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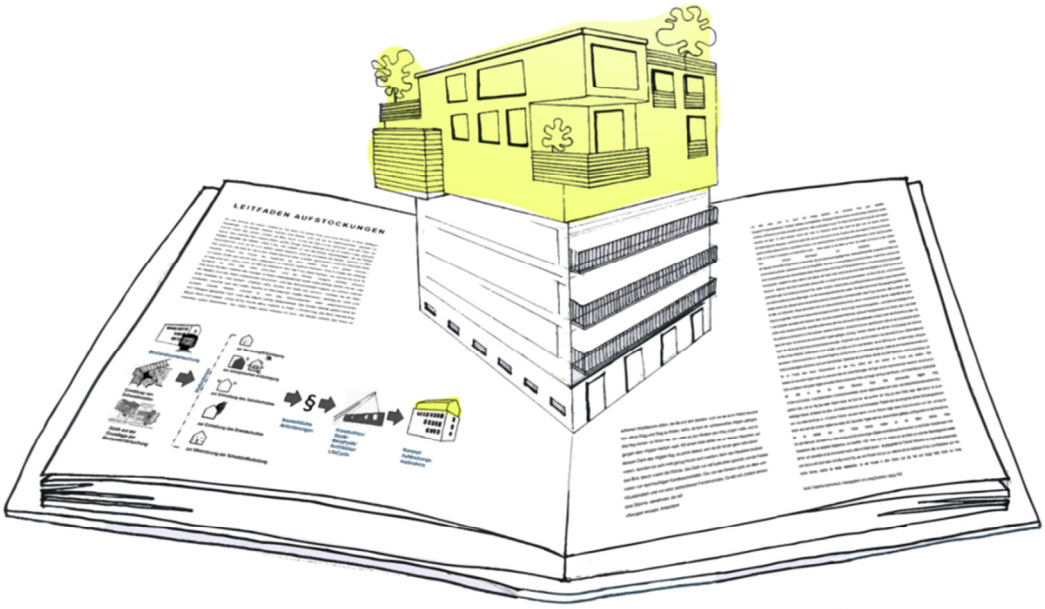
Short Report

Guideline Vertical Building Extension



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1 Starting Point and Aim

In Germany, large cities with a population of more than 500,00 and metropolitan regions are expected to grow in the coming years. As a result of this increase in the urban population, prices and rents are rising, accelerating the process of gentrification in some areas. Due to inadequate building activity in recent years, urban living space is urgently needed. Considering the demand of the German government for a reduction of the area utilization to 30 hectares per year until 2030 as well as under the aim of the reduction of greenhouse gases by triggering renovations in the existing stock, the densification of cities is of particular importance. Densification methods offer municipalities the opportunity to use existing infrastructure while at the same time increasing the number of available dwellings.

Vertical building extensions yield a potential of approximately 1.1 million low-cost apartments in areas with a high housing shortage, according to (Tichelmann et al. 2016)[1]. They would also reduce the energy demand of the existing top floor apartments by creating a heated space above their ceiling, supporting the claim of the Federal Environmental Agency for a climate-neutral building stock until 2050.

Despite the benefits, many homeowners and planners are afraid of the task of planning and executing a vertical building extension. Due to the lack of static documents or knowledge about the condition of the building, there is often a high uncertainty in planning. Previous researches have mainly focused on a separate consideration of individual challenges of sustainable urban development and focused mostly architectural, non-static or constructive concerns.

The aim of this project was to significantly increase the potential of vertical building extensions as an urban densification measure by substantially reducing the planning effort. Therefore a guideline has been developed, which includes essential indicators and parameters that are necessary for a comprehensive assessment of an existing building, in order to be able to manage the decision process and thereby reduce the planning effort.

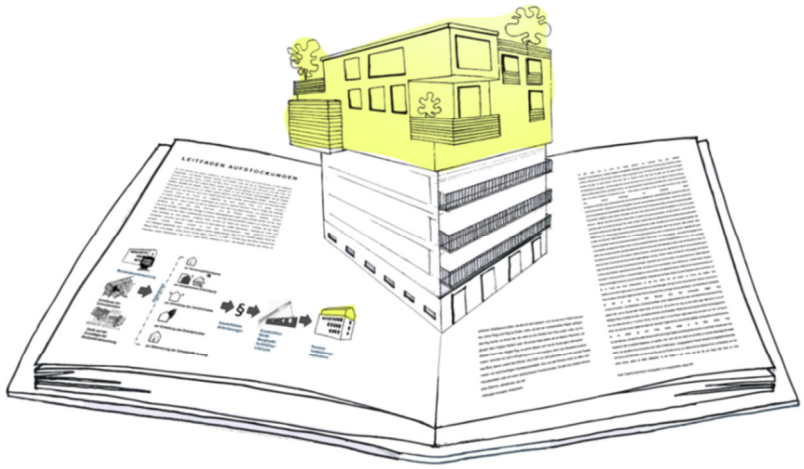

Figure 1 Concept of the guideline for vertical building extensions

Likewise the guideline serves as an orientation and decision support for planners who handle a vertical building extension for the first time. For this purpose, the guideline identifies the problems in-

[1] Tichelmann, Ulrich Karsten; Groß, Katrin; Günther, Matthias (2016): Wohnraumpotentiale durch Aufstockungen. Deutschland-Studie 2015. Hg. v. Technische Universität Darmstadt. Darmstadt.

volved in the planning process and the implementation of vertical building extensions and indicates possible solutions, like shown in Figure 2. The focus of this research project was to determine the relevant risk factors as well as evaluation principles for vertical building extensions, in order to allow every planner to assess the feasibility of a vertical building extension. The guide explains risks and problems of the individual planning steps, see also Figure 2. At the same time, it provides investigation procedures and explains possible solutions to gather all necessary information and to better estimate the risks of a vertical extension.

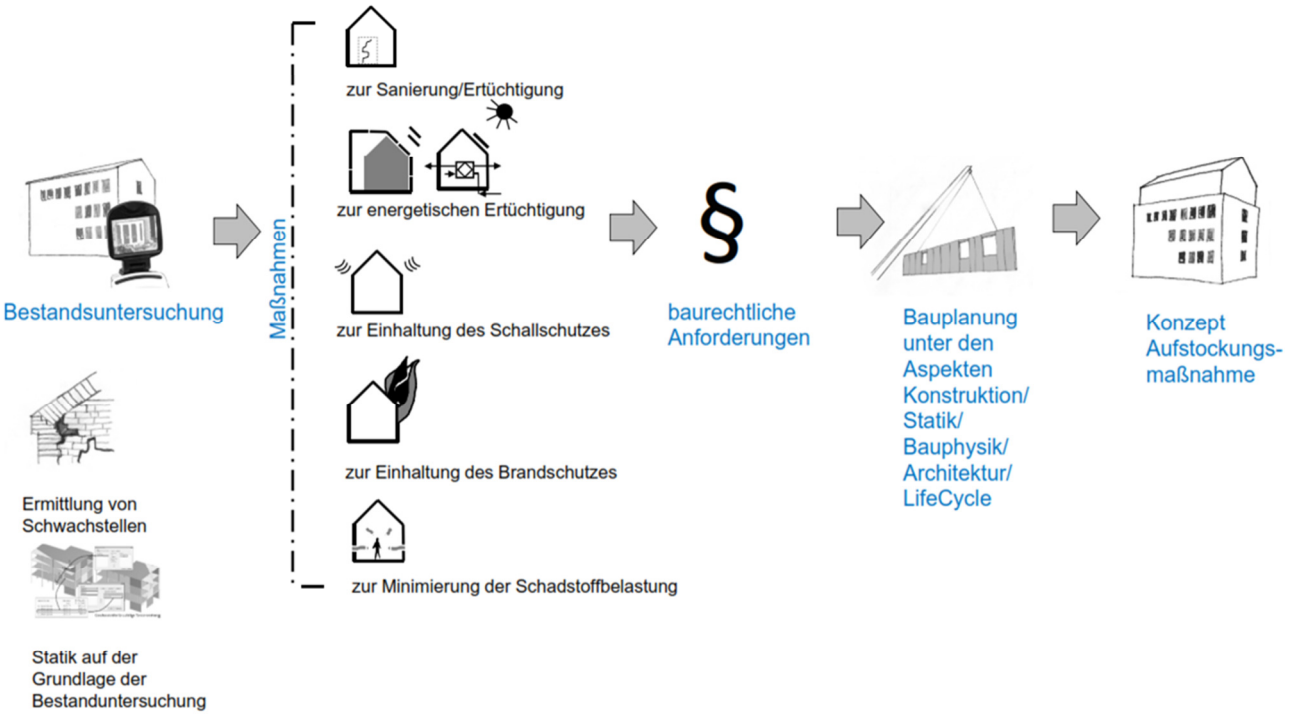

Figure 2 Planning procedure for the implementation of vertical building extension measures

2 Procedure and Results

Vertical building extensions are retrofitting actions on existing buildings. The planning process must be aligned to each building's own characteristics. Hence, this project is based on the building typology of the Institut Wohnen und Umwelt (IWU) and supplements the necessary information regarding vertical building extensions. The building typologies were classified according to their size and grouped into "Small Houses" and "Large Houses". For these groups typical constructions, defects and damages as well as building contaminants were added as important information of the building types.

Furthermore the guideline provides information on challenges along the inspection of an existing building to avoid risks as early as possible in the planning phase. Based on the building typology the guideline can be used to determine requirements and solutions in the fields structure, building law, fire protection, sustainability as well as economic feasibility and risk assessment.

Due to the fact that a vertical building extension leads to additional structural requirements to the existing structure, the inspection of the existing building is of particular importance. Additionally, it is of economic and structural advantage if the existing building is only minimally affected by destructive testing methods. Within this project the method of infrared thermography was used to identify structural weaknesses of the existing building. Using these results further examinations can

be considered specifically. For example, the suitable locations to determine the structural strength of a masonry structure can be identified.

Due to the federal system of the Bundesländer and as part of the building regulations Germany provides numerous demands a vertical building extension has to pervade. The guideline explains the regulations that have to be taken into account for a vertical extension of a building. The most important aspect to be considered in this case is fire protection, which is currently regulated separately in each Bundesland. Since a vertical building extension can lead to a change in building classes, it must be considered that not only the extension must meet these requirements, but also the existing building. This can lead to structural problems, which is why the possibility of deviations from these rules must be assessed and how these deviations can be compensated. Therefore the guideline gives further information on fire protection and on requesting deviations in a concept especially fitted to vertical building extensions.

The relevant regulations of fire protection were summarized and categorized and compared in tables for all 16 Bundesländer.

Vertical building extensions are often associated with retrofitting's and deconstructions of structures that may contain contaminants. In the typology of IWU these contaminants were not taken into account, which is why the building typology in the annex was extended according to the contaminants used in the respective building period of the existing building. The guideline gives legal conditions for the disposal of contaminants as well as instructions for sampling the existing building regarding contaminants.

In order to increase the sustainability of a vertical building extension as a densification measure in inner city areas, without additional land use, an ecological assessment in form of an LCA is carried out. It became clear that the method of life cycle assessment is not yet suitable for application in vertical building extensions. Nonetheless, some results could be obtained that indicate the required adaptions to the method in order to be able to apply it to vertical building extensions.

The results of the LCA can also be used for a profitability analysis through the determined life cycle costs. Since the guideline sets the aim to increase the cost security, the so far determined risk factors were used within such a profitability analysis, in order to be able to give stockholders economic key figures as decision guide for or against an investment.

Finally, the guideline summarizes notes for planning a vertical building extension that take into account issues encountered while reviewing various top-up projects.

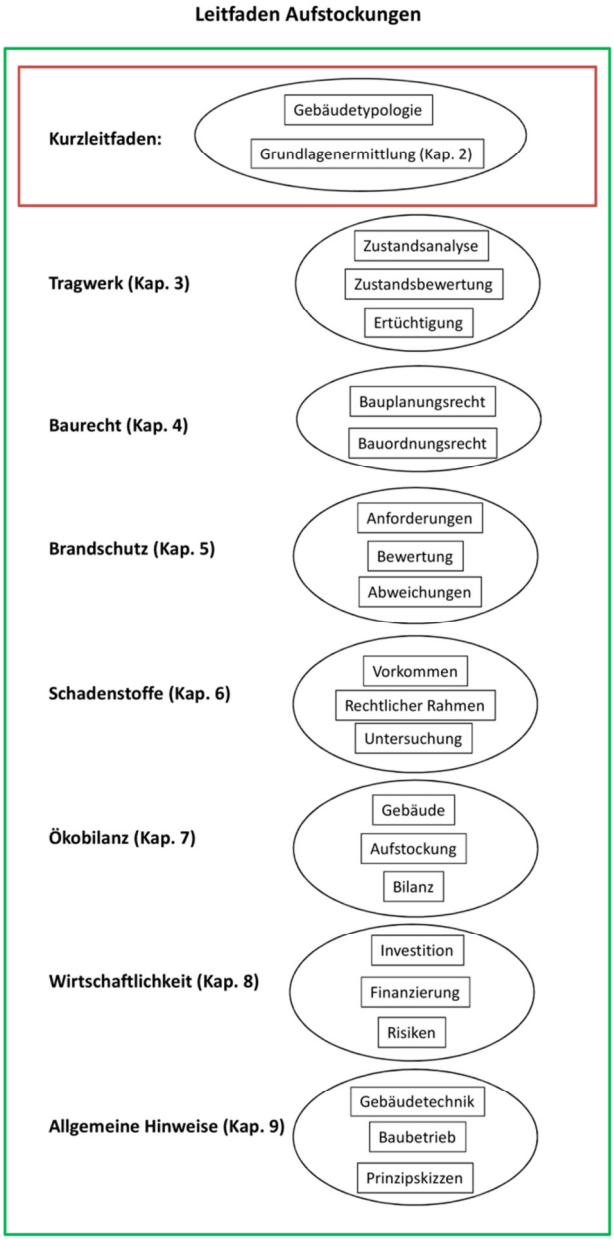

Figure 3 Summary content of the guideline for vertical building extensions

3 Conclusion

For the implementation of a vertical building extension, many parameters have to be considered within the existing building. As already explained, planners have to consider many evaluation criteria and, after a decision-making process that includes all parameters for evaluating the stock, decide for or against the measure. Figure 4 lists the evaluation parameters compiled during the project. These are greatly simplified and intended to provide a rough overview of the diversity of the planning task "vertical building extension".

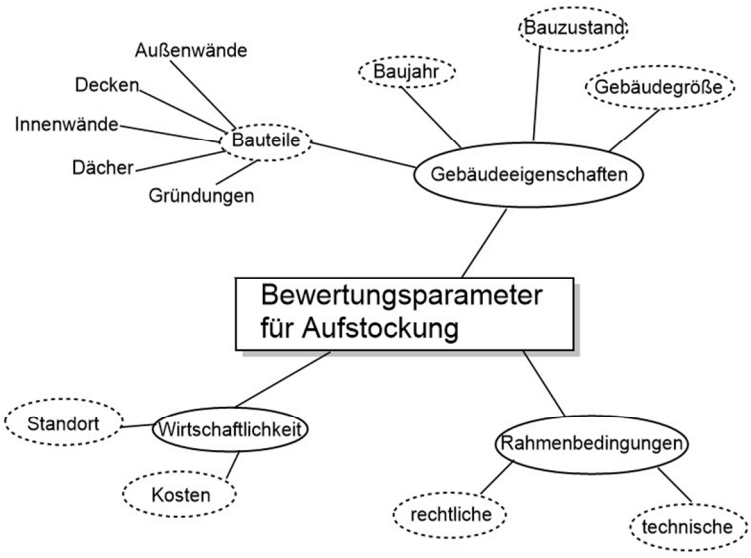

Figure 4 Determined evaluation parameters for vertical building extensions

Each vertical building extension is a special case, since the planning must be individually adapted to the respective building. Each stock brings with it different problems that have to be solved individually and attuned to the individual case. For this reason, it is not possible to give generally applicable solutions for every problem. The guideline therefore only gives suggestions and tips on how to deal with any problem that may arise during the planning.

Extensive inspection in connection with a surveyed thermographic image makes it easy to identify problematic areas in the building stock. Although the thermography also reaches its limits in some places, it is nevertheless excellently suited for the purpose of non-destructive and, as far as possible, holistic consideration of an existing building. If there is insufficiently accurate documentation for an existing building, or if plans are not consistent with the executed structure, the thermography may provide clarity. At some points, however, further investigations are urgently required, which should be supervised by an expert.

During the project, discussions with experienced project partners as well as the evaluation of questionnaires soon made clear that the planning of vertical building extensions brings a variety of problems. These issues have been summarized and addressed in the guide. In some places, however, the solutions should be investigated more detailed in further research projects.

As mentioned, the life cycle assessment method is an example for an approach that is not yet applicable to vertical building extensions. The connecting area between the extension and the stock has to be an individual solution, but further approaches should be developed, decisively considering problems with the constructive conformation of the connection. In the context of fire protection, clarification on how to deal with vertical building extensions should be provided in the future. This concerns the resulting higher fire protection requirements for the stock as a result of a change in the building class. However, it must also be determined which requirements are to be made on the extension itself and how the state building regulations in the future should deal with vertical building extensions.