initial step towards establishing an operational platform for collaboration on innovation between public clients and private firms. In the spring 2012 the Ministry of Business and Growth Denmark launched their model – an OPI guide (*Offentlig-Privat Innovationssamarbejde*) as a first step for developing the area. An important aim was to communicate “what it takes from a public authority to gain success through OPI” (Erhvervs- og Vækstministeriet, 2012). The guide is operating with four so-called points of awareness.

2.1 Four points of awareness

First is the issue of *legislation*, for public construction clients particularly important as concerns the law on tender and the EU regulatives. Two other crucial sets of regulatives concern state subsidies and rights.

As a second important point of awareness PPI projects must have *management focus* - that is have priority on responsible management level and be well-anchored in the organisation. Thus, the guide reports, previous learning for instance from cases where the development agenda is organized more in compliance with the aims of the funding bodies than taking into account the basic innovation problem tend to de-couple the PPI project.

Thirdly then, a crucial issue is the *funding*. It is generally hard for public authorities to find opportunities and room for development projects. But PPI may be seen as an investment which may later yield a return – as higher efficiency, quality, growth or the like.

Finally, focus must be on the *organisation* of a PPI project. Emphasis should be put on inter-organisational collaboration, incentives, and new roles for the private firm as well as for the public part.

In the following this model for public-private-innovation will be adapted for construction, as PPI-BUILD. The new model is incorporating previous work with approximately 200 cases of experimental building projects with participation of public clients and private companies. Relevant research based results, i.a. on innovation in a niche-management perspective, is also drawn upon in the process of transforming the model.

3. Innovation in construction – integrating levels and actors

When analyzing the basic factors at stake in innovation the complexity of innovation processes in building products and processes soon become evident (Winch, 2010). In the

research on complex systems dynamics Winch (2010) identifies three “actors” or systems in the innovation process.

3.1 Frameworks and firms

The first system - “innovation superstructure” - is broadly spoken represented by clients, research, the regulative framework and the professional organisations and associations. The interplay between these is determining the acceptance and use of innovations, and a number of factors may promote or hinder the development of innovations. Such factors being for instance the commitment of public clients, the rules of regulation, the interests and foci of research etc.

Within the second system – in the “innovation infrastructure” - the development work takes place in firms and projects. Here, decisions are taken on use of innovations, whether they are new or modifications to existing technologies, about adjustments, implementations and exploitations. Also within such firms and project oriented settings a large number of factors may promote and hinder development, for instance sharing of knowledge/ideas, incentives, learning etc.

3.2 Integrators

The interplay between these two systems is performed by a *third system of integrators*, undertaking the task of disseminating and brokering innovations. This interaction between the superstructure and the project oriented level is rather critical for development of innovations. Again, it may promote or hamper development. Innovation will advance as a result of clients’ interests, a creative research environment, favourable associations and entrepreneurial firms. Inertia – or resistance – and lacking initiatives of course have the opposite effect. Winch (2010) indicates that the role as system integrator (or broker) in construction may be divided between consulting firms and contractors. Thus, in fact two separated systems integrators may be exerting influence – one for design and one for production aspects. However, integration can also be “bridged” through professional associations, research or regulation. And also the manufacturing industry can facilitate development when acting in this function.

3.3 Managing innovations

Four central challenges are facing the management of innovations: awareness, champions, professional organisations and the client.

Awareness is created through incentives, rewarding innovation. In construction it may often be relevant to share rewards between the client and the partners in the delivery team. Shifting from lowest-prize bidding towards partnering could be a first step on this road. And innovations require *champions*. Typically, this could be a manufacturer, but also consultants and contractors can play important roles as such. New ideas often originate from niches, then being accepted by the “superstructure system” by the intervention of the integrator/broker. As indicated, in construction it becomes a challenge that the integration of

the champion's idea is divided between the consultant and the contractor. Adding to this, the role of professional *organisations* as integrators are becoming more complicated as new organisations are constantly emerging, claiming to be mouthpiece for the construction community. Finally, the open-minded and competent attitude of the *client* can stimulate the development of innovations as he understands better the proposals from brokers and can himself manage collaborative solutions with consultants and contractors. Learning seems to be a key premise to this.

3.4 The importance of building operation

The last years' development has added another central empirical aspect to these more theoretical perspectives on innovation. Thus it seems evident that the operation of buildings is playing an increasing importance in relation to developing new (resource efficient) technology (Steward, 2012). For instance, a number of surveys show lacking compliance between calculated (energy) savings and actual gains during operation. Consequently, considering building operation will become crucial to PPI-BUILD – thus influencing innovation processes in a much more explicit way henceforward.

4. Free innovation space in the building sector

Innovations can be promoted through establishing of niches, providing shelter for the collaboration on development between technology, user-practices and regulatory settings (Schot & Geels, 2008). Such niches can function as platforms for broader changes towards sustainable development in society.

4.1 Niche Management

Theories and concepts in support of this comprehension of innovation have been elaborated upon since the late 90s under the term “strategic niche management”. Much research is concentrating on niche internal processes, such as learning, networking and elaborating on visions. However, recent analyses and experiences also underline the need to pay more attention to external processes, surrounding the niche (Jensen, 2011).

Thus, through external processes the innovation niche is linked to a “socio-technical regime”, comprising the marketplace, the branch of industries, research, culture – altogether also often characterized as the sector or the business system. This level is located under a “socio-technical landscape”, representing a macro level which is normally rather stable over long time spans.

Niches may be established by clients, firms, users and research. Governments can use and support niches for development of technology which is not profitable in a business perspective, in expectation of realizing certain political goals. Altogether, niche management seems most suitable for innovations characterised by radical, high-risk and long term aspects.

As a consequence niches are often conceived of as obvious frames for development within sustainability and climatic issues which imply substantial changes in markets, for users, in regulatory provisions and the like. Such developments are challenged by the tight interlocking of technology and social changes.

4.2 The internal processes

These processes comprise (1) visualisation and wording of visions and expectations, (2) establishing networks for experiences, exploitation and funding, and (3) a number of learning processes concerning technical issues, user preferences, operational conditions etc.

Internal processes have been elaborated upon in research (Jensen, 2011). For instance, it seems important that expectations are shared by several actors, that they are specific and of high quality. Networks must be wide and comprehend resource persons. Learning processes must not only concern “first order” learning but also be open to changes in assumptions and framework conditions – “second-order” learning. When applying niche management the aim is consequently to prevent innovations from alone optimizing technical aspects to also including social considerations.

5. Experimental building – free space for development

In Denmark by the end of WW2 political focus turned towards the housing situation. In the late 40s and early 50s a number of initiatives were taken, based in the Ministry of Housing (est. 1947), and with the Danish Engineers' Association as well as with a number of architects as very active co-players. The goal was to achieve a higher level of industrialisation in the production of building components. Thus, industrialised building was developed in a ‘free space’, initiated by the ministry and actively supported by associations and clients. There was a clear vision: the need for housing should be eliminated.

5.1 Establishing experimental building as a free development space

Although several building projects within the development efforts of the 50s and 60s could be characterized as experiments there was not in connection to the individual project established a formal organisation to deal with planning the experimental issues, changing the traditional products and processes, controlling quality, evaluating and disseminating experiences. This for instance is the case with the Bellahøj buildings (1947, varying carcass systems), Engstands Allé (1953, external walls and floor decks as concrete elements), and Rungstedhave (1957, use of hollow decks).

Results were disseminated by means of meetings, articles – particularly in the journal *The Building Industry* (est. 1950, and soon a central information channel), in reports from the Danish Building Research institute, as regulatory provisions and through so-called “rationalization consultants”. This dissemination was complemented by an active governmental policy, encouraging the exploitation of results, primarily through dialogue with the social housing associations (clients).

Experimental buildings as an approach to development initiatives and innovations was evaluated in a report from the Building Development Council (BUR), established by law in 1971. In the legal framework it was stated that

“The construction sector has a considerable need for *experimental building* for development and testing of new production methods, new materials, functional designs and qualities. The need will increase along with the standardization of construction because quality improvements as well as flaws will appear in much larger scale than previously” (BUR Byggeriets udviklingsråd, 1974, p.6, our translation)

In 1977 the parliament (Folketinget) decided to grant funding for experimental building projects, to be administrated by BUR. The grant was assigned to a number of conditions which would be influencing developments in the following years. Most significant was the emphasis on the strategy to let experimental building innovate the building as a whole with all its functions, of which the individual materials and components are part. So focus should be holistically on the total product value, for instance as consequences of the energy savings on the indoor climate, on the development of new envelopes, and on housing for disabled persons.

5.2 Characterising experimental buildings

In 1979 as a joint initiative by the Building Development Council, The Building Research Institute and the Building Ministry new and more thorough guidelines on the aims, organisation, evaluation and funding of experimental buildings were published (Byggeriets Udviklingsråd et al., 1979). Experiments were defined by these features:

- ✓ The experiment concerns a total physical frame, not products
- ✓ The experiment may concern form and function as well as organisation
- ✓ The experiment is attached to construction in practice
- ✓ There are certain risks related to the experiment
- ✓ The experiment involves extra costs during planning, production and evaluation
- ✓ Substantial importance is attached to the evaluation and dissemination of results

Subsequently, in 1980 instructions for grants and funding were put forward – stating in concrete terms that

“an experiment first and foremost is to do something different from customary, at the same time to carefully describe what to do differently, and what the experiment intends to verify or disprove. And further to follow, measure and document what happens. Otherwise it cannot be classified as an experiment” (BUR Byggeriets Udviklingsråd, 1980, p.2, our translation)

5.3 Public clients as change agents

An important premise for a successful collaboration – as in experimental building – the parties must be committed and capable of contributing to the development work on the basis of knowledge and experiences. Not least this involves the client, the role of which became more central during this period. Wide circles, including the government, had the notion that clients could and should contribute more actively to the development. As a culmination to this the Danish Association of Construction Clients for public and private clients came into being in 1999. This happened in parallel with a restructuring of the administrative guidelines for experimental buildings, for instance substituting the use of reference groups as dialogue partners with a network of clients and evaluators who were participating in experiments within the same field of subjects.

To further strengthen the use of experimental building the Building Ministry published “Guiding remarks on experiments in construction” (1996) with recommendations based on reports from BUR and later evaluations. With a political prioritization of development subjects visions were formulated, in fact often as a result of previous dialogue with the sector – clients, firms, professional associations, research etc. Through this it became more legitimate and desirable for public clients to participate in experimental building.

In several cases the development work led to ministerial guidelines which were recommended as “best practice”, or sometimes converted into legal provisions – or into relaxations of provisions. Thus, one or more experimental buildings could become point of departure for influencing the whole industry. Politically, the goal was clear: the state as a procurer, and the continuing character of public building activities, should be utilized for the changing of processes and products in construction.

6. Adapting and developing the free space

As described above the use of experimental building as a free space for innovation has been adapted and developed over the years. The experiences, and the learning that had been derived, led to a number of research based recommendations in the early 2000 years and onwards. Some of the more important are listed below (Clausen, 2002):

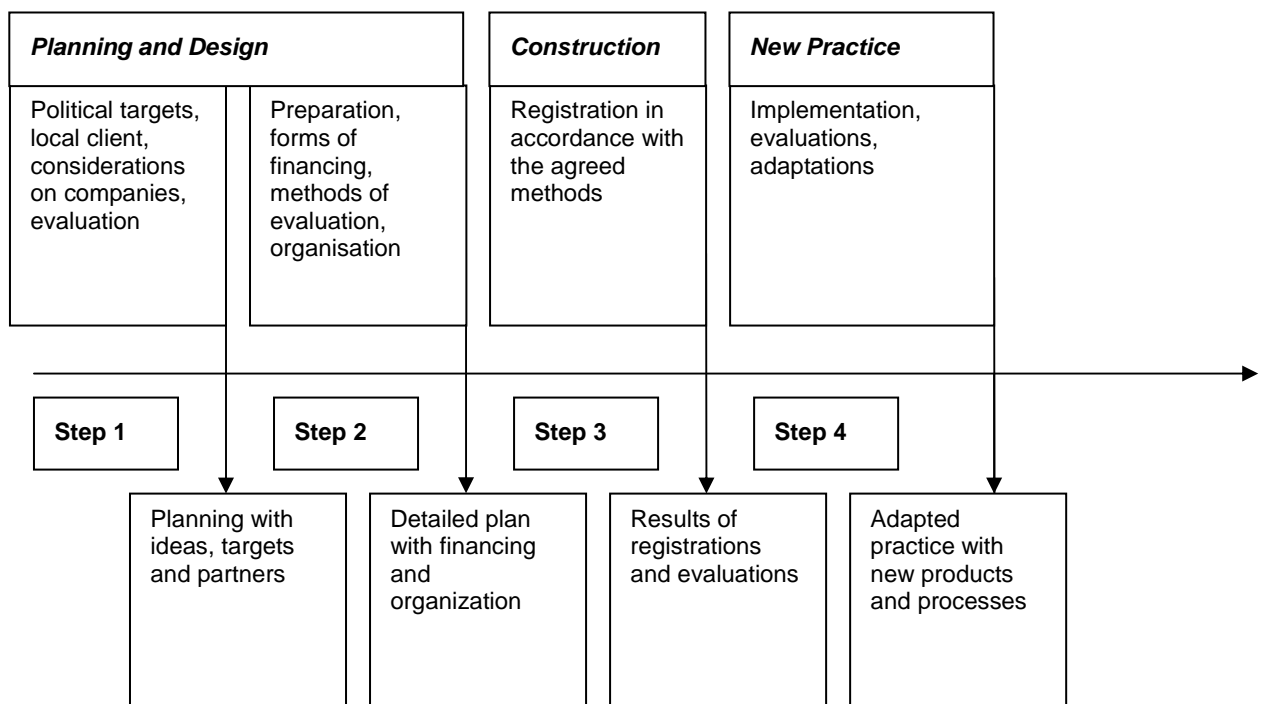
- The handover of the program for the development work to the building *project organisation* should be given greater emphasis. Practical activities should comprise training, education, simulation and social relations. The whole project organisation must have ownership to the experiment.
- Firms involved must consciously relate to their role within a learning situation. Mechanisms for learning to maintain knowledge if staff leaves must be established (or secured by a stable core of staff). Dialogue across firms and professions are crucial.
- Time and space for reflections during implementation must be provided, for instance through phasing. This makes adjustments possible along the way – in the new solution as well as in the social relations (“learning is a process, not alone a result of the innovation or the specific building project”).

- It is important to have an emergency plan in place during implementation to handle problems up front. Support for the participants must be available to secure the holding on to elements of development

Then, in 2003, the government in a dialogue with clients and the construction industry concluded on a number of necessary adjustments:

- Concerning the development subjects in experimental buildings a stronger *focus* has taken place on the expense of comprehensiveness
- The experimental buildings organise into *networks*, primarily through their clients. The networks replace previous reference groups and handle transverse conclusions, for instance for departmental guidelines
- The experimental projects and the testing of buildings must be evaluated by external *evaluators*
- Corporation with technical universities has been established with the aim of disseminating results through *education* and textbooks
- Funding for development work in firms and for the evaluation task is *no longer provided*
- Strong *secretariat backup* to the networks has proved necessary
- Reports, guidelines and other information are uploaded to a *homepage*. The need for pamphlets and other types of communication means is however evident.

At the 2010 CIB conference in Manchester an attempt was made to collect experiences and evaluations into an integrated model, while distinguishing between three main phases, Planning and Design phase, Construction phase, and New Practice phase, as illustrated below (Bonke & Olsen, 2010):



As the four steps generally take into account topics as quality assurance, risk analysis and implementation of development work they can also serve as a checklist in a concrete project which involves alterations in traditional practice.

In conclusion, and as illustrated in the figure, the ideas behind experimental building projects have been widely accepted as an adequate model for public-private partnerships (Erhvervs- og Byggestyrelsen, 2009). Within this framework the development process is progressing through the four steps 1) transforming the idea into a proposal, 2) organizing the partnership, 3) development work in parallel with execution of the building project and 4) dissemination and implementation of the results.

As indicated, learned experiences and final results achieved through such processes are made public through reports, articles, courses and seminars. In a number of cases these results have constituted decisive input to new regulatory guidelines which were then typically made compulsory to public and state supported clients.

7. Discussion

Although not verified in targeted research in Denmark, much evidence supports the view that experimental building as a free space for innovations has had probably the greatest importance for the development of industrialised building and for changing building products, processes and procedures in the post-war construction industry. New technology and industrialisation in the 50s and 60s led to radical productivity improvements and capacity growth. Processes and procedures in particular again accelerated from the mid 90s with initiatives on new forms of collaboration, digitalization, lean construction, life-cycle economy, quality management, and benchmarking. The Danish state played an active role on implementing these dimensions.

Nonetheless, it is characteristic that the approach to applying experimental building has generally taken traditional structures and organisation in the industry as given. From this basis the aim was to stand upon existing procedures, to add new perspectives, and to further develop practices thus contributing to solving the challenges in the building sector. An example of this adaptive attitude is the development of new forms of collaboration where the state agreed with the professional associations that there was no need to change existing contractual conditions (*agreed documents*) – minor supplementations would do! Similar observations have been reported Swedish research, stating that demonstrations projects as an innovation approach is suffering deficiencies concerning the strategic need for more radical structural changes (Fermenias, 2004)

Learning and experiences are further reviewed in the following sections, leading to recommendations on the model in the light of the above illustrated Manchester framework.

7.1 The Planning and Design phase

As underlined the conceptualization of a vision – perceptible, acceptable and shared within wide circles of clients, regulative bodies, research and associations – is extremely vital to the

development process. The vision is the key to the sheltered free space within which advancing development and learning can take place and be shared by committed actors.

In the development of the new-forms-of-collaboration case the state launched the initiative for a free space (niche) for interested clients and firms to develop and test new ways of interacting in building processes. Work within the niche was amplified by establishing several spaces in parallel – and phased for learning purposes, with the same vision but in networks of different clients and firms.

In a similar case, focusing on developing flexibility, the vision was again based on state commitment and shared by many actors and parties in the construction sector. This vision was unfolded in a competition, thus involving a wide circle of firms and securing the selection of the most dedicated and qualified partners to enter the free space.

Further, the internal processes in the free space must be underpinned by external processes, linking the niche to the broader industry system on market, sector, research and social relations level. In the cases mentioned this took place through reference groups or networks and public seminars. Here, also the timing of next steps towards funding and planning of the exploitation of results is of course central to maintaining the acceptance of the vision.

7.2 The Construction phase

During this phase important elements are the awareness of parties, champions to take the lead, well-articulated proponents and competent clients. In the emergence of the new-forms-of-collaboration case the call from the ministry provided a breeding ground for an initiative which, after some reluctance, gained tailwind at clients and in particular contractors. The latter – and their professional association – took on the role as champions in close interaction with the state. The free space network on its side undertook the information and follow-up assignments. As indicated, in the flexibility case, the competition and the subsequent development process in the free space, drove forward the winners as natural champions on this development subject.

7.3 The New Practice phase

A decisive element in a successful innovation is integrators or brokers, capable of bridging the free space and practice, and to create broader acceptance of the results. In the new-forms-of-collaboration case the state acted as broker through imposing requirements on the public clients. In the flexibility-case, however, the formalized follow-up was lacking, and the handling and implementation of development results was consequently weakened.

8. The Public–Private-Initiative for the construction industry

In the table below conclusions from the experimental building model are summarized for the PPI-BUILD purpose:

A PPI-BUILD Model in six phases – in comparison with the generic Danish PPI model			
Main phases	Six PPI-BUILD steps	The Danish generic model	Remarks to the new model
Plan with ideas, targets and partners	<p>1. Make the ideas to a visible vision and choose partners. For a public client in accordance with procedures for public procurements.</p> <p>2. Draw up the lines for a free room for development, a plan for the work and for the evaluation in collaboration with the partners.</p>	A: For the public partner the choice of private partner(s). Two options are possible: a partnership where the partners are chosen after a competition concerning the development work followed by a normal procurement process or a procurement process based on a competition which also contain the development work	<p>1. For the public client it is important – as the initiative is normally is up to client - to choose a competition which underline qualifications. Likewise to get a common understanding of the vision among the partners.</p> <p>2. The plan must cover original ideas and visions and take into account future possibilities for flexibility.</p>
Detailed plan with funding and organization	<p>3. As development work normally has some cost consequences it is essential to establish funding.</p> <p>4. A network of knowledgeable and key persons means a lot for the development work and for the later acceptance of results.</p>	<p>B: It is important that the development work is followed by management resources, is prioritized, secured financial and anchored in the organizations.</p> <p>C: The financial benefits have to be evaluated in broad terms – also covering aspects as productivity, quality, sustainability and growth</p>	<p>3. Funding may come from the client, the participating companies, public programs or private organizations.</p> <p>4. It is important at an early time to consider the later channelling of the ideas to the market and the building sector</p>
Results of registrations and evaluations	<p>5. The vision with the evaluation scheme should form the platform for client and companies.</p>	D: The development work will demand new roles and forms of collaboration sustained by an interdisciplinary approach.	<p>5. In many cases it may be necessary with special observations to get a clear picture of variations between normal practice and the alterations due to the development work.</p>
Adapted practice with new processes	<p>6. The work in the established free room is completed as implementation of the results at the involved partners, as a report and as opening up for marketing and sector discussions.</p>		<p>6. The registrations have to be scrutinized and gathered in a report. Dependent of the funding the report may be published. The wider implementation can be based on the network and a lot of other means as focus meetings, professional organizations, educations and eventually new regulations.</p>

9. Concluding remarks

PPI BUILD supports and further develops the more traditional ways of innovation processes in construction. Typically, innovation is viewed as a technology driven process with dialogues only with few players during the work. The ambition for PPI BUILD is to conceptualize and implement a broad-spectrum approach which contains inputs and involvement from research, users and operation phase experiences in a deliberately

organized way. This approach is in line with open innovation – and is especially suited for more radical changes with the considerable elements of risk, characteristic to construction.

In the further research at DTU Management our plan is to develop and refine conclusions as illustrated in the table above in order to pave the way for an adequate and efficient implementation of PPI in the built environment.

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