

# Housing obsolescence in practice; a pilot study.

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## **Abstract**

*Obsolescence is a serious threat for built property. As an often used demolition motive, obsolescence can be regarded as the last phase of the life span of buildings. From a sustainable viewpoint, life cycle extension is necessary to minimize waste. But there are more considerations to carefully maintain the existing stock. Knowledge about the prevention, the diagnosis and the treatment of obsolescence is therefore of growing importance. In previous research publications we combined the available knowledge about obsolescence in a conceptual model for further research on and appliance in the decision making about demolition. Since evidence based theoretical research references on obsolescence are scarce rare, the model has inevitably an explorative character. As the next step in our research, this paper describes the outcomes of a series of case studies to test and further develop the model.*

## **Keywords:**

obsolescence, life cycle extension, housing management, building performance, decision-making

## **1. Introduction**

Obsolescence is an ambiguous phenomenon. On the one hand there is general understanding that the life span of buildings, like other durable goods, is determined by becoming obsolete with demolition as a necessary end. On the other hand this assertion is not true for monuments and other structures with heritage or other intrinsic values that may not be demolished, nor is it true for empty out-of-service structures on valueless land that no one will demolish.

Knowledge about obsolescence is important because it is a serious threat for built property. Most buildings are immobile, long lasting and capital intensive and have societal and cultural significance. Minimizing or preventing obsolescence is needed to maintain the physical, economic and societal investments involved.

In previous publications we combined the knowledge about obsolescence in a descriptive, conceptual model that was meant for further research on obsolescence and application in decision making about demolition or life cycle extension. Given the limited availability of evidence based theoretical research references on obsolescence, the model has an explorative character. As next step in our research, this paper describes the results of a series of (case) studies to test and further develop the model.

Answers are explored for three research questions:

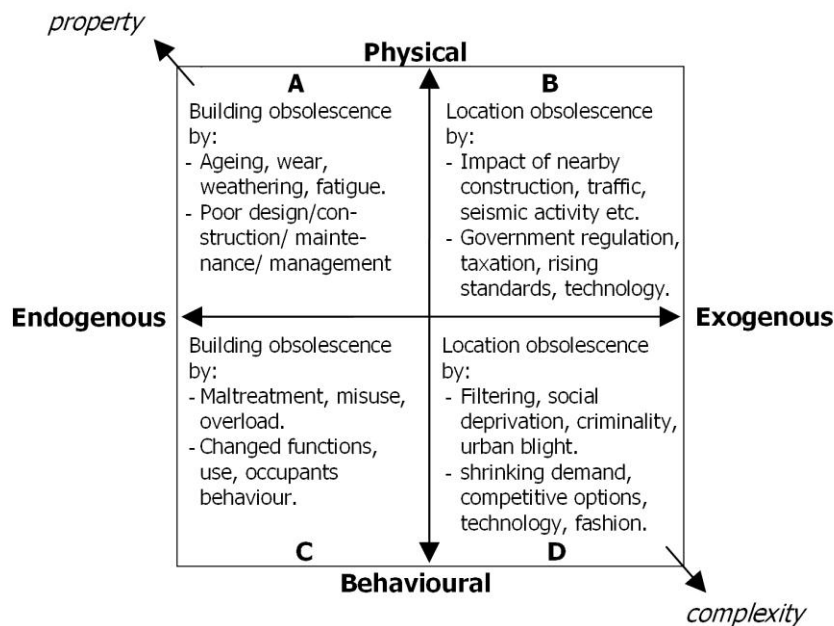
1. What types of obsolescence can be found in the cases; can all found types of obsolescence be classified by means of the conceptual model; is the model exhaustive?
2. What types of obsolescence are most important in the cases?
3. What are the relations between the types of obsolescence in the cases?

The answers are searched for in two ways. The entries to the 2009 and 2011 editions of the National Renovation Award will be used to get a first broad answer to questions 1 and 2 (section 3). The model will also be tested in more detail in case studies of renovation and demolition projects, answering research questions 1, 2 and 3 (section 4). The paper starts with a section explaining the conceptual model and ends with conclusions and discussion.

## **2. Conceptual model of obsolescence**

Obsolescence of buildings can be approached from different perspectives: causes, effects and scientific domains, each with different definitions. In this paper obsolescence is broadly defined as the process of declining performance resulting in the end of service life. Based on the literature on the one hand internal and external factors can be distinguished (cf Iselin and Lemer, 1993) and on the other hand physical and behavioural factors (cf Nutt et al., 1976). Assembled a quadrant matrix can be made as depicted in figure 1 (Thomsen and van der Flier, 2011).

**Figure 1** Conceptual model of obsolescence.



Internal or endogenous factors are related to processes typical for the building itself, resulting in what Baum calls building obsolescence (Baum, 1991). The processes can be physical, like degradation and deterioration over time, caused by ageing, wear and weathering or fatigue of materials and structures, or by poor design, construction, a lack of maintenance and adaptation (quadrant A in Figure 1). They also can be behavioural, like damage by maltreatment, overload, and misuse or by changes in functions, use and occupants behaviour (quadrant C). External or exogenous factors are related to influences from outside, resulting in what Baum calls location obsolescence. These can have physical effects, like the impact of changing conditions in the environment by nearby buildings or infrastructure, traffic, pollution, noise, seismic activity etc., or by changes in government regulations, building codes and fiscal conditions, rising standards and functional requirements and new technologies (quadrant B) They can also have behavioural effects like filtering down and social deprivation processes in the neighbourhood, criminality, urban and planners blight, or like depreciation and loss of market position and value as a result of new technology, changing fashions and user preferences, the availability of better alternatives or simply a shrinking demand (quadrant D). The diagonal line from quadrant A to D depicts the increase of complexity regarding scale and participants and in the opposite direction increase of property based control. The physical factors in quadrant A are relatively uncomplicated and can be well controlled and managed by the proprietor. The mainly use-related factors in quadrant C are more complex and less easily controlled, while the mainly environmental factors in quadrant B are generally beyond control of the proprietor, as well as the highly complex factors in quadrant D. From the opposite direction, threats coming from the exogenous behavioural corner can have very serious negative effects. Where direct control fails, proprietors' responses have to be found in timely anticipation and intervention. Many of the aspects in Figure 1 are interrelated as elaborated in the models of Grigsby et al.(1987) and Prak and Priemus (1986).

### 3. Testing the model with the National Renovation Award

The first test of the conceptual model utilizes entries to the National Renovation Award (in Dutch: NRP). Since 2011 this award is renamed in Gulden Feniks ([www.guldenfeniks.nl](http://www.guldenfeniks.nl)). The NRP was founded in 1985 as a biannual reward for outstanding renovation projects. Renovation was defined as transformation of the physical, functional, financial and architectural characteristics of a building or an estate to realize a comprehensive and useful extension of the lifespan. To support the jury, the submissions were described and classified by means of a given format. The project descriptions and the jury reports offer a knowledge resource for both professional practice and education and are therefore published. The jury characterizes its report as a biannual 'thermometer' for the development of renovation practice (Thomsen, 2001). As topical collection of renovation projects the NRP can be used for the test of the conceptual model. However, there are limitations. The projects have been assembled for specific use, entries to a contest, and are not representative for the total production in the field of renovation and transformation. The larger part of the entries in the dwelling section of the NRP is from the social rented sector while this sector comprises only 30% of the total stock. The main part of the stock, the owner occupied section, is almost missing. However, high end renovation in the owner occupied sector is scarce (van der Flier and Thomsen, 2007). The second limitation stems from the character of the projects as 'best' practices; 'worse' practices are missing.

From the last two editions, 2009 and 2011, information has been collected about 40 and 44 projects before and after the renovation (NRP, 2009 and Gulden Feniks, 2011). The information regards:

- the characteristics:
  - the name of the project and the city where it is situated
  - the building period
  - the building type
  - the size of the project
  - the tenure
  - the status as monument or not
- the type of obsolescence:
  - physical building obsolescence (type A)
  - physical location obsolescence (type B)
  - behavioral building obsolescence (type C)
  - behavioral location obsolescence (type D)

Table 1 comprises the main data about the characteristics of the projects and the types of obsolescence found.

The data about the characteristics of the projects show:

- little change in building period and building type. The distribution in type is the inverse of the total stock. In the total stock 70% of the dwellings are single family and 30% multifamily dwellings.
- social rented dwellings are the larger part of the entries: 80-90% compared with 30% in the whole stock.
- (intended) sale of rented dwellings after renovation (SR>OO) occurs in approximately 45% of the projects; the percentage is not growing between 2009 and 2011.
- the percentage of monuments is stable.

The data about the type of obsolescence show that:

- in almost all projects physical (A) and functional (C) building obsolescence were mentioned. There was almost no mention of physical location obsolescence (B).
- in two third to three quarter of the projects behavioral location obsolescence (D) was mentioned. In 2009 this was made up of insufficient differentiation of type in 25% of the projects and insufficient image in 55% of the projects. In 2011 the figures were 33% and 40%.

**Table 1** Results NRP 2009 and Gulden Feniks 2011 compared

Characteristics	2009		2011	
	Abs.	%	Abs.	%
Building period				
- pre war	13	33.0	17	38.0
- 50-60	5	12.0	6	15.0
- 60-80	22	55.0	21	47.0
Building type				
- multi family	28	70.0	29	68.0
- single family	12	30.0	15	32.0
Tenure-change*				
- SR>SR	18	45.0	18	40.0
- SR>SR+OO	14	35.0	11	25.0
- SR>SR+CR+OO	1	2.5		
- SR>(SR)+CR	1	2.5	3	8.0
- SR>OO	3	7.5	5	10.0
- OO>OO	2	5.0	3	8.0
- CR>OO	1	2.5	4	9.0
Monument				
- yes	12	30.0	11	25.0
- no	28	70.0	33	75.0
Obsolence mentioned				
- physical b.o. (A)	40	100.0	44	100.0
- physical l.o. (B)	2	5.0	0	0.0
- behavioral b.o. (C)	40	100.0	44	100.0
- behavioral l.o. (D)	30	75.0	27	60.0
Total number of projects	40	100.0	44	100.0

\*SR = Social Rent; CR = Commercial Rent; OO = Owner Occupied

Concerning the three research questions it can be concluded that:

- the model is exhaustive / complete in the sense that all types of obsolescence mentioned can be classified
- most important types of obsolescence mentioned are physical (A) and behavioral (C) building obsolescence. That can be explained by the fact that all these projects are renovation projects, the dwellings are at least 25 years old and the decision has been made to maintain them. It can be expected that physical (B) and / or behavioral (D) location obsolescence will be mentioned more in projects where the decision has been made to demolish the dwellings.
- in almost all cases physical (A) and behavioral (C) building obsolescence go together. The detail of the data is too limited to draw conclusions about causal relations between them. To draw such conclusions, projects have to be analyzed in more detail (see next section). The data also show relations between types of obsolescence and building characteristics. There is a relation between behavioral location obsolescence and dwelling type: insufficient differentiation of dwelling type (D) is only mentioned in case of multifamily dwellings. There is also a relation between behavioral location obsolescence and tenure change and dwelling type: in 2009 insufficient differentiation of type (D) is related to sale of multifamily dwellings only; in 2011 insufficient differentiation of type (D) is related to sale of both multifamily and single family dwellings. This trend shows the changing 'business model' of housing associations that have to sell part of their stock to finance renovations.

#### 4. Testing the model with case studies

The second test of the model is using case studies of three renovation and two demolition projects. The renovation cases regard estates from the three periods also distinguished in the NRP data: prewar period; 50-60 period and 70-80 period. All cases are of the social rented stock. This stock is professionally managed and as such presumably trustful information source in this stage of the research. For practical reasons the cases have been picked from the stock of two housing associations: three renovation cases of Woonbron, a large multiregional housing association managing 50.000 dwellings in the Southern part of the Randstad, and two demolition cases of Kennemer Wonen, a midsize regional association with 10.000 dwellings on the coast north of the Randstad.

The first two renovation cases are situated in Delft, the third one in Spijkenisse. All are owned by Woonbron. Woonbron is known for its policy to give new residents the choice to rent or to buy their dwelling ('in Dutch: 'Te Woon'). As large housing association Woonbron manages its housing stock in a professional way. The approach is laid down in the asset management policy. This policy contains objectives about target groups, composition of the stock and quality and price of parts of that stock (neighborhoods or product-market combinations), and measures to realize these objectives. The policy is updated periodically.

### Case 1 Dr Schaepmanstraat e.o (estate 2) in Delft

The city of Delft with 98.000 inhabitants is situated between Rotterdam and The Hague. The housing market is tight due to the presence of large employers like the Technical University, with 17.000 students and 4.500 employees, and related institutions for higher education. The municipality expects the market to be tight in years to come (Gemeente Delft, 2008).

Estate 2 in the Dr. Schaepmanstraat and the Odolphustraat is in the Eastern part of Delft in the neighbourhood Vrijeban. It comprises 65 dwellings built in 1921. 51 dwellings are single family dwellings and 14 are 'double maisonettes' (in Dutch: beneden boven woningen).



A substantial part of the residents lives in the estate for a long time already. A lot of them have improved (the inside) of the dwelling themselves. The estate is popular because:

- it is well situated close to the city centre
- the dwelling type is popular and in Delft scarce
- the price is low: E. 365 for 60-75m<sup>2</sup> (single family dwellings).

In the eighties the facades of the dwellings were insulated from the outside using ISPO. Due to lack of experience with this type of insulation and insufficient knowledge of residents how to handle insulated dwellings large condensation problems and problems with moisture occur. The housing association is now deliberating about the future of the estate. Because of the age and the low rent it is not feasible to solve the problems by removing the old and adding new insulation. On the other hand the dwellings are cheap and quite popular and it is nowadays impossible to construct new ones with the same quality

– price ratio. Therefore demolition in the short term is neither a good option. Another option may be to rent them out as so called do it yourself dwelling (in Dutch: kluswoning) and have the tenants improve the dwelling. Given the on-going deliberations the dwellings will be maintained for at least 10 years (van Hemmen and Winkels 2012).

Based on the case description the three research questions can be answered as follows:

1. The dwellings in the Dr. Schapemanstraat suffer from physical building obsolescence (A). They are 90 years old and do not meet actual requirements on physical quality. The insulation in the eighties was applied wrongly and did not match with the living style of the residents. So it is also an example of behavioral building obsolescence (C). There are no problems related with the physical location of the estate (B). Behavioral location obsolescence (D) is almost absent: the social cohesion is positive and the dwellings are quite popular on the housing market. All the problems mentioned can be classified by means of the model.
2. The main type of obsolescence is physical building obsolescence (A).
3. Behavioral building obsolescence (C) occurred as a result of the type of insulation used. This insulation was applied to counter physical building obsolescence (A).

### Case 2 De Mijerstraat (estate 4) in Delft

Estate 4, the Mijerstraat e.o., is situated in the NW part of the city in the neighbourhood Hof van Delft.



It comprises 75 dwellings built in 1955. 39 are single family dwellings (picture below) and 36 are ‘double maisonettes’ (in Dutch: beneden-boven woningen).

The larger part of the residents already lives in their dwelling for a long time and especially the single family dwellings are popular because:

- the estate is situated in a well-designed neighbourhood close to the city centre
- the dwelling type, single family dwelling, is popular and in Delft scarce
- the prices are relatively low: E 465 for 88m<sup>2</sup>
- the social cohesion is high.

The main problems of the estate are physical. In 1989 the cavity walls were insulated and the window frames replaced by aluminium ones but in a wrong way. This resulted in thermal bridges and condensation problems. In 2009 the policy of the housing association regarding the estate was reconsidered. Given the popularity of the estate and the favourable quality - price ratio the association proposes to extend the life cycle of the estate with at least 30 year. The renovation will focus on the

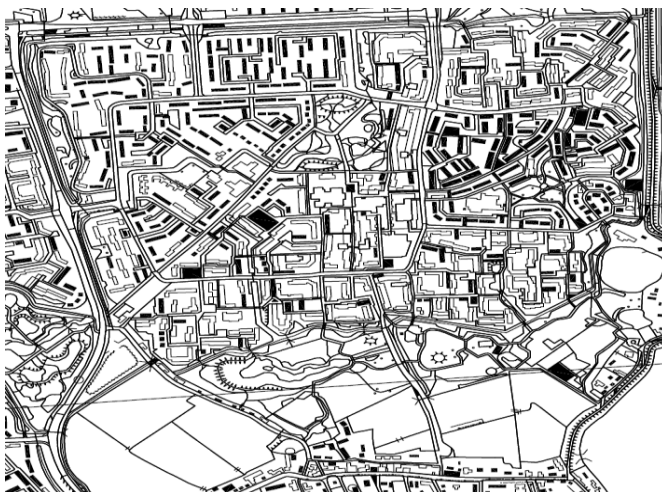


façade and the energy performance, leaving the inside to the residents. After the renovation the dwellings will probably be offered in *Te Woon*, which means that the residents may choose between renting the dwelling and buying it (Koch and Breedveld 2012 and van Hemmen and Winkels 2012).

Based on the case description the three research questions can be answered as follows:

1. De Mijerstraat is a clear case of physical building obsolescence (A). The 60 years old buildings have suffered deterioration due to wear and weathering and a low energy performance. Additionally the mistakes of an earlier intervention have to be remediated. Given the age of the dwellings there will be probably be functional problems (C). These have already been remedied by the tenants themselves or are left to them for the future. There are no problems related with the location (B) of the estate. Behavioral obsolescence is almost absent: the social cohesion is positive and the dwellings are quite popular on the housing market (D). All the problems mentioned can be classified by means of the model.
2. The main type of obsolescence is physical building obsolescence (A). Other types of obsolescence seem to be absent or are left over for the tenants.
3. Only one type of obsolescence is mentioned. There is no relation with other types.

### *Case 3 Snoekenveen in Spijkenisse*



The city of Spijkenisse with 75.000 inhabitants is situated at the South-West border of Rotterdam. It is one of the cities designated in the seventies to act as a centre of growth (in Dutch 'groeikern') and to absorb the growing population of the Rijnmond region. That was part of the national spatial policy to concentrate the growth of the population in a limited number of cities to safe rural areas from uncontrolled urbanization.

Waterland (picture) is one of the districts of Spijkenisse. It was built between 1972 and 1979. It is an example of the so called cauliflower districts (in Dutch



'bloemkoolwijken') because the urban lay-out resembles the inside of a cauliflower. It comprises 3.400 dwellings; 84 % are single family dwellings and around 30% are social rented dwellings. The social rented dwellings are concentrated in six of the thirteen neighborhoods (Giesen et al., 2007)

One of the neighborhoods is called Snoekenveen with 135 single family dwellings built in 1978. In the course of time Snoekenveen saw outmigration of original residents (starting family households) and an immigration of large (often ethnic) households from Rotterdam looking for affordable housing. Originally all of the dwellings were social rented dwellings but Woonbron sold 19 dwellings in the last ten years.

When the asset management policy of Woonbron for Snoekenveen was reconsidered in 2009 a lot of problems were observed: physical problems in the 30 years old dwellings and a low energy performance because the dwellings have not been insulated; the state of the living environment was also mediocre. Besides these technical deficiencies large social problems were detected. Research showed that:

- 85 % of the households lived on some kind of social benefit
- 60% had debts
- 60% had health problems
- 50% did mention nuisance in the neighborhood
- 50% did mention problems with youth.

The presence of large social problems meant that the willingness and ability of residents to participate in renovation of their dwelling was low. That is why the housing association developed a two-track policy (van Dijk en Wuister, 2012):

- the social manager of the housing association started a project 'behind the front door'. This project takes the social situation of the residents as starting point, tries to detect their problems and the causes and helps the residents to contact institutions, which can help them solve the problems. The aim of the project is to help residents solve their problems and to use the contacts with residents to increase their ability and willingness to participate in the renovation project. An example is a check of the energy consumption of the residents and an advice to reduce this consumption and the related costs.
- the technical manager of the housing association started a design and development process with contractors and technical advisors. Objective was to make a showcase of a sustainable and affordable renovated dwelling in the area that was indicated for a first project. The focus in the development process was on proven technology and technology that is not very sensitive for resident behavior to prevent disappointment about energy reduction after realization. The showcase was meant as catalyst and boost for larger renovation projects.

The strategy was successful and created interest for a first project of 21 sustainable and affordable dwellings that was realized recently. The strategy was also successful because it raised interest in other parts of the neighborhood. The objective is to continue this approach in these other parts of Snoekenveen.

Based on the case description the three research questions can be answered as follows:

1. Snoekenveen shows both two types of behavioral obsolescence: changing occupants' behavior (C) and filtering processes on the neighborhood level (D), and one type of physical obsolescence: low energy performance of the dwellings (A). There are no problems mentioned related to the physical characteristics of the location (B). All the problems mentioned can be classified by means of the model.
2. Although there are substantial physical problems in the project the main type of obsolescence is behavioral (C and D): changing use of dwellings related to changing composition of the population.
3. The relation between types of obsolescence is that the social rented dwellings, from which the original residents moved, are allocated to households with large social problems who do not have the ability to and the interest in the upkeep of their living environment. In that sense the behavioral building and location obsolescence (C and D) increase the regular physical building obsolescence (A). Tackling the social problems first became a necessary condition for dealing with the physical ones.

The two demolition cases are owned by the housing association Kennemer Wonen, a regional merger of a dozen local social landlords.

#### *Case 4, Verspyckweg in Bergen aan Zee*

Bergen aan Zee is part of the municipality of Bergen (NH) situated on the North Sea coast 35 km north west of Amsterdam and consisting of 8 separate villages around the town of Bergen with a total population of 30.701 inhabitants. The housing market is tight, due to the superb nature and high quality of the environment, the status of rich sought after residence in the proximity of the northern Randstad and the high property prices (approx. 20% above the level in the region). Bergen aan Zee is a small beach resort typical for the coastal region above Amsterdam with a population of 405 permanent residents, which in summertime can be redoubled. Because of the peripheral location and the lack of shops, services, regular public transport and permanent employment, the housing market of Bergen aan Zee is less tight. The attractiveness of the resort has recently been enhanced by the addition of new expensive townhouses and villas.

The case Verspyckweg consists of 6 single family row houses in the social rented sector, the only ones in the resort, built in 1952. The tenants were originally working class families with children; the relets rate was very low with an average stay of decades. The rent price was relatively low, due to the modest floor space (approx. 70 m<sup>2</sup>) and limited original early postwar quality that has not been updated by renovation or major repairs.

The dwellings were demolished in 2006 to be replaced by new construction, according to the website of Kennemer Wonen in consent with the tenants (Kennemer Wonen, 2012a), but according to one of the last tenants because of the offered opportunity to move to an attractive dwelling or elderly apartment in Bergen town combined with a removal subsidy.



The main motives for the demolition were the poor physical and energetic quality i.e. the absence of thermal insulation, the insufficient noise reducing capacity of the main partition walls, the low quality of the small bathroom (shower) and its location on the ground floor and the poor quality of the timberwork windows, frames etc. suffering from substantial backlogged maintenance. The replacement was motivated by the expectation that the costs of renovation to up to date standards would equal the costs of new construction (Van Grinsven, 2012).

The replacement plan (see below) consists of 2 x 3 single family row houses and 8 apartments in the social rented sector. Up to now, the project is still in the planning state. Due to a disagreement about the rents: category 1 (affordable) as the local authorities demand referring to the demolition agreement, or category 2 (market) as the housing association wants referring to the high expected unprofitability of category 1, plan approval and building permit are still under discussion (Van Grinsven, 2012). Regarding the up scaling of the market category and the number of dwellings it may be discussed to what extent the demolition was motivated by physical obsolescence or by acquiring the land value of the plot.



Based on the case description the three research questions can be answered as follows:

1. De Verspyckweg is primarily a case of physical building obsolescence (A). The 60 years old buildings have suffered deterioration due to wear and weathering, low acoustical and energy performance. Additionally the lack of maintenance or improvement intervention has to be remediated. The modest floor space, poor sanitary equipment and insufficient noise insulation of the dwellings may further have caused behavior related shortcomings (C). To what extent these had already been remedied by the tenants themselves was not traceable anymore. Due to the isolated location there may have been some problems related with the location (B). Due to the same reason, behavior related obsolescence may also have been emergent: the social cohesion was positive but the dwellings tended to be less popular on the housing market. The implicit land and housing market related desirability of more attractive replacement or acquisition of the land value has apparently been decisive (D).  
All the problems mentioned can be classified by means of the model.
2. The main type of obsolescence in this case is ambivalent. Both physical building obsolescence (A) and high expected land value (D) are observable. Other types of obsolescence are to some extent also traceable but less important and partly related to A.
3. There is a relation between the age related physical problems underlying type A and type D.

### *Case 5, Boendermakerhof in Bergen*

The town of Bergen is the largest center of the Bergen municipality. The town is known as an art and fashion center and home to the famous Bergen school of fine arts. The town has a population of 12.400 permanent residents with a substantial addition of tourists in summertime. The housing market of Bergen is extremely tight, with high property prices surpassing the regional level with 25% and a large housing stock, mainly villas, of 1 to 5 million euro.

The case Boendermakerhof consists of 34 small dwellings for elderly in the social rented sector, 16 as single floor row houses and 10 apartments in 2 layers, built in 1957. The estate is renowned because it surrounds the 'Kunstzaal', the workshop of the late Lucebert, the famous multi artist and poet.

The tenants were originally working class elderly couples, later mainly female singles; the dwellings were originally very sought after with a long waiting list and a low relets rate. The rent prices are moderate, due to the small floor space (approx. 50 m<sup>2</sup>) and the limited original early postwar quality that has not been upgraded by renovation.



According to the website of Kennemer Wonen, 26 of the dwellings, 8 of the single floor and all apartments will be demolished to be replaced (Kennemer Wonen, 2012b). The residents will use or have used the opportunity to move to an attractive replacing apartment or nursing home combined with a removal subsidy. The main motive for the demolition is according to the website that the dwellings are 'due for replacement'. In more detail, the underlying reasoning rests on the poor physical and energetic quality and substantial backlogged maintenance. The replacement was motivated by the low quality, the weakening market position and the opportunity to rebuild (Van Grinsven, 2012). Why this does not refer to the 8 single floor dwellings with the same age and quality that will be maintained is not motivated.

The replacement plan consists of 32 new dwellings: 8 single family and 18 apartments in the social rented sector; 4 semi-detached houses are planned for commercial development on the land of an adjacent flattened workshop. Also in this case, disagreement about the rents: category 1 (affordable) as the local authorities demand, or partly category 2 (market) as the housing association wants, to cover the high expected unprofitability of category 1, delayed the decision making (Van Grinsven 2012). Regarding the up scaling of the market category of a number of the dwellings it may be discussed to what extent the demolition was motivated by physical obsolescence or by acquiring the land value of the plot.

Based on the case description, the three research questions can be answered as follows:

1. De Boendermakerhof is primarily a case of physical building obsolescence (A). The 55 years old buildings show physical shortcomings due to ageing, low energetic and acoustical performance and lacking improvements. The outdated physical quality may be expected to have caused behavior related shortcomings (C) but this is not mentioned by landlord or residents. No locational (B) or housing market related reasons are mentioned, except the implicit land and housing market related desirability of more attractive dwellings and acquisition of the land value (D).

All the aspects mentioned can be classified by means of the model.

2. The main type of obsolescence in this case is ambivalent. Both physical building obsolescence (A) and high expected land value (D) are detectable.
3. There is an obvious relation between the age related physical problems underlying type A and type D.

## 5. Conclusions and discussion

### *Questions and limitations*

In this paper a first test is conducted of the conceptual model developed in a previous paper. The test was guided by three research questions:

1. What types of obsolescence can be found in the cases; can all found types of obsolescence be classified by means of the conceptual model; is the model exhaustive?
2. What types of obsolescence are most important in the cases?
3. What are the relations between the types of obsolescence in the cases?

Two sources have been used to answer the questions: the entries to two editions of the National Renovation Award (NRP) and five cases of renovation and demolition projects of housing associations. The sources limit the significance of the results. They only regard projects of social rented dwellings and the stock and the asset management policy of only one large and one midsize housing association. Another limitation is the source of the information: both the information about the NRP projects and the cases come from professionals: architects, officials and employees of housing associations. Information from (former) residents has only incidentally been collected. It can be expected that residents will stress other types of obsolescence than professionals.

### *Answers*

Summarizing the data of the NRP and cases, the table below can be made.

	Obsolescence:		
	types found	main type	relation
NRP	A + C + D	A + C	?
Dr Schaepmanstraat, Delft	A + C	A	A → C
De Mijerstraat, Delft	A + (C?)	A	No
Snoekenveen, Spijkenisse	A + C + D	C + D	C + D → A
Verspyckweg, Bergen a/Zee	A + D + (C?)	A + D	A → D
Boendermakerhof, Bergen	A + D + (C?)	A + D	A → D

Based on the assembled data research questions 1 and 2 can be answered as follows. The results of the NRP show that all types of obsolescence mentioned can be classified. Probably due to the fact that the NRP concerns projects where the decision has been made to renovate the dwellings physical building obsolescence (A) and behavioral building obsolescence (C) have been mentioned in all the cases and seem to be the main type. In the larger part of the NRP project behavioral location obsolescence (D) has also been mentioned: insufficient differentiation of dwelling type and image. Physical location obsolescence (B) is absent. The case studies show partly the same results; all the types of obsolescence mentioned can be classified. Physical building obsolescence (A) is always present. Behavioral building obsolescence (C) has usually been mentioned or (implicitly) referred to. In some cases behavioral location obsolescence (D) has been mentioned. Physical location obsolescence (B) is absent again. The implicit reference to behavioral building obsolescence in one of the Delft cases can

be explained by the tight financial resources of the housing association combined with the objective to keep investments and consequently rents low. Due to these reasons behavioral building obsolescence (C) and countering it by improvement of the functional quality is not mentioned and / or left to the tenants to act upon. In the demolition cases behavioral building obsolescence is probably absent because it is subordinate to physical building obsolescence and behavioral location obsolescence. Snoekeveen is an exceptional case because social problems are in the forefront.

The answer to research question 3 is that the NRP shows that in most cases physical (A) and functional (C) building obsolescence go together. However, the detail of the data is too limited to draw conclusions about possible causal relations between them.

The case studies show that physical building obsolescence (A) sometimes leads to behavioral building obsolescence (C) and particularly when the physical building obsolescence is not taken care of in a proper way: inappropriate insulation leads to living problems. Again Snoekeveen is remarkable because it shows that social problems can increase physical problems because they prevent an effective approach of physical problems. The case studies also show that physical obsolescence (A) can lead to locational obsolescence (D), depending on the land value and the opportunity to rebuild.

Together the results reflect the new business model of housing associations. In this model they cannot rely on subsidies and have to finance investments themselves. In the renovation cases this can be found in the sale of a part of the dwellings after renovation; in the demolition cases it can be found in the decision to demolish and rebuild in higher market categories to capture the land value.

### *Significance and next steps*

The research shows that the model can be used to describe the phenomenon obsolescence. It is also useful as it shows different types of obsolescence and to some extent the relation between them. However, the information base has to broaden. The number of cases is limited and all the cases are from the social rented sector. To broaden the information base case studies of other parts of the stock should be conducted. Also the problems mentioned by the residents should be part of the data collection to see if they focus on other types of obsolescence. The broadening of the information base could further shed more light on the relation between types of obsolescence and the decision that is made about the future of the project: life cycle extension or demolition.

A challenge is also to (try to) convert the descriptive model into an explanatory one. To be explanatory the model has to become more operational and detailed. The current model distinguishes between four types of obsolescence in a rather crude way. To be more operational the model should make use of standards laid down in building and planning regulations and common management methods and tools. To make physical building obsolescence (A) more detailed the distinction of the Dutch Building Code could be used i.c.: health, safety, energy performance and usability. This can also be applied for quadrant B where a distinction could be made between environmental obstacles as (absolute) nuisance because of traffic, works or mills in the environment and (relative) nuisance because of distance to amenities and services and formal hindrances like changing zoning plans. Obsolescence in quadrant C can be specified for the dwelling itself, the accessibility and the internal and external common space of the estate. Also figures extracted from maintenance data and methods to assess behavioural location quality like the Dutch LEMON (liveability monitor) can be used. Quadrant D can be operationalized by housing market monitoring data about popularity of the dwellings related with building type, tenure, price quality ratio and image and popularity of the neighbourhood.

Elaborated in this way the model can become more useful to understand building obsolescence and prevent it. That is important to maintain the large physical, economic and societal investments that are 'stored' in the built environment.

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