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HOLISTIC ENERGY RENOVATION OF PRE- AND POSTWAR APARTMENT BLOCKS IN DENMARK

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Summary

A significant proportion of apartments in Denmark are build during the years 1930-1970. This group of buildings generally have not exhausted their lifetime, but suffer from immense needs for renovation, both regarding energy use and functionality, in order to bring them near to the standards of today.

This paper presents the Danish research project Holistic Energy Renovation, which aims at performing a holistic energy renovation of two case buildings. As part of the project nine parameters for a holistic renovation have been defined, a method for developing and assessing a holistic building renovation is developed, development of products especially for building renovation has been facilitated and all stakeholders, among those the users of the buildings, have been involved early in the renovation process.

The paper presents the preliminary results of the project including development and test of the assessment method and an evaluation of how the holistic perspective has influenced the project process and product development.

Keywords: Energy renovation, apartment blocks, holistic considerations, stakeholder involvement, product development

1 Introduction

In Denmark around 50% of the building stock is built in the years from 1930-1979, which is mainly before the first strict national regulations regarding energy was introduced [1] and in Denmark approximately 30-40% of the total energy use is related to buildings [2]. The buildings considered typically have not undergone a thorough renovation and thus typically use a lot of energy. Furthermore, typically there are also other challenges with some of the buildings from this period such as outdated floor plans, poor indoor

environment or moisture problems and therefore there is a major need for renovation of this stock of buildings within the coming years.

Some examples of successful Danish renovations have been performed and described [3]. However in order to cope with the challenges both regarding energy and satisfaction of the general need for renovation, a holistic approach is needed [4]. In a holistic approach, not only the need for energy efficiency should be taken care of, but also the other areas mentioned need to be considered, as well as the needs of the users of the buildings are a central part.

This paper presents the preliminary findings in the Danish project “Holistic Energy Renovation”, covering the renovation process from the first idea to the development of the main concept. In the project nine overall evaluation criteria for a holistic renovation were defined and subsequently a method for development and assessment of a holistic energy renovation was developed. The project also included participation of manufacturers in order for them to develop suitable products or solutions especially for energy renovation of this type of buildings. As a central part of the project the stakeholders, especially the building inhabitants, were involved at an early stage and throughout the process. Based on the developed method and an extended user involvement the main concept of holistic energy renovation was developed for one of the two case buildings in the project.

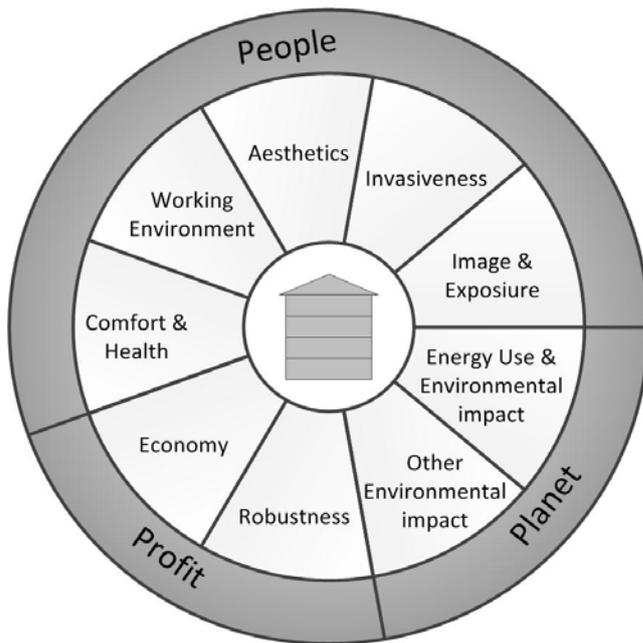
2 Method

Different methods have been used in the project to satisfy the aim of the project. Initially, two case buildings were located based on demands set by the project group, comprising engineers, architects and a knowledge institution. This was to ensure that the buildings were usable for a research project. The buildings have worked as basis for development and testing of the assessment method and the end-users and owners of the buildings have been involved in meetings, workshops and questionnaire surveys. Workshops have also been used to facilitate the product development. This has made it possible for manufactures to discuss and develop products or solutions with input from end-users and other manufactures. Furthermore, an aim of the project has been an early involvement of stakeholders, which has led to a fine dialogue within the project team and between stakeholders.

3 Results

3.1 Project evaluation criteria

As a framework for a holistic energy renovation, nine overall evaluation criteria were defined in the project. These criteria are intended to work as evaluation criteria for all solutions in the project. Initially the project group aligned expectations and prioritised the criteria. This was followed by a thorough review of each criterion, to define them in depth and to prevent misinterpretation. In the figure below, the criteria and a prioritised list can be seen.



Prioritisation of evaluation criteria

1. Economy
2. Energy Use & Environmental impact
Comfort & Health
Aesthetics
3. Robustness
Invasiveness
4. Image & Exposure
Other environmental impact
5. Working environment

Fig. 1 The nine evaluation criteria for the project

The criteria were prioritised to be usable in a decision process and the evaluation of the criteria is preferably measurable. However where this is not possible, a qualitative evaluation is used. Below, some of the evaluation criteria from each of the categories: people, planet and profit, can be seen.

The category “people”, which relates to social aspects, include the following.

Aesthetics – it is underlined that all initiatives related to a renovation is performed with respect to the surrounding environment and that the product development also considers aesthetics.

Invasiveness – the solutions are evaluated with regard to their influence on the everyday life of the inhabitants. In the product development, especially the user interface should be prioritised.

The category “planet” relates to environmental aspects and includes the following.

Energy use and environmental impact – the energy use measured in kWh and the environmental impact measured with CO₂-equivalents should be reduced by the renovation, product development and possibly energy supply.

The category “profit” is related to the economic bottom line.

Robustness – the risk of every initiative regarding indoor air quality, condensation on building parts, degradation, vandalism or the like should be evaluated with regard to user behaviour. The robustness of the products is a focus area in the product development.

3.2 Method Development

On basis of the above described criteria a method for development and assessment of a holistic energy renovation was developed. The aim is that the method should be used both in the design phase of a renovation and after a renovation for assessing the “added value” of the renovation. Every element of the method is considered equally important, however a chronology is proposed. The evaluation will be relative and cannot be used for comparison between buildings. Below the method is presented.

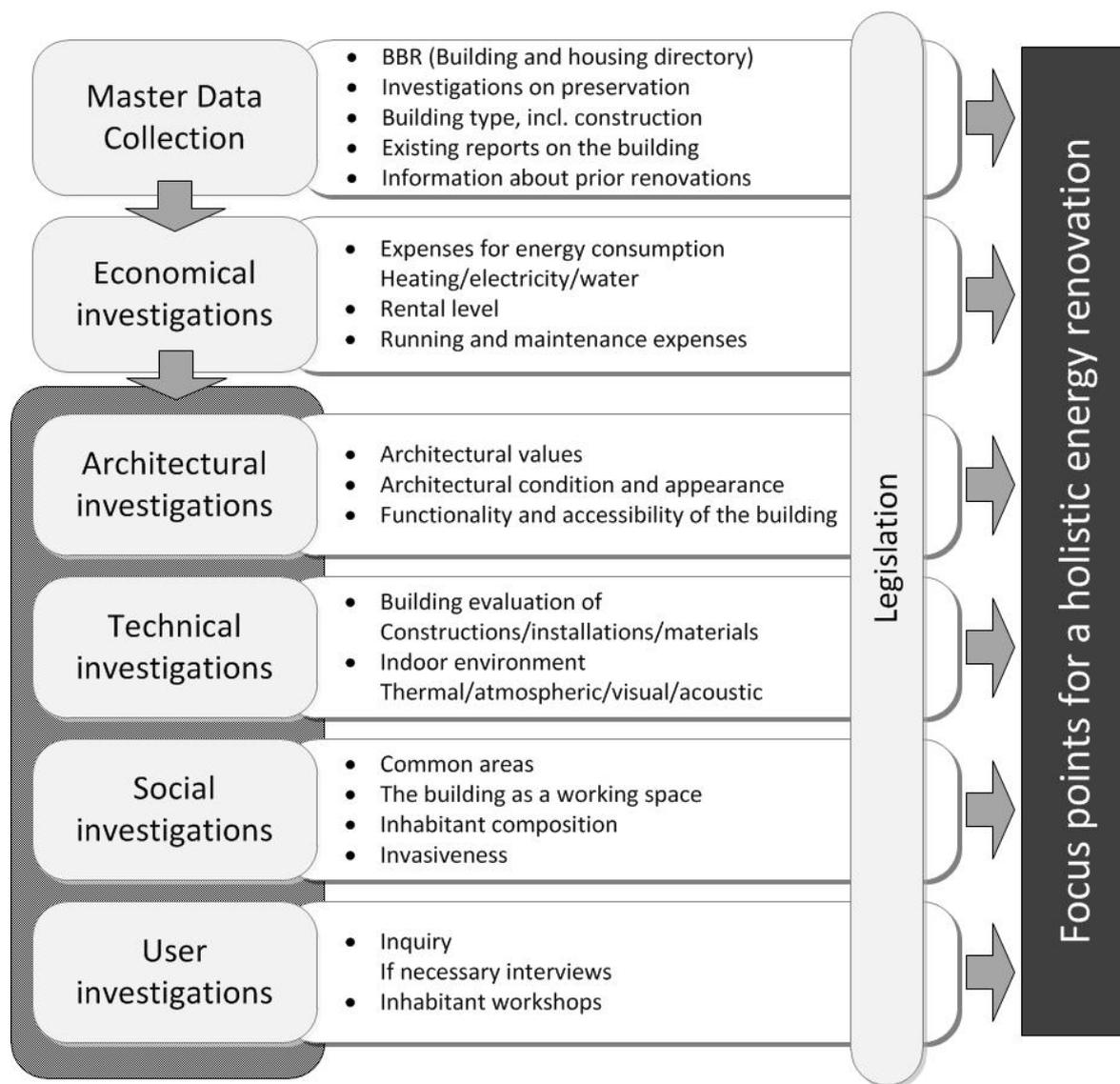


Fig. 2 Method for development and assessment of a holistic energy renovation

This method comprises six elements that span across the nine evaluation criteria in the project. Across these six elements lies the legislation that should regularly be consulted during the investigations. The arrows indicate the recommended way through the process.

Gathering master data about the potential buildings is the first step. The aim is that this element will give an overview of the building that is to be renovated, regarding its use, size, preservation and existing data. The next step is an economical investigation that will indicate the economic latitude of the building and will give an idea of the energy use in the building. Having performed these two steps, it should be assessed if a holistic energy renovation is realistic and possible, or not.

The further steps concern architectural, technical and social investigations of the buildings and have user investigations as a central element.

The architectural investigations aim to clarify the architectural value of the building, their characteristics, and how they work in their local context. This part of the method is inspired by the Danish method SAVE (Survey of Architectural Values in the Environment),

a system for mapping environmental quality and identifying buildings which are worthy of preservation.

The technical investigations aim at giving a qualified evaluation of the condition of the building. The investigations consider construction parts and the indoor environment. A part of this is inspired by already existing Danish registration checklists combined with measurements of the indoor environment.

The social investigations aim at describing the combination of inhabitants and put focus on invasiveness and the working environment for the caretaker.

The user investigations are considered very important, as they aim at giving the users of the building a possibility to inform of how the building functions in everyday life. This knowledge is investigated through questionnaires and workshops throughout the process of the project.

For every element, an investigation of relevant subjects is performed and an evaluation is given. These evaluations lead to the focus points in a holistic energy renovation. The method will not suggest specific solutions, but indicate where focus should be for the project team in the further work.

3.3 Test of method on case building

The method described in Section 3.2 has been used in the development of the main concept for the privately owned building seen in the picture below.



Fig. 3 The case building Kretahus



Fig. 4 The case building Kretahus

3.3.1 Master Data

Tab. 1 Master data for the case building Kretahus

Building Address	Grækenlandsvej 27-33, Kretavej 1-3 and Maltgade 26-34
Preservation state	Not rated as worthy of preservation
Year of construction	1935
Built area	1470 m ²
Number of apartments	136
Energy labelling	2010
Storeys (excl. roof and basement)	5
Housing area	7238 m ²
Trade area	234 m ²

3.3.2 Economic summary

The rent level in the non-refurbished apartments leaves room for an increase in rent according to the Danish rent act. The inhabitants perceive their rent level as appropriate, or even low compared to the state of the building. Furthermore no larger renovation has been performed before, which also makes it relevant to continue the investigations of the building for a future holistic energy renovation.

The energy use for heating and hot water in the building is higher than for average multi-story buildings in Denmark. Also the inhabitants perceive the energy use for heating as high.

3.3.3 Architectural summary

The balconies and the simple look of the building are typical features of the style and tradition that the building belongs to. The building mainly comprises apartments with one and two rooms. The area around the building is easy to access, but the access to the building is only via stairs. The municipality of Copenhagen has performed a SAVE evaluation of the building and found to be on average. However, it should be noticed that the environmental value (not ecological) is high.

3.3.4 Technical summary

The technical investigations show that the building is in an acceptable state; albeit that some building parts need maintenance.

The facades are massive and un-insulated. The ceiling below the attic and the floor above the basement are un-insulated. The windows are relatively new, and the doors are old and not tight. External stairs are in a bad condition. The balconies are not large enough to contain furniture. The central heating system is the original one-string system and in several apartments the radiators are placed centrally, away from the facade. Measurements of the thermal indoor climate show temperatures around 20°C. The building is naturally ventilated, with exhaust from kitchen and bathroom. Measurements of the relative humidity show large fluctuations, especially when the shower is in use and, most likely, also when the inhabitants are cooking.

3.3.5 Social summary

The composition of inhabitants in the building is characterised by the size of the apartments and there is a tenant renewal rate of around 10% per year. The courtyard area, the basement and the attic are the only common areas, and the inhabitants have specific wishes to improvements in the basement and the attic. During the assessment of the building, no circumstances indicated that the working environment should be risky.

3.3.6 User summary

Participation in the questionnaire was 19%, most age groups were represented and more than 50% of the inhabitants have lived in the building for more than six years.

The survey showed that the inhabitants find the rent level to be on average or even low, considered the condition of the apartments. The inhabitants are positive towards merging apartments, but if that will influence how long they will stay there cannot be determined.

The inhabitants find their energy use for heating to be high, they experience cold, especially in the living room and the kitchen during winter, they find that the ventilation is poor, they need more power sockets, and they wish for larger balconies.

3.3.7 Conclusion – focus points

Based on the thorough investigations done, by use of the development and assessment method some focus points for development of the renovation can be identified.

In this case it was found that especially the building envelope, the indoor environment, balconies, utilisation of the attic and apartment merging should be in focus.

3.4 User involvement

User involvement has been an important part of this project for several reasons. The users have an extended knowledge of the building in an everyday context, which can be beneficial in locating building specific problems and indicating which needs, often unspoken, the user experiences. Involving the users early and throughout the process increases the chance that the users feel ownership and responsibility for the building and the solutions introduced, which is important as the users have a big influence on how well the building performs after a renovation.

In this project the users have been involved through information meetings, inquiry surveys and workshops. The inquiry surveys, held for the end-users, were part of the evaluation method and were used to gather information about composition of the inhabitants, their perception of the indoor environment, the state of the building or amount of energy use. The results found in the survey, were compared to the results found in the other parts of the evaluation method. The workshop procedure has been different for the two case buildings, due to their different type of ownership. In one case, a privately owned building, only one workshop was held, while in the other case, a council housing, a series of workshops were facilitated by their client design advisor. The workshop series comprised four workshops and an inspiration trip to other renovations as can be seen below.

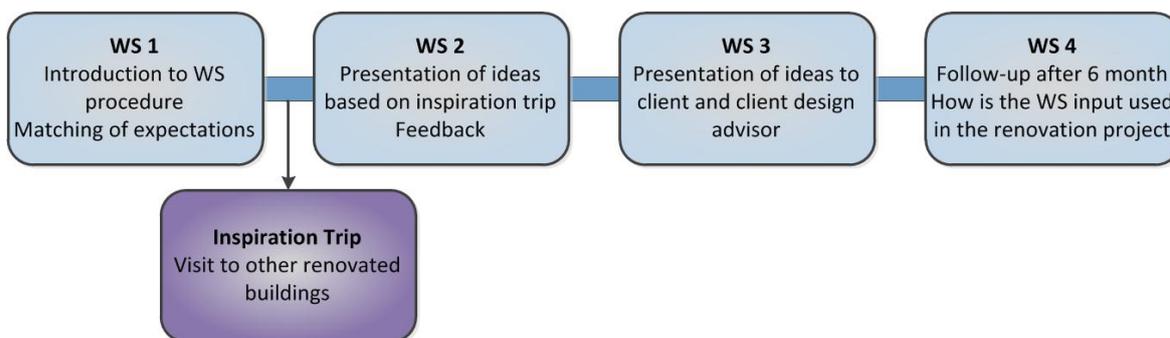


Fig. 5 Workshop procedure at case building Korngården

The users were working in smaller groups between the workshops preparing for the next workshop.

In the project there has to some extent been an agreement between the problems clarified by the users and the technical needs in the building. Furthermore the users have realised that a thorough renovation that will e.g. significantly reduce the energy consumption will influence the architecture of the building. A final evaluation of the user involvement cannot be done before the renovation has been performed.

3.5 Product development

As a part of the project, focus has also been on development of products especially for renovation. The development has been an open process where interested manufacturers were invited to be involved in the project and a great interest was detected. During the process the group of manufactures has been trimmed and now contains nine manufactures, working on both new products and merging of existing products.

The two case buildings have different challenges and needs and therefore the manufactures have been connected to the relevant building and the development of products has been facilitated through workshops and meetings.

4 Discussion

The results presented in this article are preliminary and only comprise the renovation phase until development of the main concept, thus a large part of the renovation process is still remaining.

Further one may question if this is not just another renovation project, as it has been seen several times before, just with a few additions. Since the process is not finished yet, and no final product, in the form of a building renovation, has been presented, it is difficult, at this stage, to evaluate if it will lead to more holistic energy renovations. However involvement of many stakeholders early in the renovation process has changed the approach to the renovation project itself. It is seen that in general, the nine evaluation criteria, the assessment method and the early user involvement have given a broad perspective in the design phase, which can lead to better projects, with a higher amount of expectations met.

Among the things that still remain to be seen is the use of the developed method as an assessment method, assessing the added value resulting from the renovation solutions chosen. Further an evaluation of the user involvement can first be performed when a renovation is finished. At that time it will be interesting to see if the early involvement of many stakeholders and the subsequent increase in expenses early in the project will result in more holistic projects, with a high level of ownership among the end-users and awareness of the solutions.

5 Conclusion

The preliminary project findings indicate that an early involvement of as many relevant stakeholders as possible can create ownership and involvement in the renovation process and matching of expectations as well as defining a set of criteria in the project team has given a smooth project process.

The structured form and elements considered in the developed evaluation method has given a clear outline of important areas that should be in focus during development of the main concept of a holistic energy renovation. The method still has to be tested as an assessment method though.

An implementation of the renovation proposals is needed to find out if the renovation process, as proposed in this project, will give more holistic energy renovations and eliminate dissatisfaction among stakeholders or sub-optimisation of buildings.

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