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The selection of effective retrofit scenarios for panel houses in urban neighborhoods based on expected energy savings and increase in market value: The Vilnius case

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Abstract

Some of the problems associated with assessing the retrofit effectiveness of apartment buildings in urban areas are considered. The retrofit of houses should be followed by the amelioration of their surroundings. The priority order of districts to be renovated depends on the condition of the buildings in a district and on strategic urban development programmes. In order to determine the profitability of investments in housing retrofit, a number of retrofit scenarios should be developed. The authors of this paper offer a new approach to determining the retrofit effectiveness of houses based both on expected energy savings and the increase in market value of renovated buildings. In line with the proposed approach, retrofit scenarios for apartment buildings in Vilnius were developed, i.e. retrofit investment packages for various districts were prepared and arranged in the priority order for their application according to the method of geographical analysis suggested by the authors.

Keywords: Large-panel buildings; Energy savings; Increase in market value; Method of geographical analysis; Investment packages; Retrofit scenarios; Vilnius case

1. Introduction

Most European countries have succeeded in reducing energy consumption of new dwellings by more than 50% without increasing their building cost, and therefore, energy efficiency has achieved great acceptance among building owners [3]. These buildings represent about 20% of the building stock but consume only 5% of energy. Concentration on improving the energetically poor building stock has great potential. The lack of interest in housing retrofit can be explained by the fact that economic interest in a building expires after 30 years.

When the problems involved in housing retrofit, especially the solutions aimed at energy conservation, are considered, the increased market value of renovated buildings is not always taken into account. The experience has shown that reconstruction of local heating units as well as the renovation and regulation of heating systems are effective measures of saving energy. However, insulation of walls, replacement of windows, renovation of roofs, etc., which also help save energy, are not so economically effective because of large investments needed (they are usually repaid only in more than 20 years) [17]. The benefits of retrofit are often considered in terms of reduced thermal energy costs. However, retrofitting also improves the condition of all building elements as well as prolonging the lifetime of a building. It makes possible a considerable reduction in building maintenance costs and investments in the repair and replacement of worn-out elements, which would be inevitable in the future. By ignoring these significant factors, the above approach makes it difficult to prove the need for a more extensive renovation intended to improve the condition, energy conservation, and architectural and aesthetic appearance of a building (when trying to get the required loan). The order of priorities in implementing retrofit scenarios of apartment buildings in particular urban neighborhoods is determined by strategic urban development programs and the current condition of the buildings and the environment in a district.

2. The criteria used in rating retrofit scenarios

The critical criterion when examining and proposing any of the alternative management schemes is the sustainable

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development of society [13]. Coherent and efficient retrofit scenarios are commonly based on a building's state of degradation and its obsolescence. An advanced method, based on multicriteria analysis, also helps design effective retrofit scenarios [5]. Before a decision is made to proceed with any project of building retrofit, a brief but reliable report is needed describing the current state of the building and estimating the cost of building operations to be performed [4]. The developed methodology and software apply to specific refurbishment work and cost assessment of building renovation needs with respect to energy conservation and improvement of the indoor environment.

Several methods were proposed for rating buildings or retrofit scenarios based on criteria including thermal energy consumption for heating, availability of cooling and other appliances, retrofit impact on the environment, indoor climate, and costs [21].

The potential for energy conservation in apartment buildings was investigated following the EPIQR methodology and several scenarios were evaluated for various apartment buildings [1]. Energy savings in each building were accounted for in order to identify the most effective scenarios.

According to [30], design and realization of effective building retrofit scenario requires an exhaustive study of all solutions involving planimetric and volumetric changes, the elimination of the deteriorated and obsolete elements of a building, the improvement of its architectural and aesthetic appearance and indoor amenities, etc. The effectiveness of the building retrofit under consideration depends on many factors, including costs, annual fuel savings, when the retrofit is completed, the tentative payback period, harm to human health caused by the materials used, aesthetics, maintenance, functionality, comfort, sound reduction, longevity of structures, etc.

In general, housing renovation policy aims to:

1. Reduce energy consumption by 50%, and thus to improve the environmental value.
2. Increase the market value of dwellings.
3. Improve the condition of buildings and prolong their lifetime (for about 30–40 years) as well as preserve housing resources.
4. Raise the level of comfort in apartment blocks.
5. Avoid maintenance expenses and investments in buildings which would otherwise be needed in the future.
6. Improve the architectural appearance of the facades of apartment houses as well as harmonize them with the environment.
7. Make residential areas more attractive to their residents; improve the residential quality of a building.
8. Attract more middle-class residents to these areas.

When apartment buildings do not meet the residents' needs, the question arises of whether they should be renovated or demolished. A consensus is growing that it is easier and less expensive to slow down building deterioration by investing in proper maintenance and, thereby, prolonging its service life before reconstruction. To compare reconstruction to renovation in mathematical terms, the following formula [20] was proposed:

$$C \geq R + M\left(\frac{1-(1+i)^{-n}}{i}\right) + \frac{C}{(1+i)^{n}} \quad (1)$$

where C is the cost of new construction, R the cost of renovation, M denotes the savings in annual maintenance costs in the case of new construction, n the expected prolonged service life (in years) of the renovated building, and i is the interest rate per year. The right-hand side of this formula is the sum of the renovation costs plus the current value of higher maintenance cost and the discounted current value of the new construction which might be delayed by n years. This basic formula has several logical flaws. Some researchers believe that the value of the existing building should also be added to the renovation cost. Others argue the opposite, namely, that reconstruction should bear as an extra cost the waste of demolishing a valuable (though old and ill-functioning) existing building, while the renovation option utilizes the existing value of the old building and just adds to it.

Deciding between renovation and demolition can be made easier by the use of criteria for assessing the value of preserving a building. Not only technical building requirements but also, above all, the economic and ecological advisability of comprehensive renovation measures as compared to demolition of a building and construction of a new one or to its fundamental redevelopment must be examined more closely [19]. Once a decision to retrofit has been made, questions must usually be answered about the extent to which retrofitting measures are necessary and the extent to which one must and/or can retrofit the building structure and its technical systems. The speed and security of the return on one's investment is becoming increasingly important for property managers and owners as a criterion for their decision, in particular with respect to the nature and extent of retrofit.

In order to achieve the goals of an optimal retrofit strategy, it is essential that any given capital investment be directed to the most cost-effective group of energy-saving measures. This can be achieved by ranking the measures in order of decreasing savings—to investment ratio (SIR), where [6]

$$\mathrm{SIR} = \frac{\text{current value of the total lifetime energy saving}}{\text{investment cost}} \quad (2)$$

If a measure has a SIR greater than 1, the predicted savings exceed the investment, and the measure can be regarded as cost-effective. The higher the SIR, the larger the return on the investment. To calculate the SIR, the current value of the total energy saved must be found. Finding this value requires the discounting of all future savings to their equivalent current value, using the following equation:

$$\mathrm{PV_c} = C\left[\frac{1-(1+r)^{-n}}{r}\right] \quad (3)$$

This gives the current value, $\mathrm{PV_c}$, for an annual saving C, occurring for n number of years (lifetime of measure), with a real discount rate of r.