Building Process Organisation Model fit for Innovative Housing Concepts?

Case Study of the Netherlands

I. Kondratenko, B. Jablonska
ECN Energy research Centre of the Netherlands
Efficiency & Infrastructure, Energy Technology in the Built Environment
kondratenko@ecn.nl
+31 224 564346
+31 224 568966

Abstract

There is growing justification and political commitment in Europe to tackle energy efficiency in new and existing buildings, both residential and non-residential. It requires shifting the construction sector towards large scale successful implementation of innovative energy efficient and sustainable building concepts. Nowadays, a number of innovative building concepts exist, to name a few: Very Low Energy, Passive House, Zero-Energy, Zero-Emission, Energy Producing, etc. However, the experience in the Netherlands has shown inflexibility in the behaviour within the traditional building process to allow the necessary changes for large scale introduction of innovative integral building concepts.

This has led to examining the question: *"How well does the building process organisation model in the Netherlands allow the implementation of innovative housing building concepts?"*

Answering this question required to gain specific knowledge of the behaviour of the traditional building process, its characteristics, advantages and disadvantages, phases and actors involved. It also demanded to focus on the nature of barriers within, and on possibilities to overcome identified bottlenecks. Also, examined was the suitability of several selected novel concepts in their opportunities for adapting the building process organisation model and the behaviour of actors within, such as: The Life Cycle Analysis, (including the Whole Building Life Cycle Costing and the Least Life Cycle Costing), The Cradle to Cradle (C2C) Concept, The Living Building Concept and Private Initiatives. This also included recent experiences with building projects implementing these concepts in the Netherlands.

In summary, there are a number of challenges. The traditional building process in the Netherlands is fragmented in nature into successive phases with a strict way of cooperation and division of tasks and responsibilities between actors. There is also a cost / risk approach preventing enabling long-term relationships between possible parties and taking the whole building life cycle and building operational costs into the equation. To overcome these barriers, the way individual phases and individual actors are structured and connected should be re-engineered in a way that enables long-term relationships to be established, and the whole building life cycle and building use operational costs to be taken into account. Novel tendering and contracting strategies are desirable.

Recently there are developments and experiences in the Netherlands with novel concepts (whole Building Life Cycle Costing, C2C, the Living Building Concept and Private Initiatives). The implementation of these concepts is still in an experimental phase, with exact means of implementation in need of further development. The weakness is in the practicability, as it is difficult to translate principles into formal agreements between actors of the building process. Also tools and instruments for real application are missing.

The results of this work also serve as preparatory work for part of 7th Framework Programme project 'Cost-Effective: Resource and Cost effective integration of renewables in existing high-rise buildings'.

Key words: Innovative building Concepts; Building Process, Organisation Model, Behavioural Changes; Very Low Energy Buildings; Energy Producing buildings.

1. Introduction

The Netherlands has, similar to other European countries, committed itself to realising large energy savings in the building sector within the coming decades.
Nowadays, a number of innovative building concepts exist for new and to be renovated buildings, which have a great potential for energy saving. To name just a few: Very Low Energy, Passive House, Zero-Energy, Zero-Emission, Energy Producing, etc. In theory, the built environment can be energy producing within a few decades. But in practice, there seem to be many barriers and inflexibility in the behaviour within the traditional building process organisation model in the Netherlands. This hinders a large scale introduction of such innovative concepts.

The adoption of innovative building concepts such as passive houses in other countries, like Switzerland, Austria or Germany, is much better than in the Netherlands. This is due to many factors: governmental support, financial mechanisms, users' consciousness-raising campaigns for low energy houses, better availability of materials, building products and services, and a different building process organisation model.
It seems the Dutch way of organising the building process differs in many important aspects from the ones in above countries.

This has led to examining the question: "How well does the building process organisation model in the Netherlands allow the implementation of innovative building concepts?" And what behavioural changes are necessary to introduce innovative building concepts on a large scale in the future?"

Answering this required gaining specific knowledge of the traditional building process, its characteristics, advantages and disadvantages regarded the introduction of innovative concepts, phases and actors involved. It also demanded to focus on the nature of barriers within, and on opportunities to overcome identified bottlenecks. Also, examined was the suitability of several selected novel concepts for opportunities in adapting the behaviour of the building process organisation model, such are: The Life Cycle Analysis, (including the Whole Building Life Cycle Costing and the Least Life Cycle Costing), The Cradle to Cradle Concept, The Living Building Concept and Private Initiatives. This also included recent experiences with building projects implementing these concepts in the Netherlands.

The methodology for this work is based on a literature review, experts interviews and own expertise. The acquired knowledge will be further used and expanded within the 7th Framework Programme project: "Resource- and Cost-effective integration of renewables in the existing high-rise buildings (acronym "Cost-Effective"). Within this project, among other things, the building process organisation models in the partner countries will be investigated, as well as the experience with novel concepts. In this way participating countries can exchange knowledge, learn from each other and recommendations can be made. It also acts as a knowledge base to form new models, i.e. alliances in the building process extending over the entire value chain, aiming to overcome the typical problem of fragmentation in the traditional building process and actors working separately with their individually minimised costs and calculated risks.

2. Traditional Building Process Organisation Model in the Netherlands – phases and actors.

An important feature of the Dutch constructional sector is its traditional way of organising the building process. This organisation model is dating from around 200 years ago. Naturally, there have been certain developments over time, but the essence has stayed the same. The present traditional building process organisation model, as explained later in this paper, seems to be too persistent, rigid and inflexible to allow the introduction of innovative very low energy or energy producing buildings on a large scale.

The traditional building process organisational model in the Netherlands has its typical phases and actors involved in these phases. In this study, we have looked at the building process from the entire Life Cycle

approach that means from the very first activities related directly but also indirectly to the building, to the last activities which return the building into the state of raw materials.

The main phases within the building process and the actors involved in them can be defined as follows: Within the Pre-building phase (1.), the preparatory work is carried out and conditions are created which have an effect on the building design and construction. For example, changes in building regulations, knowledge / research development, etc. The following phase, Constructing on paper, consists of several subsequent sub-phases: Initiation (2.), Definition (3.), Design (4.) and Specification (5.). The feasibility study, schedule of requirements and definitive design are elaborated. In each sub-phase, different actors are involved. Constructing in practice is the actual Realization (6.) phase of the project. After the project is realised, the building is (formally and legally) handed over to the principal (client). The construction is then, as concerning the realisation and organisation, finalised.

The User Phase starts when the end users occupy the building. It consists of two sub-phases: After-care and Maintenance (7.) and Demolition and Recycling (8.). In order to consider the entire Life Cycle perspective, the After-care and maintenance phase has been extended with other activities which take place much later but are still related to the same building, like components replacement, refurbishment and renovation. At the end of its lifespan, the building will be demolished and potentially building materials offered for recycling. The loop is closed and the whole cycle can start again, beginning with the Initiative Phase of a new building to be built.

The figure 1 shows the phases within the traditional building process organisation model from the entire Life Cycle approach:

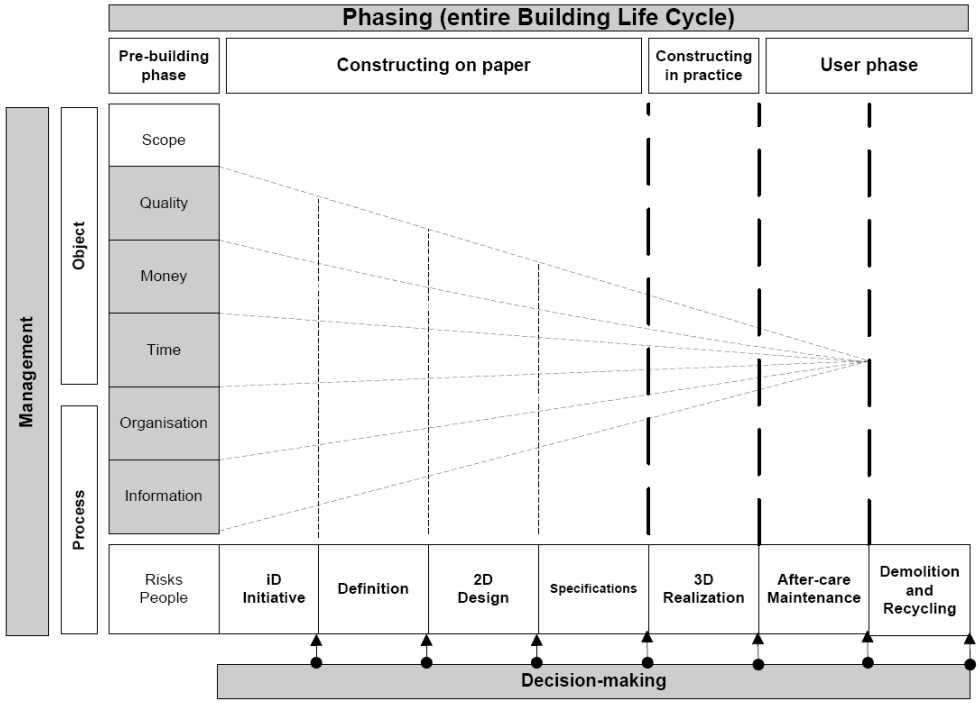


Figure 1: Traditional building process organisation model from the entire Life Cycle perspective. Source: (www.onderwijshuisvesting.nl and ECN)

There are many actors, which play a role within the traditional building process. Some of them have more influence and/or involvement in certain phases than others. Below, the actors are categorised in groups according to the sector or kind of influence.

A. Technology and Science

B. Regulating parties (legislation)
C. Principal / investor (client)
D. Designing parties
E. Executing and supplying parties
F. User parties

The table 1 below shows the involvement of actors in certain phases of the building process. It is obvious that many actors are involved merely in one or several phases and in fact no actor during the entire life cycle of the building process (lead contractors and principals are involved in the most phases, but not in the pre-building process phase end typically not in the part of the after-care and maintenance phase when the building is renovated, and as well not in the demolition and recycling phase). This makes it difficult to reach the optimal cooperation and communication.

Table 1: Division of involvement of actors in certain phases of the building process.

Building Process and Actors

PHASES	1. Pre-BP phase	2. Initiative	3. Definition	4. Design	5. Specifications	6. Realization	7. After-care; Maintenance (Including Refurbishment and Renovation)	8. Demolition and Recycling
ACTORS								
A. Technology and science								
Knowledge Institutes	X		X	X	X		X	X
Market parties	X						X	X
B. Regulating parties								
European Commission	X						X	
Central Government	X		X				(X)	
Province	X	X	X		X		(X)	
Municipality	X	X	X		X		X	X
C. Principal / investor (client)								
Municipality		X	X		X		X	(X)
Housing association		X	X		X		X	X
Property developer		X	X		X	X	X	X
Consultancy or ingeneer agency			X	X	X	X		
D. Designing parties								
Town planner			X	X	X	X		
Architect			X	X	X	X	X	
Consultancy or ingeneering agency			X	X	X	X	X	X
E. Executing and supplying parties								
Main contractor			X		X	X	X	X
Subcontractor						X	X	X
Project site supervisor					X	X		X
Installer					X	X	X	
Manufacturer / supplier					X	X	X	
Utility company					X	X	X	
Enrgy supply company					X	X	X	
F. User parties								
Investor		X	X	X	X			X
Private person (house inhabitant)		X	X	X	X			
Housing association		X	X	X	X			X
Operators							X	X

X - major involvement/influence; (X) - limited involvement/influence

3. Is the Traditional Building Process Organisation Model fit for Innovative Building Concepts?

The traditional building process organisation model creates barriers but also opportunities for a large scale introduction of innovative building concepts in the Dutch construction sector, which would lead to very low energy and energy producing buildings. A consideration of both barriers and opportunities can be seen below.

In summary, barriers relate to:

- Fragmentation
- Tendering
- Division of responsibilities
- Poor communication and cooperation
- Reluctance to take risks connected with innovation

In summary, opportunities relate to:

- open price competition
- good control possibility
- clear process
- risk-free character

The traditional building process organisation is fragmented in its nature with a number of sub processes and parties that carry out only their part of the work. The phases are strictly divided and the co-operation among actors takes place mostly within the phases only. The responsibility for design and realisation is as well completely divided among the parties involved.

The traditional residential building process is also not user driven as there is constant shortage of dwellings on the Dutch market. The client is typically very dominant and in the majority of cases the client is not the end user of the building. A step towards improvement would be when the end user is also the client, or at least represented by the client. Adding to this is the constant scarcity of housing where the user or the buyer has little say in the quality and form of what will be built.

The tendering process and the division between the design and the construction describe the core of the problem. The principal (client) grants the contract nearly always to the lowest tender. Like this, many aspects that should be considered, like building quality, energy use, sustainability, get little attention. This hinders the introduction of innovative ideas.

The principal (client) draws up the so-called Schedule of Requirements up to small details. The contractor has to follow it and carry out the work as described in the Schedule of Requirements.

In the Netherlands, the government typically decides on regions for housing development and selects developers to buy the land and build hundreds of dwellings in one project. The government and the developers are the most powerful parties in the process. In recent times the government has coordinated efforts with local governments and enabling housing associations to act as main players in the housing sector. There are cases where aspirations of tenants or citizens are taken into account.

For the adoption of innovative building concepts into the building process it is very important that the added value in the supply chain will be created for the involved actors. The supply chain should be re-engineered, changing the role of parties as well as involving them much earlier in the project than they would typically be. This would as well improve the communication and exchange of information between parties.

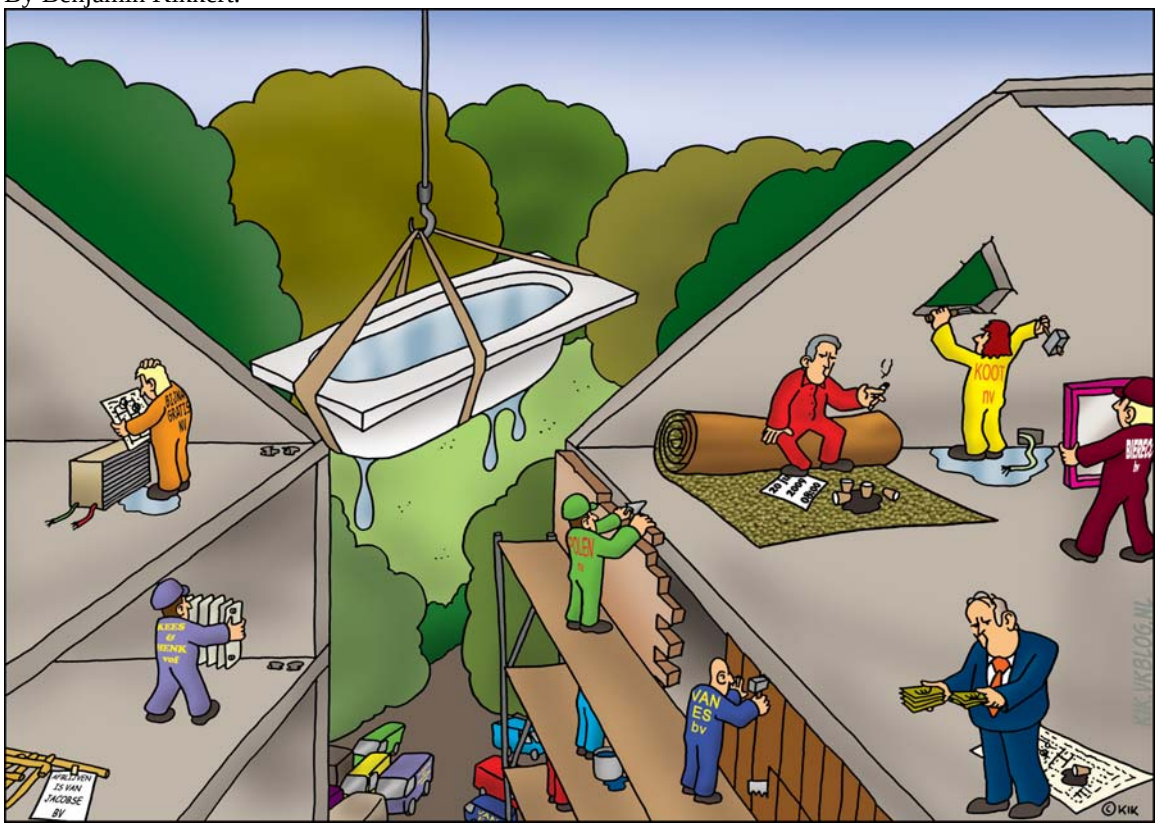
The traditional way of organising the building process has also some advantages, like open price competition, good control possibility for the client, clear process divided in defined and subsequent phases and risk-free character for the sub-contractors (carrying out only routine work and according to the detail

defined Schedule of Requirements). Nevertheless, the disadvantages are in the majority, like little space for innovations, since in most cases the solution with lowest price is adopted and because the builder is not involved at the design stage and his know-how is neglected, unique solutions are undesirable, onetime investments, bad protection of ideas, (it is not secured that the know-how introduced by the sub-contractor or designer when submitting an alternative innovative solution will not be taken over by another party in case he does not get the contract) or the cheapest instead of the best solution. Even though the possibility exists for the contractor to submit an alternative on the design, the limitations are too big, (for example the contractor has to follow into the smallest detail elaborated Schedule of Requirements and the submitted innovative solution must be the best economical option), and since the risks are too high due to bad protection of ideas.

There are two known innovative tendering forms that could tackle some of the bottlenecks of the traditional building process organisation model: 'the building team' (in which a temporarily form of cooperation among the initiative takers, designers and contractors takes place) and 'the integrated model' (integration of design and realisation) (Personal interview Geurts, C. and Sebastian, R. 2009, TNO Built Environment and Geosciences, Delft. There are two kinds of an integrated model: Turnkey model and the Design & Contract model. Both models are little applied in the practice in the Netherlands because the principal (client) is reluctant to reduce their level of control in a project.

The artist's impression of the Dutch traditional building process organisation in practice can be seen in picture below. The fragmentation, lack of communication and co-operation and no space for innovative solutions are evident.

Illustration 1. Artist's impression of the Dutch traditional building process organisation in practice.
By Benjamin Kikkert.



4. Opportunities with Novel Concepts in the Building Process Organisation Model

Recently there have been developments and experiences in the Netherlands with novel concepts aiming to overcome bottlenecks and pave way to re-engineering the behaviour within the building process organisation model and role of actors. Several selected novel concepts were analysed, including their experimental building examples of implementation, and assessed in terms of suitability, opportunities and drawbacks.

The Cradle to Cradle, C2C, theory principles means that "everything will be used again" (McDonough and Braungart 2002). It can be the basis for innovative and sustainable building and larger district developments and urban plans. This requires innovative strategies and the integration of solutions for maximising the use of renewable energy, improving building services and systems in buildings and turning waste output into useful flows.

In the Netherlands the practical implementation towards C2C in buildings and district developments is in an experimental phase. Experience has shown, (Personal interview Kimman, J. 2009, Lector Nieuwe Energie, Hogeschool Zuyd Adviseur Taakveld Energiestrategie en transitie), that changes to the building process organisation model are necessary to enable required novelties in collaboration and relationships between parties to take place. An example is the so called "open innovation project" where traditionally competing parties are encouraged to work together in offering the best solution. Also, the project is defined with a programmatic approach in which decisions and parties engagement in the process are all being part of it, taking care of the overall project results with good knowledge of the whole sustainable concept of the project.

Several Dutch municipalities (Almere, Haarlemmermeer, Venlo, etc.), have become enthusiastic about applying principles of C2C in municipality developments. Projects are under way including a vision for sustainable regional model, a C2C office park, factories that recycle their own waste, and greenhouses for a world flower exhibition in 2012. Also, in the Limburg province (Meuse-Rhine Journal, Sustainability at Avantis 2008), an ambitious project called Tomorrow's neighbourhood is being developed. It involves construction of a zero energy building with the use of new technologies and ideas in an experimental home, office space and an energy innovation centre.

Another of the novel concepts analysed in this study is the Living Building Concept (De Ridder 2008). It is affecting all links between actors in the building process within the entire life cycle of the building, being responsive to changing internal and external conditions. In theory, the concept is fostering changes in behaviour of parties. It gives an opportunity for parties to come up with innovative and creative solutions. Aside from that, the parties have an interest in being involved because they can make a profit on a long term. The main contractor changes the way he builds with the subcontractors, thinking years ahead and accepting the responsibility. The whole life cycle of the building approach and long-term cooperation between parties is used to ensure continued involvement of relevant parties of the building process after project commissioning.

The implementation of the two above concepts in buildings in the Netherlands is still in an experimental phase, with exact means of implementation in needs of further development. The weaknesses of concepts are in their practicability, as it is difficult to translate C2C and LBC principles into formal agreements between actors of the building process. Also tools and instruments to real application principles are missing.

The concept of the inhabitant as a builder, as a way to build one's own house is a new one in the Netherlands, although it may be common in other countries. The regional level government supports these initiatives and has defined quotas of new dwellings to be built with strong involvement of the future owner. This is the so called Private (Collective) Initiative (VROM 2008), that is being introduced by some municipalities and a target to reach a 23% of dwellings built by future inhabitants. The Private initiative is

based on the principle of involving closely the future owner / inhabitants since the very start of the project. A variation of the principle is the so called Collective Private Initiative where several future neighbours actively collaborate throughout the building process of their future dwellings.

In the city of Almere 30% of the newly built houses are built in own management of the users. Advantages of this concept are in giving people more responsibility and involvement from the start of the planning and design, with typically lower final cost between 15-40% than the market price. Barriers for implementation of the concept are limited experience within municipalities, housing associations and project developers. Also, due to shortage on the housing market municipalities are under pressure to build large quantities of dwellings realised by project developers which leaves fewer possibilities for Private (Collective) Initiative. Although the initiative is supported by the government it still represents a small percentage of all newly built houses in the Netherlands.

Including the approach of the Whole Building Life Cycle Costing as an integral part of the building process is important when concerning innovative housing concepts in order to take full account of the benefit of energy and emission savings / energy generation over the whole life cycle of the building. The approach can be used to show advantages of innovative concepts over 'business as usual' approach and to select the cost-effective design alternative over the life cycle of the building. When used, the decision making not only takes initial investment cost into account, but also to operating and maintenance costs and long-term savings. Problems with implementation however are related to uncertainties with forecasts of energy prices, costs and lifetime of building components and materials, etc.

5. Conclusions

The main characteristics of the Dutch traditional building process organisation model are its fragmentation into successive phases involving actors each playing their own role in the process without much communication between them. There is a strict division in the influence, involvement and responsibility of individual actors within different phases of the process, for example between design and construction phase.

Every single detail is described in the Schedule of Requirements by the client who is in dominant position in the process. All parties involved have to follow it and often do not know of other parties involved in the project as there is contracting, sub-contracting and sub-subcontracting. After completing their part, actors are not any longer involved in the project. Building users are rarely, if at all, included as part of the building process.

The housing sector in the Netherlands is not user-driven, and as the social housing represents 37% of the housing stock, it is influenced by the central and local government with housing associations acting as main players. Adding to this is the constant scarcity of housing where the user / buyer has little say in the quality of what will be built.

An exception to this is the (Collective) Private Initiative where end users are involved from early stages in the building process where they can decide about many aspects of their future homes, also taking directly part in the building process management. The initiative is supported by the government but still it represents a small percentage of all newly built houses in the Netherlands.

It should also be mentioned that there are some qualities of the traditional building process such as: open price competition, good possibility for control, clear process with distinct phases and clearly marked risks for actors as they only carry out work as described in detail in the Schedule of Requirements. However, the disadvantages are in the majority, for example: the cheapest instead of the best solution prevails; unique solutions and possible risk with innovative solutions are undesirable, with poor protection of ideas submitted in alternatives on the designs.

So, what can be done to overcome these bottlenecks?

Possibilities are in breaking down the way that individual phases and individual actors are structured and connected in the traditional building process organisation model. In other words, it should be re-engineered in a way that enables many parties to be involved with long-term relationships, e.g. the whole building life cycle and operational costs of the building use are taken into account. This will improve organisation of project teams, flow of information between parties and phases. To enable this, different tendering and contracting strategies are desirable. Instead of specifying and controlling to the last detail, the role of the client should be to specify the functions of the building ('performance oriented approach') and allow parties to come up with best solution, giving room for investments in innovative solutions.

The artist's impression of an improved building process.

Illustration 2. Artist's impression of an improved building process organisation. By Benjamin Kikkert.

Recently there have been developments and experiences in the Netherlands with novel concepts. Several selected novel concepts were analysed, including their implementation and assessed in terms of suitability, opportunities and drawbacks.

The Cradle to Cradle, C2C, concept is well suited to innovative integral building concepts as it requires innovative strategies and integration solutions for maximising the use of renewable energy, improving technical cycles in buildings and turning waste output into useful flows. Changes to the building process organisation model are also necessary to enable required novelties in collaboration and relationships between parties to take place.

The Living Building Concept is affecting all links between actors in the building process within the entire life cycle of the building, being responsive to changing internal and external conditions. In theory, the concept is fostering changes in behaviour of parties. It gives an opportunity for parties to come up with innovative and creative solutions.

The implementation of these concepts in buildings in the Netherlands is still in an experimental phase, with exact means of implementation in needs for further development. The weakness is in the practicability, as it is difficult to translate principles into formal agreements between actors of the building process. Also tools and instruments to real application are missing.

Including the Whole Building Life Cycle Costing approach is important in order to take full account for the benefit of energy and emission savings / energy generation over the whole life cycle of the building. The problems with implementation are related to uncertainties with forecasts of energy prices, costs and lifetime of building components and materials, etc.

The results of this work also serve as preparatory work for the 7th Framework Programme project "Resource and Cost effective integration of renewables in existing high-rise buildings, (acronym: Cost-Effective". It acts as a knowledge base to form new models, i.e. alliances in the building process extending over the entire value chain, aiming to overcome the typical problem of fragmentation in the traditional building process and actors working separately with their minimised costs and calculating risks. It also intends to merge the developments in the field of Life Cycle Costing and building process innovation based on value creation instead of cost-control.

6. Acknowledgements

The authors would like to thank the interviewees Dr. Ir. Chris P.W Geurts, TNO Built Environment and Geosciences, Delft, and Dr. Rizal Sebastian, TNO Built Environment and Geosciences, Delft (a partner of ECN in the Building Future Consortium), for their input as experts in the field of the building process and innovations. In particular for their insight into the nature and specifics of the Dutch building process and Life Cycle Management, shortfalls of some of the novel concepts for the building process organisation and on alternative tendering and contracting. We would also like to express our gratitude to Dr. Jacques T.N. Kimman, Lector Nieuwe Energie, Hogeschool Zuyd, Limburg Province, for his contribution with experience of implementing Cradle to Cradle principles in on-going building projects. Finally, we would like to thank for the support of the Energy Technology in the Built Environment group, E&I Unit, ECN and Benjamin Kikkert, ECN, for the artistic impressions of the traditional Dutch building process in practice and improved.

7. References

De Ridder, (2008). The Living Building Concept.
http://www.livingbuildingconcept.nl.
Donkervoort, R. & Geurts, C. (2006). Grensoverschrijdend vernieuwen in de bouwsector. Delft: TNO Bouw en Ondergrond.
McDonough, W. and Braungart, M. (2008). The Cradle to Cradle Concept.
http://www.mbdc.com
Rossum van, J.P,. Van Ham, J.C. (2003). De (on)mogelijkheden van het traditionele bouwproces. Paper voor het colloquium vervoersplanologisch speurwerk. Delft: TNO.
Sustainability at Avantis. Online article. (2008). Meuse-Rhine Journal.
http://www.meuse-rhine-journal.com/html/Bus_20080114114518.html).
VROM magazine article. Private Initiative (2008). No. 8. p. 16.