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HOUSING PATHOLOGY; TOWARDS A HOLISTIC PATHOLOGICAL APPROACH OF RESIDENTIAL BUILDINGS

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ABSTRACT

Housing pathology is the holistic approach to identify, investigate and diagnose housing deficiencies, specify preventive measures and remedial interventions and evaluate their effects. In analogy with health as the core condition for the quality of human life, the health of housing accommodations stands for housing quality, being the ability of residential buildings to fulfil adequate shelter for specified groups of residents.
The relevance of housing and building pathology as a relative new knowledge field lies in the paradigm shift from new construction to maintenance and adaptation of the existing housing stock that occurs in most western countries, but also in the fast growing urban areas in developing countries. To maintain the fast ageing housing stock in developed countries as well as to shelter the growing population in emerging economies in a durable and sustainable way, the service life span has to be optimally extended. The impending assignment to reduce the ecological footprint and CO2 and N2 emissions of the construction and housing sector – also a major paradigm shift - requires major adaptations of homes and services as well as of the mindset and behaviour of builders, managers and residents. For the implementation of the Paris Climate Action Agreement, knowledge based sustainable stock management and adaptation will be indispensable.
Though it is the combination and interference of technical, social, spatial and economical processes that is determining for the health and life span of housing stocks, they are hardly interdisciplinary studied nor integrated in practical knowledge, let alone in a pathological context. The existent theoretical and applied knowledge about the different fields of housing stock management – in particular life span, life cycle and quality condition management is up to now too limited and segmented to successfully fulfil the new assignments. Rearrangement in a comprehensive pathological domain appears as an obvious solution.
This paper defines and explores the knowledge the knowledge required for the coming assignment, overlooks the available knowledge and shortcomings, the field of application, the main diagnostic tools and instruments and the practice in housing management. The paper concludes with the necessity of better holistic, building type and behaviour directed pathological knowledge and further international interdisciplinary research cooperation.

KEYWORDS: building pathology, housing quality, housing management, life cycle management, sustainability.

1. INTRODUCTION

What will be - and should be - the future of our (residential) buildings stocks? Though this question urges for answers the knowledge to do so is not sufficiently available.
After a century of unprecedented building production during which the housing stock in most countries was multifolded, the construction sector is undergoing a fundamental paradigm shift from mass new construction to maintenance and adaptation of the existing stock [1]. While new construction in most

western countries has faded down below an annual production of 1% of the existing dwelling stock and far below [2] [3], these existing stocks are ageing fast, facing deficiencies and shortcomings and large parts do not satisfy residents needs and preferences. As at the same time new assignments to reduce the ecological footprint, in particular CO2 and N2 emissions are knocking on the door[4] [5] and the implementation of the Paris Climate Action Agreement, – also a major paradigm shift the magnitude of which is not even sizeable [6] - the focus has to be shifted to life span extension by renovation, adaptation, transformation, reuse and recycling. Notwithstanding the growing awareness of this huge assignment - and the fact that the total lifetime costs of maintenance and use of a building amount to a multiple of the initial construction costs [7] - the mindset of the building construction and development sector is still mainly focussed on new construction and (re)development. Compared with the knowledge and research investments in new construction, those in management and adaptation of the existing stock are still small and – also due to the deficiencies stated below - insufficient for the coming assignment.

1.1. Relevancy: Why housing pathology?

With the above in mind, the relevance of housing pathology as a relatively new knowledge field within the broader field of building pathology is manifold. Residential buildings count for the vast majority of the total building stock. Their specific character, social and economic significance and the abundance of available – be it segmented - knowledge justify a special building type specific holistic approach, enabling a better diagnostic insight in the performance and quality development of residential buildings, a better more efficient, effective and sustainable management and a reduced ecological footprint by more energy-efficient and more durable residential stocks.

1.2. Research questions, methodical approach and content

The research questions underlying this paper are:
1) What are the research objectives and assignments regarding the future of residential building stocks?
2) What kind of knowledge is essential to answer these assignments and which shortcomings occur?
3) What is housing pathology and to what extent can it cover these research needs and shortcomings?

The answers to the research questions are mainly obtained by literature search, case studies and interviews.
This paper stands on the shoulders of earlier publications [8] [9]. This first section introduces its objectives and relevance, answering research question 1). Section 2 contains an inventory of the research assignment, the required knowledge and shortcomings, answering research question 2. Section 3 defines the knowledge domain of housing pathology and its applicability, answering research question 3. Section 4 concludes with an outlook on further development.
To limit the length of the paper only the key references are included.

2. THE IMPENDING ASSIGNMENT

The implementation of double paradigm shift as described above consists of the following main assignments:
- Sustainable management of the existing housing stock;
- Reduction of the ecological footprint of building construction;
- Elimination of environmental harmful emissions.

Although interlinked, they involve the following associated interventions, research tasks, required knowledge and shortcomings.

2.1. Sustainable management of the existing housing stock

The only way to reduce the ecological impact of building construction and land use is minimizing new construction by sustainable use and management of the existing stock. Keyword for that is lifespan

extension, by careful maintenance, refurbishment, renovation, adaptation, transformation, reuse and finally recycling. Although new additional and/or replacing construction will remain indispensable for a long time, it should only be allowed if the ecological effect is proved to be better.
This approach requires broad knowledge and research about the nature, health, life cycle and life span of residential buildings, in particular the underlying processes of ageing and decay and the application of associated remedial interventions. As discussed below, this implicates pathological knowledge that can be denoted as housing pathology.

2.2. Reduction of the ecological footprint and elimination of environmental harmful emissions

In addition to sustainable management, the reduction of the ecological footprint and the elimination of harmful emissions represent an additional challenge for the adaptation of existing stock. In addition to broad knowledge of building construction and stock management, it requires specific knowledge and research of material life cycle, energy consumption and use related ecological impact analysis, the underlying causes and effects, and alternative technologies and behavioural strategies and methods to prevent and/or minimize the effects. In the context of this paper it is sufficient to refer to the abundant publications on this subject.

2.3. Required knowledge and shortcomings

Most of the required knowledge is pointed above. In addition to that two underlying basic themes need further attention.

2.3.1. Housing quality

Housing quality can be defined as the extent to what dwellings can fulfil the demand of the residents and secondary of the proprietors or otherwise interested parties [10]. Since housing quality is highly determining for the quality of human life, governments interfere in the housing and building market by means of legislation, enforcement and subvention. But clear standards for what these qualities are - or should be - are hardly available and strongly depending on country and culture [11].
Up to recently, housing quality was usually assessed by an inventory of technical defects and shortcomings. Actual housing management approaches aim at the more holistic question what quality level is needed for maintaining a healthy lifespan of residential stocks [12]. The answer is attempted by, as an example, successively distinguish the market potency, using product-market combinations (PMC's); identify the corresponding physical and functional conditions for optimal performance, using critical success factors (CSF's) and the underlying physical, functional and economic performance requirements [13].

2.3.2. Life span and life cycle approaches

The lifespan of a building - in this paper defined as the useful service life - is a vital variable. In economic terms the life span determines the return on the investment, usually pre-calculated on 50 years for buildings and 75 years for the land. According to a recent expert inquiry however, the expected life span is much longer, 125 years [14]. Reliable data about the real life span of dwellings do not exist. Due to the worldwide construction boom in the last century, housing stocks are so young that the vast majority is still in use and reliable ex-post data about the average life span are not yet obtainable. Starting from an ex-ante approach - the maximal available construction capacity to replace the existing stock - and assuming a constant demand, the minimal required service life varies to date from 200 years (NL) to over 1000 years (CH, GB). As the real replacement rate is substantially lower, the minimum necessary life span has to be consequently much longer.
In the past decades, a range of scholars studied the life cycle of buildings and developed various models and approaches. Fig. 1 shows a frequently used model [15] [16]. To date, none of these models and approaches covers all relevant cause-effect processes nor links the included variables to empiric data. Empirical knowledge about the lifespan of buildings is limited. Though life span

data are the core of nowadays LCA based sustainability assessments, a recent study shows that the basis and substantiation of these data are faulty and basically a rough guess [17].

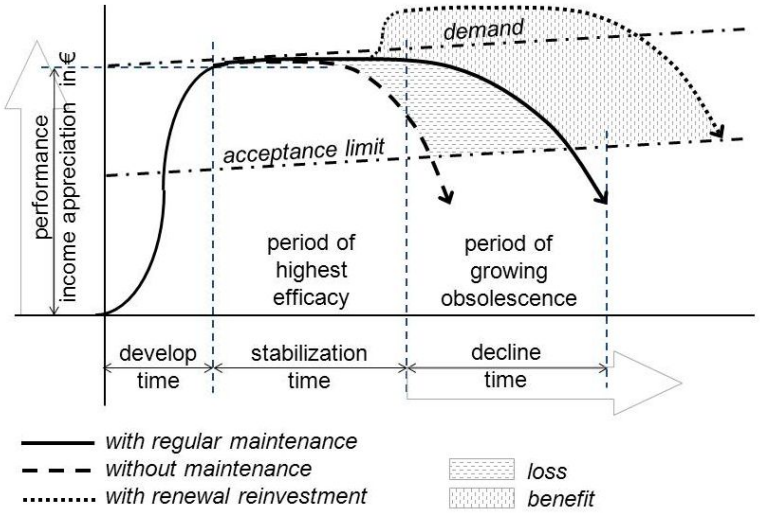

Figure 1: Real Estate Project Life

2.4. Holistic and building category specific approach

Though it is the combination and interference of technical, spatial, economical and behavioural processes that is determining for the health and life cycle of building stocks, it is remarkable that these fields are up to now hardly interdisciplinary studied in a pathological context. This is particularly true for housing stocks [18]. The existing research sources from the last decades show a wide variety of research domains about all kinds of aspects in the housing field, mainly case studies; but theoretical sources are rare, the knowledge is segmented and exchange and cooperation, in particular between the technical and behavioural domains, is little [18] [10].
While the aforementioned paradigm shift is well under way, the knowledge about how and when to successfully maintain a healthy housing stock has still a way to go. Buildings are man-made artefacts, their life cycle and lifespan are determined by human behaviour and decisions. Although ageing and decay are generally characterised as physical processes, their causes - most often neglection of maintenance and repair - are more behavioural than physical; and demolition is rarely due to technical failure but usually to economic opportunity [18]. The understanding grows that implantation of the new assignments are only partly related to physical problems and solutions and solving them requires more than bricks and mortar. To understand the problems that are facing us holistic i.e. integrated interdisciplinary approaches are indispensable. Housing pathology as a new category specific knowledge field may well fill this need.

3. HOUSING PATHOLOGY AS METHODICAL BASE

3.1. Definitions

The term pathology has its origin in the medical science [19] and is generally defined as the systematic study of diseases with the aim of understanding their causes, symptoms and treatment. Derived from the medical context and similar to its methodical and often forensic practice, Watt defines building pathology, both as a term and as an overall concept, as the holistic approach to understand buildings [20] [21] and consequently building diseases and deficiencies. Building pathology, also referred to as forensic building technology, is a CIB-acknowledged professional knowledge field, generally applied for real estate property owners, insurance companies etc. to assess the causes, remedies and responsibilities in case of serious building deficiencies or disasters.

Housing pathology can similarly but in a broader way be defined as a holistic approach to identify, investigate and diagnose housing deficiencies, specify preventive measures and remedial interventions and evaluate their effects. In analogy with health as the core condition for the quality of human life, the health of housing accommodations stands for housing quality, being the ability of residential buildings to fulfil adequate shelter for specified groups of residents.
The analogy with living beings falls short on one essential difference: Unlike living beings, houses and other buildings are not god given but immobile men made artefacts intended to serve specific needs, and the health and lifespan of dwellings are the result of men's decisions.
Though buildings can physically exist long after being abandoned, the relevant life span of dwellings is the real service life: the period a dwelling actually meets demand [22]. Housing pathology concerns this phase.

3.2. Obsolescence as key issue

As stated above, obsolescence is the main threat for the useful service life of buildings. The control, detection, treatment and prevention of obsolescence is a prerequisite to maintain a healthy housing stock and as such a key issue of housing pathology.
In our recent research, obsolescence is defined as the declining performance of buildings [18] resulting in the end of what Awano [22] calls the service life of buildings. Combining the available knowledge, two main dimensions can be distinguished [23]:

- physical vs. behavioural
- endogenous vs. exogenous

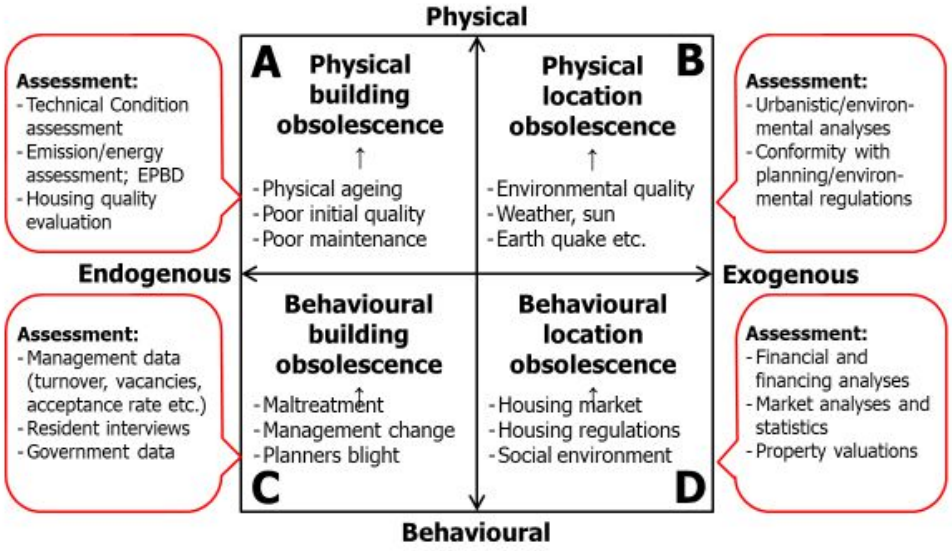

Figure 2. Analytical model of obsolescence

Physical aspects regard the physical characteristics of the building. Obsolescence can find expression in these characteristics, e.g. in defects. Behavioural aspects regard the behaviour regarding the building. Obsolescence can also find expression in the behaviour of users and owners regarding the building, e.g. misuse or declining appreciation on the housing market. Endogenous aspects regard processes related to the building itself. Exogenous aspects regard external processes, e.g. an earthquake that impact on the physical characteristics of the building or on the behaviour regarding the building. Combined, a basic model can be made with four types of obsolescence as shown in Fig. 2 [23].
The model has in principle the potency to enable normative assessment, taken the availability of sufficient measuring instruments. As discussed in the next section the model can be useful as analytic tool for housing pathology.

3.3. Housing pathology, principles and practice

Housing pathology in practice will usually be dealing with performance deficiencies in different stages, varying from the apprehension about or prevention of obsolescence through the identification and cure of serious deficiencies. This practice is as such an essential part of professional housing management and will generally be carried out on a regularly basis to underline management strategies and maintenance plans. Unplanned reasons can be unexpected performance deficiencies and sudden serious quality loss by internal (deformation, leakage, stench, fire, explosion etc.) or external (storm, lightning, flooding etc.) calamities, often in addition with assessment of liability and loss. The latter kind of assessment belongs to the highly specialized field of forensic building pathology and will not be further discussed.
As described above in section 2, the practice of housing pathology can be divided in four basic steps: 1. anamnesis; 2. diagnosis; 3. remedy and cure; 4. evaluation and prevention.
Nowadays housing management practice comprises a wide range of approaches, instruments, knowledge bases and tools, varying from technical performance management to resident satisfaction, liveability and housing market analyses and from policy preparation and decision support to evaluation. Some of these tools are applied on a regular systematic basis, some others only in case there is a special need. In fact they all are in some way related to different aspects and steps of housing pathology; a selection is included in the conceptual model of obsolescence (Fig. 2).
This section describes the four basic steps of housing pathology and the tools and instruments involved.

3.3.1. Anamnesis

The anamnesis consists of the systematic collection of historical and actual data, relevant for the identification of nature and health of residential buildings.
The anamnesis is a vital part of professional strategic housing management. Basic general data are i.e. building and construction type, construction date, location and tenure. It will usually further consist of data about the initial construction, renovation, adaption and maintenance history and the technical, functional and economic/market performance, preceded by formal and legal information, like land register records, building permits etc. Sources are in the first place legal data including land and ownership registration, building, land and use permits with approved drawings, completed with more building and owner specific data about (periodical) quality and safety assessments, EPBD energy labels, guaranty documents, user manuals, etc.; in case of emergent problems completed with additional specific on-site inspection.
Further basis data for the identification are legal data as administered by government agencies, sometimes on a legal basis i.e. the Building File as used in Australia, containing a complete package of building permit, licences with drawings etc. [24]. Similar data sets are used by authorities and agencies in other countries.
Professional property owners like housing associations and real estate companies use comparable data collections, completed with rental administration and management information data including market position, attractiveness, contracts, inspections, resident's modification permits, post use evaluation, maintenance costs, periodical condition assessments and long term maintenance plans etc. (see i.e. [25] and [26]. To date a range of specialised software is available for that purpose, e.g. [27].

3.3.2. Diagnosis

The diagnosis can be described as the systematic search for the nature and possible causes of housing problems, starting with careful analysis of the symptoms found in the anamnesis. In professional practice, the diagnosis follows, as part of the strategic housing management cycle, the analyses of the anamnesis. Thorough knowledge of the symptoms and underlying possible disorders and their causes is an essential prerequisite. As argued above, housing deficiencies are seldom single sided. To serve as a reliable input for possible remedies, the diagnosis should therefore cover all relevant causes of and influences on the central problem, including starting-points for alternative strategies, and excluding hidden biases.

Accurate and objective diagnoses are of vital importance; poor diagnoses can have severe and sometimes fatal consequences. Opportunity driven biased prejudices - not uncommon in the construction and property trade – e.g. leaking roofs should be replaced, damp walls are caused by ill-occupancy, aged obsolete housing blocks should be demolished – entail the risk of planners blight: self-fulfilling authoritative disqualifications, because the accused residents won't bother anymore and few will invest in turned-down property.
Examples of useful analytical are the analytical model of obsolescence as described above (fig. 2) and the Restate diagnostic model, a decision support tool consisting of four consecutive steps with intervention options (fig. 3) [28].

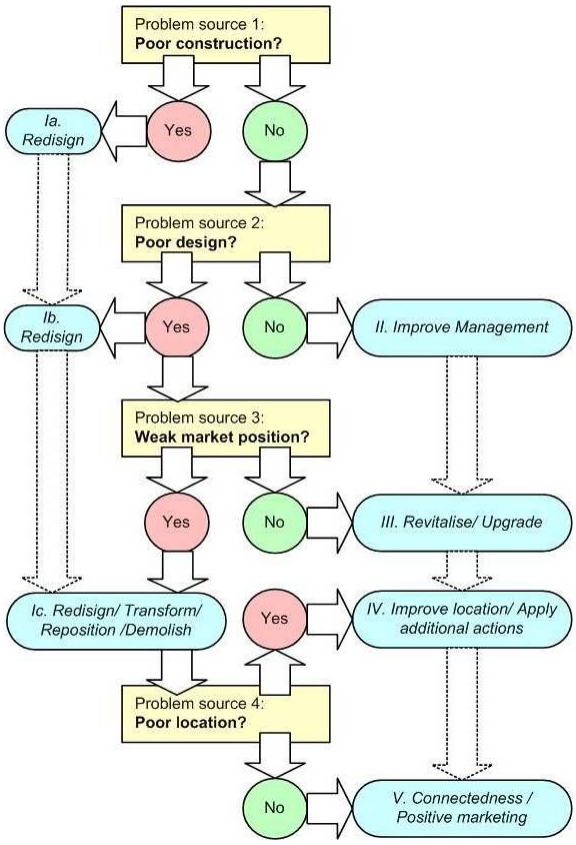

Figure 3. Restate diagnostic model

3.3.3. Remedy and cure

As the Restate model shows, remedial treatments cover a wide array of interventions, varying from technical/physical actions trough managerial and (des)investment.
In the past decades, a growing number of specialized architects, consultants and maintenance companies have focused their expertise on this subject, establishing a new branch and expertise. This professionalization emphasizes the significance of housing pathology as a broad interdisciplinary knowledge domain.

3.3.4. Evaluation & Prevention

Evaluation is of vital importance, as well to check if and to what extend the treatment was successful, as to gain knowledge to be applied for determination and prevention. The analytical models of fig. 2 and 3 are examples of the fruitful results of case evaluations and secondary analyses. Similar extensive case evaluations are aimed at developing preventive 'thermometers' for the health of residential stock and critical success factors (CSF's) as described above. While large scale comparative surveys are of great importance for the development of pathological knowledge, in practice every single dwelling, row or block has its own characteristics, values and weaknesses.

For the health of the housing stock, the knowledge and experience of the direct responsible housing manager, proprietor and/or consultant is essential. As the ability of the building trade to learn from experience is not strong, a growing number of intermediary knowledge and support organisations, often associated with branch organisations of housing associations, owner-occupiers or tenants, are trying to fill the gap.

4. CONCLUSIONS AND DISCUSSION

Housing pathology is in fact not a new knowledge field. As shown in this paper much of the content consists of existing knowledge and practice of professional housing management, including methods and software for anamnesis and diagnosis. New is the combination of the available often segmented and fragmented knowledge in an holistic, all-encompassing and building category specific research domain, enabling and facilitating research cooperation, exchange and discussion.
As a recent inventory of professional practice in the Netherlands showed, pathology based knowledge combined with life cycle costing and sustainable adaptation has become an essential part of nowadays professional real estate portfolio management [29]. Combined with increasing requirements regarding energy efficiency and sustainable life cycle extension, the adaptation and improvement of the building stock will be a huge task and the need for integrated holistic pathology-based knowledge and skills will keep growing.
The inventory in this paper shows housing pathology as a broad, fast growing but fragmented field of existing and knowledge and practice, applied by a range of professionals in the real estate field, but in practice not recognised as a coherent knowledge field within the domain of building pathology. It also shows the need for or a more integrated interdisciplinary research practice and knowledge exchange, being the research objective of this paper.

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Limited to the most relevant basic references. For a full list of references contact the author.

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