The central role of the construction sector for Climate change adaptations in the built environment

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Abstract

Over the past years, research has clearly enunciated the necessity of adaptation to climate change in the built environment. Policy is being developed on national and municipal levels to have adaptations implemented. However, for the actual application of the measures, property owners are the actors that have to commission the construction industry to take action. But the construction sector is highly fragmented, causing several barriers for an easy uptake of measures other than the 'business as usual' ones.

Based on rehabilitation intervention processes where technical measures are applied to dwellings of a housing association in the Netherlands, a governance approach for implementing adaptation measures is explored that focuses on collaboration in the construction process. In the proposed approach actors are working closely together, guided by elements of network governance. By not only integrating the complete supply chain, but also making it 'intelligent and aware', climate adaptation is no longer a surplus to the process, but reflected in any decision.

Keywords: Adaptation Measures, Climate Change, Construction Process, Networks.

1. Introduction

There is clear evidence that the global climate is changing (Fussel, 2009; Smith et al., 2009). In order to limit the risks caused by a rising sea level rise or extreme weather events, adaptation to climate change is necessary. At present, governance strategies to a large extent focus on policy making on national (e.g. Biesbroek et al., 2010) and municipal level (e.g. Bulkeley, 2010), not taking into account the policy level of property owners. However, they are the actors that are in the position to commission physical adaptation activities to the construction sector that is responsible for the actual application of physical measures to buildings. Moreover, the construction sector itself is struggling with negative effects of its inherent fragmentation, causing disadvantages such as miscommunication, long lead times and extra costs and it hampers innovation (Davey-Wilson, 2001). The existence of this fragmentation in the construction sector can be clarified by the pivotal position of a building, between a network of stakeholders (owner, user, financer etc.) on the demand side and a network of actors (designer, contractor, industry etc.) on the supply side (Vrijhoef, 2011).

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Moreover, both the demand- and supply side networks have their own fragmentations. For the demand side, this is caused by the different natures of the stakeholders, the owner wants a building that meets the needs of the user, the financer wants a certain return on investment, etc. For the supply side, this is caused by the need for specialisation, necessary for enhancing competitiveness (Dulaimi et al., 2002) in a market-driven environment (Figure 1). Literature has shown that there are developments in the decrease of fragmentation in construction. On the supply side, efforts have been made to bring about better integration, by adopting a partnering approach (Bygballe, 2010) in order to align the differences in goals and values, that originate from the present procurement methods and contracts (Bresnen and Marshall, 2000). However, the current partnering approach is criticized as being primarily a dyadic approach, between principal and construction company, not taking into account other actors in the supply chain (Dainty et al., 2001). Literature on public administration has elaborated on the increasing importance of network governance (Meuleman, 2008), which can be considered a sign of integration by the demand side. The interconnection between actors of the two systems in a multistakeholder partnership (Pinkse and Kolk, 2012) can be a promising starting position regarding the implementation of physical climate adaptations to buildings. However, literature on this matter is scarce.

This paper provides a framework for implementing physical adaptations to social housing, therewith contributing to building knowledge on what adaptation means for business, an area that is still in need of theoretical and empirical elaboration (Nitkin et al., 2009). The central question in this paper is: “How to actively involve the construction sector in implementing physical climate change adaptations in existing social housing?”

In the following chapters we will discuss what measures are to be implemented and what the characteristics are of the process to be followed in order to implement the measures. In the concluding chapter, recommendations for the involvement of the construction sector will be given and topics for further research shall be presented.

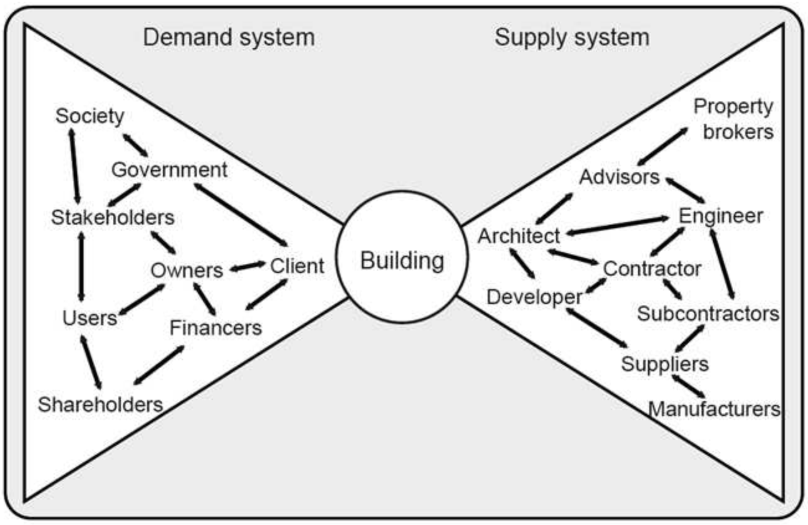

Figure 1: Pivotal position of the building between demand and supply system (Vrijhoef and De Ridder, 2005)

2. Methodology

In order to develop the guidelines on how to shape the construction process involving the construction sector in implementing climate change adaptations, it was important to elaborate on the adaptations themselves, to know what has to be implemented. In addition we elaborate on the rehabilitation intervention process in order to retrieve information on what has to be done to actually implement the measures.

For the adaptations we have taken as a base a list of 155 adaptation measures for the built environment in the Netherlands, drawn up by MWH (2011) under assignment of the Dutch Ministry of Infrastructure and environment, based on literature review and expert judgments (MWH, 2011). The measures on the list focus on the potential of newly built dwellings. However, as the production of new dwellings represents on average 1% of the total stock (www.cbs.nl), taking into account a horizon of 2050, this means that around 40% of the stock will be renewed by then, assuming that all new dwellings substitute old ones. For the Netherlands it is more likely that only half of the newly built dwellings serve as replacement of the stock, while the other half is meant to extend the stock. But even if we assume that all new buildings substitute the existing ones, still 60% of the stock has to be adapted in the existing situation, which also goes for housing associations. Whereas new building provides possibilities to implement climate adaptations at relatively low costs and effort, according to the list by MWH (2011), the existing situation may be different. As this is not elaborated in the original list, we have evaluated the measures for the existing situation.

If we look well at the climate change adaptation measures it turns out that they can be considered as technical modifications to a dwelling, in this case focusing on adaptation to a changing climate. In essence, the measures do not differ significantly from other technical measures that are applied for a special purpose such as energy efficiency or burglary safety, to name a few. For instance, in order to improve energy efficiency, technical measures such as adding an insulating material to the façade are applied, and in order to improve the dwelling's burglary safety existing door locks are substituted for locks that are more difficult to break. In the case of the insulation material, research and development by industry has resulted in a material with good insulating and application characteristics, whereas in the case of the door locks research and development by industry has resulted in locks that are difficult to falsify or are made out of a strong material (alloy) that is difficult to break. In our case, research on climate change adaptation measures has resulted in the measures as brought together in the list by MWH (2011) that make a dwelling more climate resilient.

In this paper we are not focusing on the technical quality of the measures, such as insulation capacity, strength of alloy or the contribution to climate resilience, but we are focusing on the process leading to the implementation of a measure. For this reason we have taken as an example two processes to implement technical measures to dwellings; the first process deals with the implementation of energy saving measures and the second deals with the application of safety measures to the dwelling to obtain the 'Police Label Safe Housing'. The two case descriptions are based on observations by one of the researchers during his four years employment at a housing association in the real estate management department.

3. Physical adaptations

The physical climate change adaptations known to date that can be applied to the Dutch social housing stock are mainly focused on heat, especially the urban heat island, and water nuisance, caused by increased levels of precipitation and river/sea flooding (PBL, 2009). The 155 adaptation measures for the built environment drawn up by MWH (2011) have been elaborated on many characteristics, but for the purpose of this paper we only present the ones that show differences between the new built situation and the existing situation, being application costs and the intensity of maintenance. The measures are collected in a database, which is accompanied by a factsheet for every measure. The factsheets contain information on the characteristics as described above, and have a short description of the measure, the interrelationship with other measures and references to literature.

Before discussing the measures for the existing situation, we will give an overview of the set of measures for the new built situation that are focusing on the level of the building and the building plot (table 1). These measures are considered to be within the responsibility field of the housing associations. Out of 155 measures, 46 focus on the building and plot level. The nature of the measures can generally be considered as having limited extra costs of application, if combined with regular work. Of all measures, 72% falls within this category. 17% is considered to have an equal or lower price, whereas 7% is more expensive than a conventional measure. 4% of the measures cannot be combined with regular measures, so they cannot be assessed on their application costs. Most measures (72%) are expected to have the same maintenance intensity as conventional measures, represented by the ‘+/-’, but 24% has an increased maintenance intensity and 4% requires less maintenance.

Taking the list of MWH (2011) as a base, filtered for the measures on building level and building plot, we have evaluated the feasibility of application of the measures. Here, some significant differences appear. First of all, it becomes clear that measures do not have such low application costs as the new built situation, which is shown by the 33% of the measures with the ‘-‘ assessment (newly built 7%). This is mainly caused by the fact that in the existing situation the adaptations have to be designed especially for the situation. Some measures are not even possible to compare, because they cannot be applied to the existing building, for example the orientation of the building cannot be changed. This argument holds for 28% of the measures. Another 30% of the measures has limited extra costs (< 1,000€ per dwelling), while only 9% is cheaper than or equal to the existing situation. The general increase of the application costs is caused by the fact that most measures are additions to the existing situation. In the new built situation a climate adaptation measure can be an alternative product with the same price but with other (i.e. climate adaptive) characteristics. For the measures that were feasible in the existing situation (33 out of 46) we have assessed the application complexity, represented in three scales: applicable by tenant or all-round craftsmen from the housing association; applicable by specialized company within 1 day; or applicable by specialized company in more than 1 day. The figure shows many ‘-‘(52%), meaning that the measures are difficult to apply, but not impossible. From the point of view of the housing association, also the maintenance intensity increases in 45% of the measures, compared to the existing situation.

Table 1: adaptation measures on building and plot level (Adapted from: MWH, 2011)

	New			Existing						
Measure	Application costs	Maintenance intensity		Application costs	Application complexity	Maintenance intensity HA		Inconvenience tenant at impl.	Impact use tenant	Window of opp. (per x yrs)
Improvement soil structure, porous sand	+/-	+/-		+/-	-	+/-		-	+/-	13
Heat and cold storage in the ground	-	+/-		x						
Cooling by river water	-	+/-		x						
Shallow subsurface infiltration	+/-	+/-		+/-	-	+/-		-	-	13
More porous pavements in private plots	+	-		-	-	-		-	+/-	13
Green roofs	+/-	-		-	-	-		+/-	+	25
Green façades	+/-	-		-	+/-	-		+/-	+	1
Temporary nature on wasteland	x	+/-		+/-	+	-		+	+	1
Green spaces	+/-	-		+/-	+/-	-		+	+	1
Mediterranean plantation	+/-	+/-		+/-	+	+/-		-	+	13
New vegetation for allotments	+/-	+/-		+/-	+	+/-		-	+	1
Saline crops	+/-	+/-		+	+	+/-		-	+	1
Water storage crates	+/-	+/-		+/-	+/-	+/-		-	+	13
Blue roofs	+/-	+/-		-	-	-		+/-	+	25
Rainwater tank	+/-	+/-		+	+	+/-		+/-	+/-	1
Backwater flap	+/-	+/-		+/-	+/-	-		+	+	50
Shadowing of buildings	+/-	+/-		-	+/-	-		+/-	+	1
Shadowing by trees	+/-	-		+/-	+/-	-		+/-	+	1
Spray systems on roofs and terraces	+/-	+/-		-	-	-		+/-	+	1
Vegetation at inlets of ventilation shafts	+/-	+/-		+/-	+/-	-		+	+	1
Natural ventilation in buildings	+/-	+		+/-	-	+		+/-	+/-	2
Apply insect screens	+/-	+/-		+/-	+	-		+/-	-	1
Architecture (orientation)	+/-	+/-		x						
High albedo material	+/-	+/-		+/-	-	+/-		+/-	+	6
Insulated, heat reflecting buildings	+/-	+/-		-	-	+/-		+/-	+	1
Building without crawl space	+/-	+/-		+/-	-	+		+/-	+	1
Mediterranean construction style	+/-	+/-		x						
Roof overhang	+/-	+/-		-	-	+/-		+/-	+	1
Sleeping rooms on the north façade	+	+/-		+	+	+/-		-	-	13
No sleeping rooms on the upper floor	+	+/-		+	+	+/-		-	-	13
Extra sun blinds	+/-	-		-	+/-	-		+/-	+	1
Pitched roofs	+	+/-		-	-	+		-	+	25
Water in an atrium	+/-	-		-	-	-		+/-	+/-	1
High rise buildings	+	+/-		x						
Double façade	+/-	+/-		-	-	+		+/-	-	1
Closed building block	+	+/-		x						
Buildings partly in water	-	-		x						
Highwater proof building	+/-	+/-		x						
Dryproof construction	+/-	+/-		-	-	+/-		-	+	1
Wetproof construction	+/-	+/-		-	-	+/-		-	+	1
Bridge buildings	+	-		x						
Bank dwellings	+	-		x						
Pile dwellings	+/-	+/-		x						
Rise ground level	+/-	+		x						
Flexible and demountable building	+/-	-		x						
Own back-up system (water, electricity)	x	+/-		-	-	-		+	+	1

An important factor in the existing situation is the tenant that lives in the dwelling, because it is his living space that is being touched. Only 15% of the measures have hardly or no hindrance for the tenant when being implemented. Small and high hindrance occurs in respectively 48% and 36% of the measures. For example, application of less impervious pavements may be a feasible option from a technical point of view, but implementation can imply that a tenant has to restructure his garden completely. In such a case, the inconvenience for the tenant is considered as high. The inconvenience for the tenant during the use period has been evaluated rather positive, 70% of the measures have hardly any or even a positive impact on the use of the tenant whereas small and high hindrance in use occur both in 15% of the cases.

Even though the measures might not be of a high technical complexity, they merely imply an organizational complexity, as the measures have (temporarily) impact on the living quality of the tenant and the strategic management planning. In the last column an indication is given of the 'window of opportunity', the moment to apply the measure with the least financial impact or inconvenience for the tenant. For example, the measure on applying less impervious pavement in the tenant's gardens requires acceptance by the tenant, so in order to apply these measures the housing association either has to convince the tenant of the necessity of the measure, or has to wait until the tenant moves and apply the measure before the new tenant starts to live in the dwelling. Another example is the application of green roofs, which will only be feasible from an asset management point of view when the technical and/or financial lifespan of the existing roof system is reached.

4. Implementation of measures

In order to have an overview of how a housing association has designed its processes to implement modifications to its dwellings, two of these kinds of processes are described. The first one deals with the implementation of measures necessary to obtain the Police Label Secure Housing (PLSH) for a dwelling, a label that fits within the "Crime Prevention Through Environmental Design" reward scheme in architecture and urban planning, which is comparable with the British Secured by Design scheme (Stummvoll, 2012). The certificate confirms that the dwelling fulfills certain requirements to make a dwelling safer from burglary and fire accidents. The second process deals with the implementation of energy saving measures to dwellings. The measures are being applied as a spin-off from the implementation of the Energy Label. This is an indicator for the energy performance of the dwelling, resulting from the regulations set up by the European Union in the EPBD. Housing associations are obliged to provide an energy label at every transaction moment (selling/renting) of a dwelling (AgentschapNL, 2012). The housing association decided to provide the whole building stock with an energy label, which made it possible to use it as input for the strategic portfolio management.

These processes were selected because in both cases the measures are changes or additions to the existing building which are not strictly necessary from a maintenance point of view neither are they -yet- imposed by legislation. So in governance terms, housing associations are not forced to take action within a hierarchic regime; taking action is deliberate, although from different perspectives. The PLSH for existing buildings can deliberately be applied by housing associations, but upon applying the label, the measures are mandatory, otherwise the label is not issued. On the contrary, the energy label is mandatory at transaction moments of the dwellings, but does not require any specific measures to the dwellings, as it only rates the energy performance. Although the two processes of applying measures are not mandatory, they deal with applying measures of a specific theme, which makes it possible to serve as an example of applying technical measures, in our case within the theme of adaptation to climate change.

Within the process of applying measures, the housing association followed a two-step approach in the design phase, as described by Pereira Roders (2007). The first phase consisted of an inventory of the existing situation and the second phase entailed planning and decision making on the measures before going on to the execution phase. In both cases the inventories of the existing situation were carried out by specialists from external consultancy companies. They also gave recommendations on the measures to be applied. After the deciding on the measures by the housing association, specifications were drawn up by a consultant or specialist from the housing association. These specifications had to be interpreted and understood by the construction company and 'translated' for execution works. The interventions to the dwellings were carried out by construction companies. During and after the execution phase, the housing association controlled the quality of the work in order to see if it really received what it asked for: an improved dwelling. What we see in the described cases is that there are many moments where information is transferred from one party to the other, implying risks of miscommunication and failure costs.

5. Discussion

5.1 Generic versus local information

Not only because of the risk of miscommunication and failure costs the implementation of climate change adaptations should have a different implementation process than that of the PLSH or energy label. Climate change adaptations namely differ in characteristics from PLSH and energy efficiency measures in the sense that for the latter group the requirements for the dwellings are generic. They are established theoretically, based on standardized values that are equal for all dwellings over the country, for example the thermal resistance of an outer wall of every dwelling should be 5 m2 K/W. On the contrary, climate adaptations are depending on the situation of the local environment (Pinkse and Kolk, 2012), so knowledge of the local situation is required to apply the right measures. This asks for not only integrating built environment professionals, but also policy makers and scientific community (Bosher and Dainty, 2011). The latter actors are to date highly important because of the relatively newness of the topic and knowledge is still being developed. According to Stone (2012) much information on climate change impact in cities is unknown or difficult to retrieve on national level, as it is in some cases only locally known. This presupposes that the coming years there should be a constant influx of information into the construction process in order to make the building stock more vulnerable. Apart from the expected 'top down' information inflow from scientific research carried out on a local, regional or national level, it can also be actively retrieved from the people living in the neighborhood, using a 'grassroots community based approach' (Bosher, 2012). The involvement of the local stakeholders can create a window of opportunity for applying measures especially if people have already experienced the negative impacts of climate change, for example flooding after heavy rainfall. In many cases action appears to occur only after extreme events have happened (Amundsen et al., 2010). From all perspectives, an integrated process without the traditional barriers between parties and/or phases will enhance free flow of this knowledge between the stakeholders (Bosher and Dainty, 2011).

5.2 Enablers

Housing associations will not apply adaptation measures if they cannot make a good business case or if regulation forces them to take action. In the case of applying energy saving measures, a financial stimulus exists in the process, because saving energy also saves costs. Thanks to the covenant that has been negotiated with the government, housing associations are allowed to increase the rent when the energy label improves (MinVROM, 2008), which provides a direct financial incentive to the housing associations. Moreover, several financial schemes have been in force to incentivize housing associations to take action. For the application of measures prescribed by the PLSH no financial gains can be generated by the housing associations, but still they are willing to apply the measures, thanks to their sense of corporate social responsibility and network pressure by local authorities that want safe neighborhoods in their cities. For some of the climate adaptation measures, a connection can be sought with other actors that can help building the business case. If this is not possible, the most efficient way of implementing the measures has to be sought, preferably by ‘mainstreaming’ them, i.e. combining with other measures (Pinkse and Kolk, 2012). Combined with the sense of social corporate responsibility and the quality improvement of the dwelling, in the sense that the tenants have less hindrance by the impacts of climate change, as much barriers as possible can be overcome.

5.3 The proposed process

When focusing on implementing measures without searching for other actors that can financially help closing the business case, we propose an intervention process that differs from the current situation (Figure 2) where the actors from the design phase are separated from the actors from the execution phase. The main communication instrument in the traditional setting is the document with design specifications, which is drawn up by the design team, confirmed by the housing association and has to be mastered by the execution team. All in all there are many information transfer moments between the actors which leaves a reasonable risk of measures not being applied, because each information transfer moment implies a risk of information loss (Vrijhoef, 2011). The proposed process (Figure 3) is characterized by a more integrated role of the construction sector. Main contractors should not just deliver activities predefined by specifications of housing associations, but in close collaboration with designers, consultants and subcontractors and suppliers they should offer a tailor made answer for a dwelling. The network of supply-side actors operates with full access to knowledge on the one side and requirements of the dwelling on the other side.

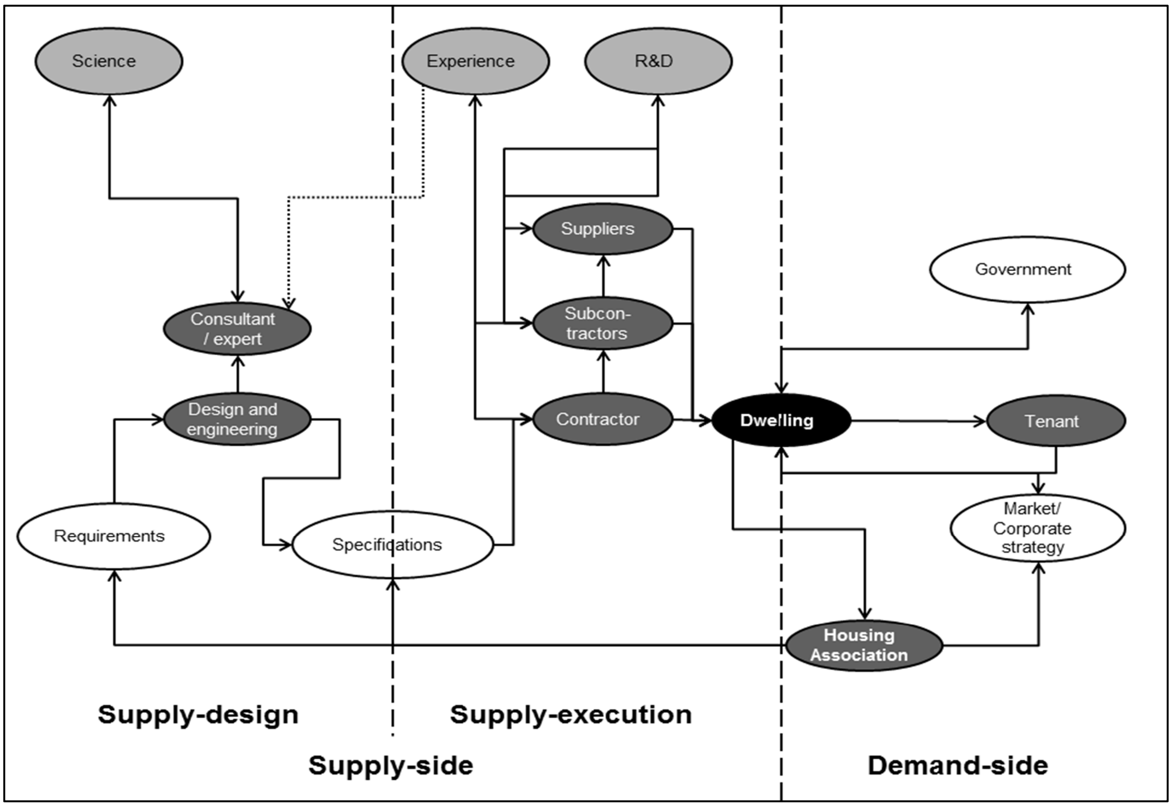

Figure 2: Traditional construction process

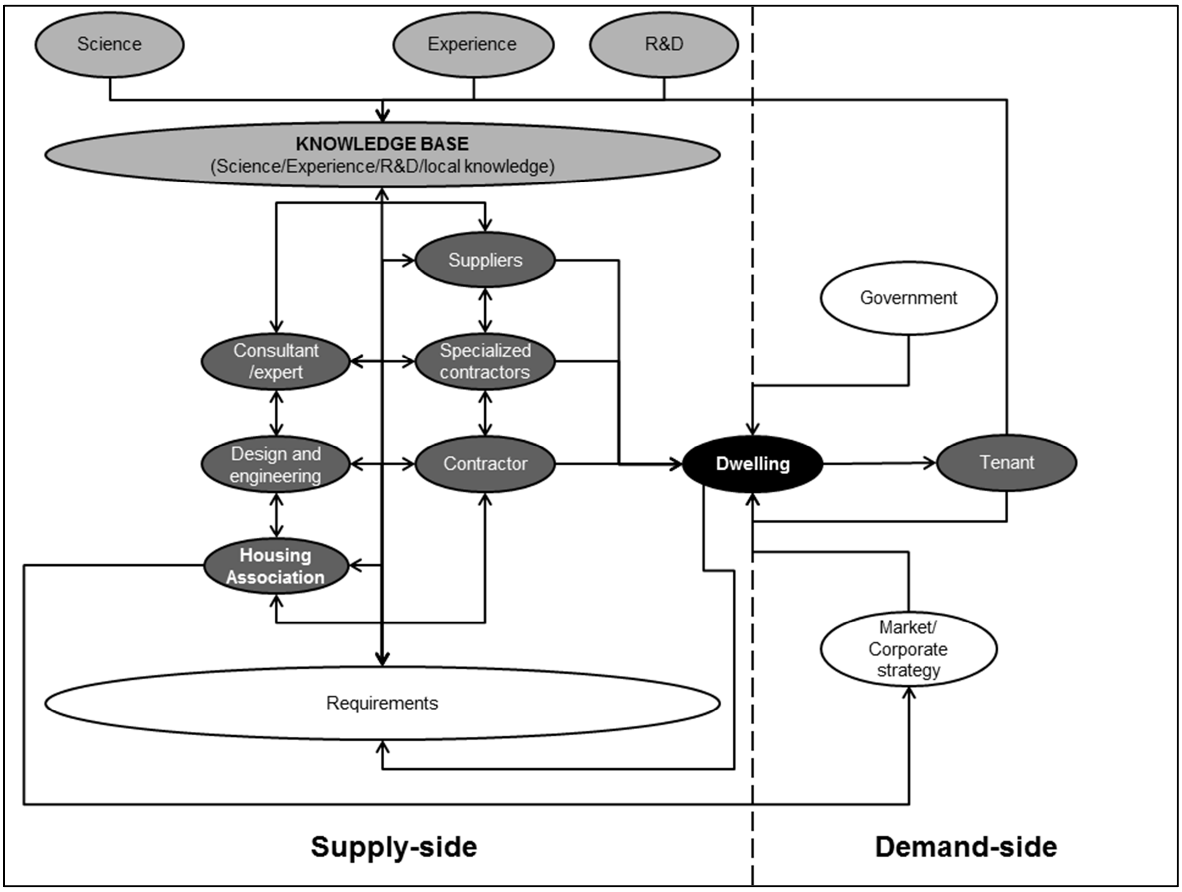

Figure 3: Proposed layout of integrated construction process

In this situation it is the responsibility of the supply-side actors to give a proof of the quality of their bid. In order to be able to offer the best possible solution, the supply-side actors have to know the main requirements the dwelling has to fulfill and to process the knowledge into the rehabilitation intervention. Within the network setting all actors have their own identity which keeps the possibility open to carry out activities individually, without interfering with the goals of the other supply-side members. For example the consultant on the one hand can be working for the housing association providing information on a strategic level, while on the other hand he can serve as a facilitator of knowledge sharing among the supply-side actors, merely for activities on the operational level.

6. Conclusion

The adaptation measures that are available to date are mainly based on newly built dwellings, whereas the renovation sector is becoming more important. In this paper we have assessed the feasibility of measures for the existing building stock. It became clear that the feasibility of measures in the existing stock is lower because of increased investments and maintenance compared to the current situation and implementation causes nuisance for tenants. However, the impact on the tenant during the use period is generally positive. This clearly requests for an efficient implementation process that can take away the implementation complications as much as possible. In order to trace what activities have to be undertaken to implement measures to dwellings we have shortly elaborated on two processes within a housing association that led to the implementation of measures to dwellings. In the case descriptions the increased technical performance is confirmed by a certificate. The use of certificates is possible if the performance is quantifiable and generic for each dwelling, whereas for climate change adaptations there are no normative values possible as the vulnerability of dwellings can differ in every city, even in every neighborhood or street, so no certification system is possible yet.

One could argue that the proposed approach is a very deliberate one, out of the control field of the housing association, especially compared to a traditional construction process and the portfolio approach of the energy label assessments, where the housing association prescribes exactly what has to happen. To a certain extent the housing association is indeed less ‘in control’, but by distilling the requirements of the dwelling that are shaped by: the dwelling itself, local conditions, government and strategies from the housing association, the supply-side actors can together develop a solution for the dwelling, making use of their own experiences and knowledge and those of others. With this process, the application of climate adaptations is framed as a distinguishable quality element within a market setting, which will increase the probability of adoption. However, housing associations have to acknowledge that the climate adaptations are an added value to the dwelling, otherwise they will not reward them. The creation of awareness is clearly a task of the government. Moreover, the construction sector has to be willing to take a proactive role in offering solutions for climate adaptations, developing the project from the beginning together with consultants and the housing association. As the proposed approach is only theory-based, further research is necessary to have its feasibility judged by field experts, and a further elaboration on the relationships between and attitudes of members of the supply chain is needed, for which the existing discourse on partnering and supply chain integration is a valuable starting point.

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